Dear Liebe Group Members and Supporters,

It is with great pleasure that we present to you the Liebe Group Local Research and Development results book for 2016. This book contains results from research and development conducted in the Coorow, Dalwallinu, Perenjori and Wongan-Ballidu shires from the 2015 season. The book also outlines current Liebe Group projects to keep you updated with the interesting work that is going on in the district. Due to unavoidable circumstances, there are some results that are not available at the time of printing; these will be published in subsequent Liebe Group newsletters.

Many thanks must go to the researchers, agribusiness organisations and growers who have cooperated to conduct valuable local research and development. We thank you for the opportunity to present these results in our 2016 book.

Also we would like to remind you that many trial results will be reviewed at the **2016 Trials Review Day on Tuesday 16th February** at the Dalwallinu Bowling Club and the **2016 Liebe Group Crop Updates on Wednesday 2nd March** at the Dalwallinu Recreation Centre**.** We invite you to bring this book along to these days so you can follow the trials and ask questions regarding any results you may have found interesting. The annual **AGM** will be held after the Trials Review Day on **Tuesday 16th February**, members interested in becoming more involved in the direction and workings of Liebe Group are encouraged to join one of our many committees.

Please interpret the results in this book carefully. Decisions should not be based on one season of data. Please contact the Liebe office if you have any further queries.

All of our partners and supporters play a vital role in ensuring the continued success of the Liebe Group. We acknowledge the invaluable support we receive from the Grains Research and Development Corporation (GRDC), the Department of Agriculture and Food, WA (DAFWA), Australian Government Department of Agriculture, Rabobank, CSBP, RSM, CBH Group, the Farm Weekly, the Grower Group Alliance, our gold and silver sponsors and many others.

All the best for the 2016 season and let's hope it brings plenty of rain!

Kind regards,

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LIEBE GROUP SUPPORTERS

The Liebe Group would like to thank the following organisations for their invaluable support:

- Grains Research and Development Corporation (GRDC)
- Department of Agriculture and Food, WA (DAFWA)
- Australian Government Department of Agriculture
- Curtin University
- The University of Western Australia
- CSIRO
- Farm Weekly
- Shire of Dalwallinu
- Grower Group Alliance
- Northern Agricultural Catchments Council
- Wheatbelt NRM

LONG TERM RESEARCH SITE SUPPORTERS

The Liebe Group would like to acknowledge and thank all the sponsors and contributors to the Long Term Research Site for 2015. Without the generous support and assistance from supporters and contributors the management of this unique site would not be possible.

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LIEBE GROUP COMMITTEES

The Liebe Group would like to recognise the support and contribution of the Liebe Group Management, Finance, Women's, Research & Development and Long-Term Research committees to the work outlined in this publication.

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Local Research & Development Results – February 2016

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Understanding Trial Results and 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.

The LSD test

To determine if there is a significant difference between two or more treatments a least significant difference (LSD) is often used. If there is a significant difference between two treatments their difference will be greater than the LSD. For example when comparing the yield of five wheat varieties (Table 1), the difference in yield between variety 4 and 5 is greater than 0.6 t/ha (LSD), therefore it can be said there is a significant difference. This means it 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 difference 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)
Variety1	2.1^{a}
Variety2	2.2^{a}
Variety3	2.0^{a}
Variety4	2.9^{b}
Variety5	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 variation. 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 result (e.g. soil type), and if the same trial was repeated 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 a 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 a 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.

Cereal Research Results

Wheat National Variety Trial - Ballidu

Mitchell Redpath, Research Agronomist, Kalyx Australia

Key Messages

- The top yielding varieties in this trial were Cobalt, Scepter, Buchanan, Magenta, Hydra, Mace, Cutlass, Cosmick and Zen (1.59 t/ha average for top 9 varieties).
- The season was punctuated by two extended dry periods, one in June and July and another through September and October. The first limited tillering as plants aborted tillers and the second resulted in limited grain fill; these effects impacted on yield and reduced the differences in yield between varieties.
- Variety performance was determined by developmental stage during these dry periods and the ability of varieties to cope with the stress and recover when rain fell.
- Grower decisions on variety replacement or retention should not be based solely on 2015 NVT data, but should include consideration of relative variety performance across locations, long term yield predictions and local farmer knowledge.

Background

The National Variety Trial (NVT) program is a national program of comparative crop variety testing with standardised trial management, data generation, collection and dissemination. The program is supported by the Australian Government and growers through the GRDC and is managed by the Australian Crop Accreditation System Limited (ACAS). The NVT aims to generate independent information to growers about newly released crop varieties. The NVT system has been developed to complement the plant breeding programs.

The trials are distributed across WA and all major state cropping regions within Australia. Site selection is as even as possible across the main soil types and rainfall zones and where possible the trials are located with active grower groups to provide a focal point for grower group research sites. The trials are sown and harvested as close to or before district grower practice to ensure variety performance is similar to that seen by growers on their farms. The varieties in the trials are either currently available to growers or will soon have commercial release to market and will be benchmarked against district standards and quality check varieties.

Trial Details

Property	Ardoch, east Ballidu		
Plot size & replication	1.76m x 12m x 3 replications		
Soil type	Sandy loam		
Soil pH ($CaCl_2$)	0-10cm: 5.5	10-20cm: 5.5	20-30cm: 4.8
EC (dS/m)	0-10cm: 0.203	10-20cm: 0.072	20-30cm: 0.060
Seeding date	25/05/2015		
Seeding rate	75 kg/ha		
Paddock rotation	2012 pasture, 2013 wheat, 2014 canola		
Fertiliser	25/05/2015: 50 kg/ha urea, 100 kg/ha Gusto Gold		
Herbicides	23/05/2014: 2 L/ha Roundup, 2 L/ha Trifluralin, 118 g/ha Sakura, 0.5 L/ha Chlorpyrifos 23/06/2015: 0.025 kg/ha Monza, 0.75% Hasten 08/07/2015: 0.3 L/ha Axial, 0.5% Adigor, 1 L/ha Velocity 24/07/2015: 0.15 L/ha Prosaro, 1% Hasten		
Growing season rainfall	243mm		

Variety Descriptions

Bremer

- 3-5 days later maturing than Mace, suited to south coastal WA

- Excellent rust resistance
- AH classification

Buchanan

- Mid-late season, grown in QLD and NSW
- Developed for Asian markets
- APH classification

Cobra

- High yielding mid to long season variety developed for Western Australia
- AH classification in Western Australia
- Excellent Yellow Spot resistance

Corack

- Early maturing Wyalkatchem type with improved vigour
- High relative yield performance in low and medium rainfall zones

Cosmick

- Early-mid maturity, developed for SA and VIC
- Good yellow spot resistance, moderate stripe and stem rust resistance
- AH classification

Cutlass

- Mid-late maturing, similar maturity to Yitpi
- Excellent rust resistance, better yellow spot resistance than Yitpi
- APW classification

Emu Rock

- High yielding, short season
- AH wheat with large grain size

Fortune

- Premium udon noodle quality
- High yielding – similar to Calingiri
- Maturity similar to Calingiri

Harper

- Ideally suited to early to mid-sowing opportunities
- APW classification with Australian Hard potential

Hydra

- Mid-short season maturity
- Outstanding yellow spot resistance, excellent rust package
- APW classification

Impress CL Plus

- Mid-short season maturity, best performance observed in northern WA
- Clearfield® Plus technology, registered for use with Intervix®
- Good yellow spot resistance
- APW classification

Justica CL Plus

- Adapted to the mid to high yield potential areas
- Excellent sprouting tolerance

- Well suited to acid soils

Mace
- Highest yielding bread wheat variety in WA
- Broad adaptation, with AH quality classification

Magenta
- Long season
- High yielding
- Excellent yellow spot resistance
- APW classification

Scepter
- Early-mid maturity, slightly later than Mace
- Mace replacement, improved rust resistance over Mace, similar yellow spot resistance
- AH classification

Scout
- A high yielding variety suited to the medium to higher rainfall areas
- Medium to longer season maturity similar to Carnamah
- Contains the CSIRO Transpiration Efficiency gene, which confers improved water use efficiency
- Very good grain quality

Supreme
- Mid-short season, udon noodle variety
- Robust rust package, useful yellow spot resistance
- ANW classification

Trojan
- Mid-long season maturity, ideally suited to the medium to higher rainfall areas
- APW classification

Wedin
- Triple rust resistant high yielding soft wheat
- Classified as Australian Soft Superior rust package (Stem Rust R-MR, Stripe Rust MR-MS, Leaf Rust R)
- Longer maturity (not as long as Jitarning)
- Good grain size and hectolitre weight

Zen
- Mid-long season maturity, udon noodle variety
- Calingiri alternative
- Robust disease package, good yellow spot resistance
- ANW classification

Results

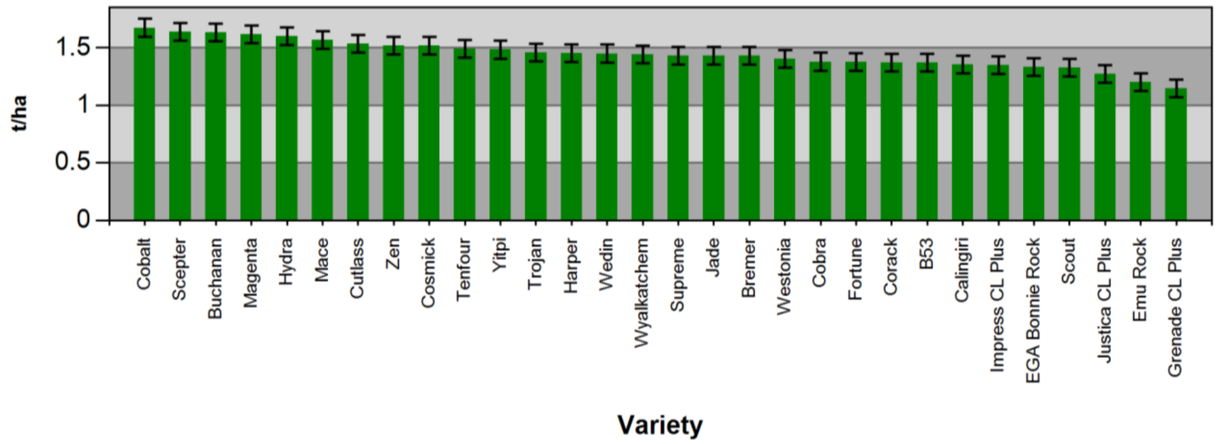

Figure 1: Yield comparison of wheat varieties sown at east Ballidu, 2015.

Table 1: Pre-harvest measurements, east Ballidu 2015.

	17/06/2015		24/09/2015	
Variety	**Early Growth Score 1=Poor, 9=Excellent**	**Establishment 0=None, 9=Max**	**Tillering Score 1=Low, 9=High**	**Zadoks Score**
B53	8	9	3.3	63
Bremer	8	9	4.0	61
Buchanan	8	8	4.0	62
Calingiri	8	9	4.0	58
Cobalt	8	9	3.0	65
Cobra	8	9	3.0	64
Corack	8	9	3.0	64
Cosmick	8	8	4.0	62
Cutlass	8	9	4.0	55
EGA Bonnie Rock	8	9	3.0	63
Emu Rock	8	9	2.0	67
Fortune	9	9	4.0	58
Grenade CL Plus	8	9	3.0	65
Harper	8	9	4.0	58
Hydra	8	9	4.3	64
Impress CL Plus	8	7	2.7	64
Jade	8	9	2.3	62
Justica CL Plus	8	9	4.0	60
Mace	9	9	5.0	64
Magenta	8	9	6.0	61
Scepter	8	9	4.0	61
Scout	8	9	4.0	63
Supreme	9	8	3.3	63
Tenfour	7	8	3.3	65
Trojan	8	9	4.0	60
Wedin	8	8	3.3	58
Westonia	9	9	4.0	66
Wyalkatchem	8	8	3.3	62
Yitpi	8	9	4.0	55
Zen	9	9	4.0	57

Table 2: Wheat yield analysis and receival standards, east Ballidu 2015.

Variety	Yield		Hectolitre Weight	Protein	Screenings (<2.0mm sieve)
	(t/ha)	Site Mean (%)	(kg/hL)	(%)	(%)
Cobalt	1.67	114	79.8	8.8	3.55
Scepter	1.64	112	78.8	7.9	3.70
Buchanan	1.63	111	80.2	8.5	0.87
Magenta	1.62	110	79.2	8.5	2.60
Hydra	1.60	109	78.0	8.4	5.87
Mace	1.57	107	80.0	8.7	2.21
Cutlass	1.53	105	78.0	8.7	4.04
Cosmick	1.52	103	78.8	8.6	7.38
Zen	1.52	104	78.4	8.4	0.87
Tenfour	1.49	102	79.2	8.3	4.83
Yitpi	1.48	101	78.2	8.7	6.22
Trojan	1.46	99	78.8	8.3	3.84
Harper	1.45	99	78.4	8.5	5.63
Wedin	1.45	99	75.6	8.9	1.89
Wyalkatchem	1.44	98	79.8	9.0	2.37
Bremer	1.43	97	79.4	8.7	2.57
Jade	1.43	98	76.0	9.0	7.91
Supreme	1.43	98	79.4	8.7	3.79
Westonia	1.40	96	77.4	9.0	4.44
Cobra	1.38	94	77.8	8.9	2.92
B53	1.37	94	78.4	9.1	3.66
Corack	1.37	94	80.6	9.3	2.13
Fortune	1.37	94	77.2	8.8	4.36
Calingiri	1.36	92	79.2	9.1	2.27
Impress CL Plus	1.35	92	77.8	9.4	3.38
EGA Bonnie Rock	1.33	91	79.8	9.8	2.02
Scout	1.33	90	78.2	8.4	3.02
Justica CL Plus	1.27	87	75.6	9.2	3.28
Emu Rock	1.20	82	79.6	9.5	7.58
Grenade CL Plus	1.15	78	76.6	8.9	2.55
Site Mean (t/ha)	*1.47*				
CV (%)	*6*				
P value	*<0.001*				
LSD (t/ha)	*0.15*	*10*			

Comments

This trial was sown on the 25th May into a friable seed bed with adequate soil moisture, following 9mm rainfall received 14 days prior to sowing. A further 4mm of rain fell in the 7 days after sowing, resulting in good establishment and early vigour. Overall rainfall for June, July and August was above average, 200mm rainfall compared to the long term average of 160mm. However, the majority fell in two large rainfall events with an extended dry period between these falls in July. September and October were also very dry with only 4.2mm rainfall over this period, which limited grain fill.

In the Ballidu region, it would be typical for wheat to be flowering at the end of August and into the beginning of September. The Zadoks score ratings were conducted on the 24th of September and found that most varieties were in flower at that time, indicating that the trial matured more slowly than would have been expected.

There were no significant differences in yield between the top 9 yielding varieties of Cobalt, Scepter, Buchanan, Magenta, Hydra, Mace, Cutlass, Cosmick and Zen. These varieties were of various maturity lengths indicating that variety maturity was not an overriding factor in this trial. Variety ranking was more likely determined by developmental stage during the dry spell and the capacity to cope with the stresses of the season. Tillering was limited by the dry spell in July and this did result in some varietal differences displayed in Table 1. The top yielding varieties were all above the site average for tillering score and these varieties were able to capitalise on the late July rainfall.

Cobalt, bred by Edstar Genetics, was the highest yielding variety at this site and performed well in WA NVT trials in 2015, but has a current feed classification. Scepter is a new AH variety developed by Australian Grains Technologies (AGT) as a Mace replacement. Scepter flowers approximately two days later than Mace and was higher yielding than Mace in AGT trials in WA. However, this is the first year it has been evaluated independently in NVT trials and there was no significant yield difference between the two varieties in this trial. Hydra is an APW classified wheat developed by InterGrain. It is a derivative of Bonnie Rock and Strzelecki, which provides genetic diversity with no Mace or Wyalkatchem in its background. It has a maturity length similar to that of Mace and has performed similarly to Mace in NVT trials.

Impress CL Plus is a two-gene imidazolinone (IMI) tolerant wheat, developed by InterGrain, with an APW classification in WA. It was not one of the top performing varieties in this trial, but does provide a yield advantage in comparison to other IMI-tolerant varieties in this trial, which is consistent with long term NVT results. Buchanan, developed by Austgrains Pty Ltd, is a variety which is heavily grown in Queensland and NSW. It has been entered into the NVT program in WA and has performed well in 2015. Zen is a noodle wheat, developed by InterGrain as a Calingiri replacement. It has a Calingiri and Wyalkatchem background and offers a yield advantage over Calingiri, which can be seen in this trial and is consistent with long term NVT results. It also offers an improved disease package when compared to Calingiri, with better leaf rust and yellow leaf spot resistance.

Overall, the site produced grain with low protein levels, with no variety having achieved levels high enough to receive AH or APW classification if delivered to CBH. Screenings were not high given the tight finish to the season. This result was most likely due to a combination of reduced tillering and increased root growth to access moisture and nutrients earlier in the season.

Acknowledgements
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Wheat National Variety Trial - Buntine

Australian Crop Accreditation System Limited

Aim

To evaluate yield and quality of new and existing wheat varieties.

Background

The wheat National Variety Testing (NVT) is part of a multi crop evaluation program funded by the GRDC and is designed to evaluate wheat varieties entering the market that have gone through selection and evaluation within the various national breeding programs. The NVT wheat trials are just one source of information on which growers can base management decisions on retention release or adoption of new varieties. Growers must use more than one information source when making significant management decisions in relation to wheat varieties.

Trial Details

Property	Niribi Farm, Buntine	
Plot size & replication	10m x 2.2m x 3 replications	
Soil type	Loam	
Soil pH ($CaCl_2$)	0-10: 6.2	10-60: 4.7
EC (dS/m)	0-10: 0.1	10-60: 0.0
Sowing date	23/05/2015	
Seeding rate	75 kg/ha	
Paddock rotation	2014 canola	
Fertiliser	23/05/2015: 80 kg/ha Gusto Gold, 50 kg/ha urea	
Herbicides, Insecticides & Fungicides	23/05/2015: 2 L/ha Glyphosate, 2 L/ha Trifluralin, 0.12 kg/ha Pyroxasulfone, 0.3 L/ha Chlorpyrifos, 0.35 L/ha 2,4-D Ester 08/07/2015: 1 L/ha Bromoxynil & Pyrasulfotole, 0.12 kg/ha Clopyralid as K salt, 0.5 L/ha LVE MCPA, 0.4 L/ha Alpha-cypermethrin, 0.3 L/ha Cloquintocet-Mexyl & pinoxaden, 1 L/ha Esters of Canola oil 704 27/07/2015: 0.7 L/ha Esters of Canola oil, 0.15 L/ha Prothioconazole & Tebuconazole 02/09/2015: 0.6 L/ha Esters of Canola oil, 1 L/ha Bromoxynil & Pyrasulfotole	
Growing season rainfall	264mm	

Results

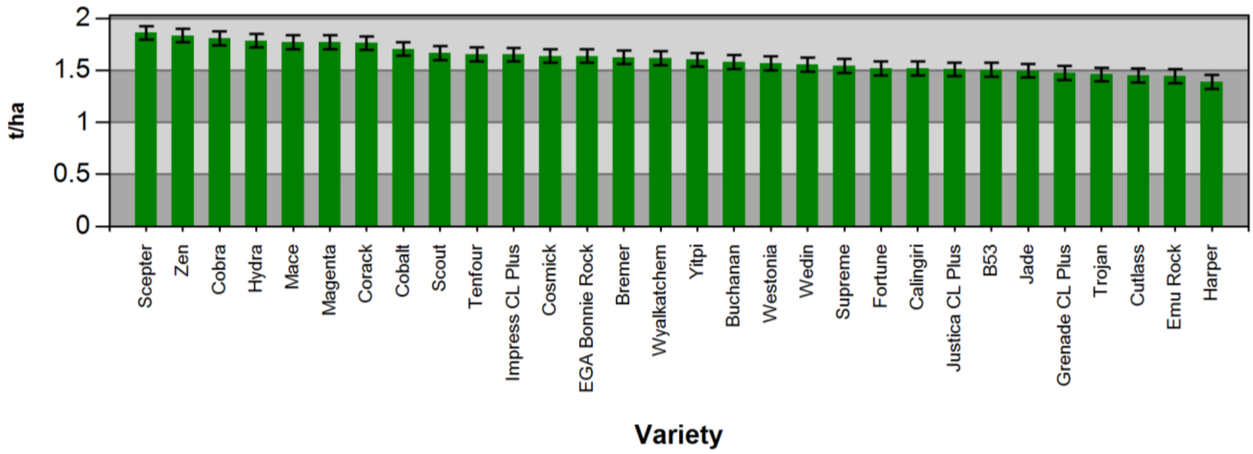

Figure 1: Yield comparison of wheat varieties sown at Buntine, 2015.

Table 1: Yield and quality results for wheat grown at Buntine, 2015.

Variety	Yield (t/ha)	Site Mean (%)	Hectolitre Weight (kg/hL)	Protein (%)	Screenings (%)
Scepter	1.86	112	78.0	9.0	1.85
Zen	1.84	110	77.6	9.4	0.46
Cobra	1.81	109	76.6	9.6	0.81
Hydra	1.79	107	76.8	9.4	1.61
Mace	1.77	106	77.2	9.1	0.46
Magenta	1.77	106	77.2	9.2	2.82
Corack	1.76	106	77.0	9.1	0.39
Cobalt	1.71	103	76.0	9.1	1.13
Scout	1.67	100	77.6	8.5	0.76
Tenfour	1.66	99	76.2	8.6	2.54
Impress CL Plus	1.65	99	78.0	10.0	0.26
Cosmick	1.64	98	76.2	9.1	4.04
EGA Bonnie Rock	1.64	98	78.0	9.2	3.2
Bremer	1.63	98	76.4	9.8	1.00
Wyalkatchem	1.62	97	77.4	9.3	0.7
Yitpi	1.60	96	77.8	9.8	0.53
Buchanan	1.58	95	76.0	9.2	2.73
Westonia	1.57	94	75.4	9.7	0.14
Wedin	1.56	93	71.8	9.9	2.56
Supreme	1.55	93	77.4	9.1	1.17
Fortune	1.52	91	74.4	9.8	1.73
Calingiri	1.52	91	77.8	9.7	1.89
Justica CL Plus	1.51	91	74.4	9.8	1.57
B53	1.51	90	77.2	9.8	3.26
Jade	1.50	90	74.4	9.8	4.42
Grenade CL Plus	1.48	89	76.2	9.4	0.91
Trojan	1.46	88	77.4	9.3	3.08
Cutlass	1.45	87	75.0	9.3	2.42
Emu Rock	1.44	87	75.4	10.0	3.66
Harper	1.39	84	76.6	9.5	3.20
Site Mean (t/ha)	*1.67*				
CV (%)	*4.33*				
P value	*<0.001*				
LSD (t/ha)	*0.13*	*8*			

Comments

For more information please refer to www.nvtonline.com.au

Wheat National Variety Trial - Cadoux

Australian Crop Accreditation System Limited

Aim

To evaluate yield and quality of new and existing wheat varieties.

Background

The wheat National Variety Testing (NVT) is part of a multi crop evaluation program funded by the GRDC and is designed to evaluate wheat varieties entering the market that have gone through selection and evaluation within the various national breeding programs. The NVT wheat trials are just one source of information on which growers can base management decisions on retention release or adoption of new varieties. Growers must use more than one information source when making significant management decisions in relation to wheat varieties.

Trial Details

Property	Mike Kalajzic, Cadoux
Plot size & replication	10m x 2.4m x 3 replications
Soil type	Sandy loam
Soil pH ($CaCl_2$)	0-10cm: 4.8 10-60cm: 4.7
EC (dS/m)	0-10cm: 0.2 10-60cm: 0.1
Sowing date	13/05/2015
Seeding rate	75 kg/ha
Paddock rotation	2013 wheat, 2014 canola
Fertiliser	13/05/2015: 100 kg/ha Gusto Gold, 50 kg/ha urea
Herbicides, Insecticides & Fungicides	13/05/2015: 2 L/ha Paraquat & Diquat, 2 L/ha Trifluralin, 0.5 L/ha Chlorpyrifos 30/06/2015: 0.12 kg/ha Clopyralid as K salt, 1 L/ha Bromoxynil & Pyrasulfotole, 1 L/ha Esters of Canola oil 08/07/2015: 0.3 L/ha Cloquintocet-Mexyl & Pinoxaden, 0.25 L/ha Esters of Canola oil, 06/08/2015: 0.15 L/ha Prothioconazole & Tebuconazole, 1 L/ha Esters of Canola oil
Growing season rainfall	267mm

Results

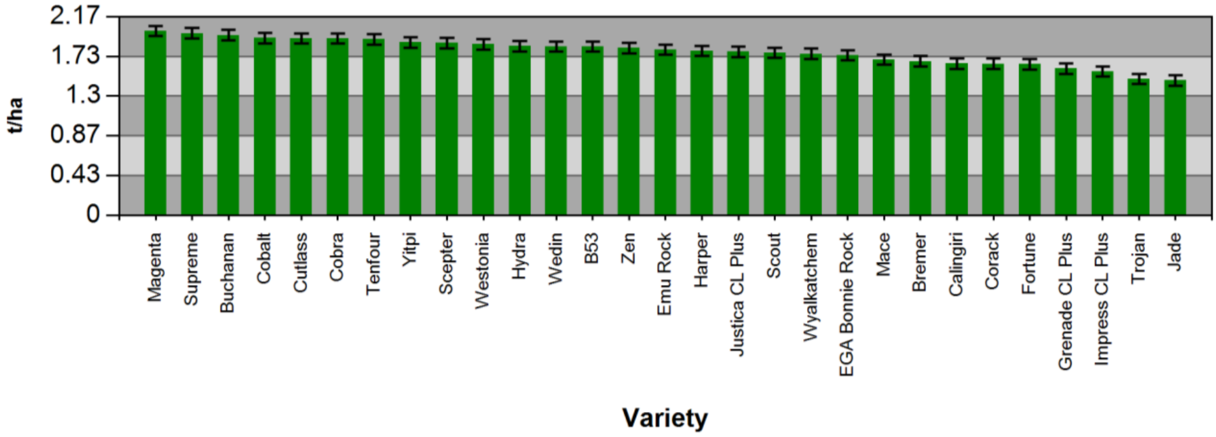

Figure 1: Yield comparison for wheat varieties sown at Cadoux, 2015.

Table 1: Yield and quality results of wheat varieties grown at Cadoux, 2015.

Variety	Yield (t/ha)	Site Mean (%)	Hectolitre Weight (kg/hL)	Protein (%)	Screenings (%)
Magenta	2.01	112	79.2	8.9	3.59
Supreme	1.99	110	79.8	8.3	2.39
Buchanan	1.97	109	78.0	8.3	0.74
Cobalt	1.93	107	78.6	8.4	0.77
Cutlass	1.93	107	77.4	8.2	0.51
Cobra	1.93	107	76.2	8.5	0.42
Tenfour	1.92	107	78.0	8.4	4.23
Yitpi	1.89	105	75.4	8.1	3.50
Scepter	1.88	104	78.2	8.5	2.20
Westonia	1.87	104	77.0	8.5	2.39
Hydra	1.84	102	78.6	8.9	0.99
Wedin	1.84	102	75.6	8.7	0.99
B53	1.84	102	80.4	8.9	0.88
Zen	1.82	101	77.8	8.9	1.83
Emu Rock	1.81	100	79.2	8.8	3.79
Harper	1.79	99	77.8	8.5	0.24
Justica CL Plus	1.78	99	75.8	9.2	0.55
Scout	1.77	99	79.4	8.7	2.37
Wyalkatchem	1.76	98	76.8	8.8	2.22
EGA Bonnie Rock	1.75	97	79.6	9.3	0.56
Mace	1.70	94	77.0	9.0	0.97
Bremer	1.68	93	78.2	9.1	0.58
Calingiri	1.65	92	77.2	9.2	0.99
Corack	1.65	92	60.4	9.5	0.97
Fortune	1.65	91	76.6	8.9	2.13
Grenade CL Plus	1.60	89	77.0	8.9	1.09
Impress CL Plus	1.57	87	77.6	9.6	4.38
Trojan	1.49	83	77.2	8.1	2.69
Jade	1.47	82	76.4	9.3	3.76
Site Mean (t/ha)	*1.80*				
CV (%)	*3.56*				
P value	*<0.001*				
LSD (t/ha)	*0.11*	*6*			

Comments

For more information please refer to www.nvtonline.com.au

Wheat National Variety Trial - Carnamah

Australian Crop Accreditation System Limited

Aim

To evaluate yield and quality of new and existing wheat varieties.

Background

The wheat National Variety Testing (NVT) is part of a multi crop evaluation program funded by the GRDC and is designed to evaluate wheat varieties entering the market that have gone through selection and evaluation within the various national breeding programs. The NVT wheat trials are just one source of information on which growers can base management decisions on retention release or adoption of new varieties. Growers must use more than one information source when making significant management decisions in relation to wheat varieties.

Trial Details

Property	Scott Walton, Carnamah
Plot size & replication	12m x 1.76m x 3 replications
Soil type	Loam clay
Soil pH ($CaCl_2$)	0-10cm: 5.3 10-60: 5.6
EC (dS/m)	0-10cm: 0.1 10-60: 0.1
Sowing date	13/05/2015
Seeding rate	75 kg/ha
Paddock rotation	2013 fallow, 2014 fallow
Fertiliser	13/05/2015: 100 kg/ha Gusto Gold, 50 kg/ha urea 27/08/2015: 30 L/ha Flexi-N
Herbicides, Insecticides & Fungicides	13/05/2015: 1 L/ha Chlorpyrifos, 2 L/ha Trifluralin, 3 L/ha Glyphosate, 0.12 kg/ha Pyroxasulfone 03/07/2015: 1 L/ha Bromoxynil & Pyrasulfotole, 0.3 L/ha Clopyralid, 0.15 L/ha Prothioconazole & Tebuconazole, 0.5 L/ha LVE MCPA, 0.4 L/ha Alpha-cypermethrin, 2.4 L/ha Esters of Canola oil, 27/08/2015: 0.29 L/ha Tebuconazole
Growing season rainfall	236mm

Results

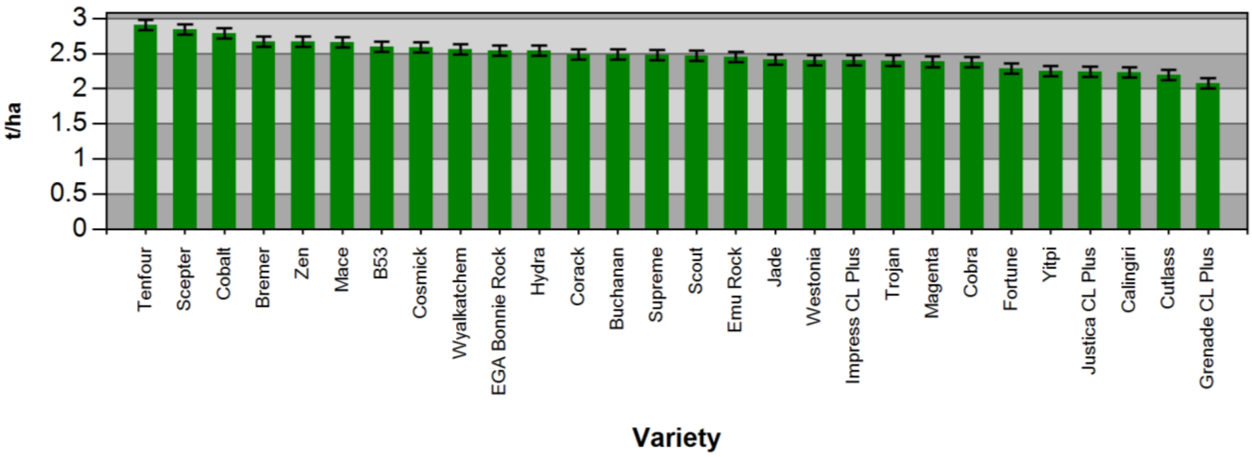

Figure 1: Yield comparison for wheat varieties sown at Carnamah, 2015.

Table 1: Yield and grain quality data for wheat varieties grown at Carnamah, 2015.

Variety	Yield (t/ha)	Site Mean (%)	Hectolitre Weight (kg/hL)	Protein (%)	Screenings (%)
Tenfour	2.91	115	75.6	10.9	3.37
Scepter	2.85	112	75.6	10.7	2.34
Cobalt	2.79	110	76.8	11.1	0.59
Bremer	2.67	106	74.8	11.4	2.14
Zen	2.67	106	74.4	11.3	0.98
Mace	2.66	105	76.6	10.9	0.38
B53	2.60	103	77.2	11.1	1.05
Cosmick	2.59	102	74.0	11.0	5.39
Wyalkatchem	2.56	101	74.8	11.0	1.24
EGA Bonnie Rock	2.55	101	77.6	11.3	3.50
Hydra	2.54	100	73.6	11.0	6.32
Corack	2.49	98	72.4	11.6	1.73
Buchanan	2.49	98	75.6	11.7	1.60
Supreme	2.48	98	75.4	11.5	3.14
Scout	2.47	98	74.2	10.7	1.95
Emu Rock	2.45	97	74.2	12.0	1.96
Jade	2.42	96	73.6	12.2	1.00
Westonia	2.41	95	73.4	12.1	1.10
Impress CL Plus	2.40	95	71.6	11.5	2.14
Trojan	2.40	95	72.8	11.5	1.59
Magenta	2.38	94	73.8	11.4	0.49
Cobra	2.38	94	72.6	11.0	0.44
Fortune	2.29	90	71.0	11.5	1.34
Yitpi	2.25	89	71.0	11.7	2.67
Justica CL Plus	2.24	89	73.0	11.9	0.19
Calingiri	2.24	88	73.4	11.7	4.58
Cutlass	2.20	87	71.8	12.0	2.85
Grenade CL Plus	2.08	82	73.2	12.6	0.24
Site Mean (t/ha)	*2.53*				
CV (%)	*3.32*				
P value	*<0.001*				
LSD (t/ha)	*0.15*	*6*			

Comments

For more information please refer to www.nvtonline.com.au

Wheat National Variety Trial - Coorow

Australian Crop Accreditation System Limited

Aim

To evaluate yield and quality of new and existing wheat varieties.

Background

The wheat National Variety Testing (NVT) is part of a multi crop evaluation program funded by the GRDC and is designed to evaluate wheat varieties entering the market that have gone through selection and evaluation within the various national breeding programs. The NVT wheat trials are just one source of information on which growers can base management decisions on retention release or adoption of new varieties. Growers must use more than one information source when making significant management decisions in relation to wheat varieties.

Trial Details

Property	Mike Bothe, Coorow
Plot size & replication	12m x 1.76m x 3 replications
Soil type	Sand, sandy loam
Soil pH ($CaCl_2$)	0-10cm: 5.6 10-60: 4.6
EC (dS/m)	0-10cm: 0.041 10-60: 0.029
Sowing date	13/05/2015
Seeding rate	75 kg/ha
Paddock rotation	2013 canola, 2014 fallow
Fertiliser	13/05/2015: 100 kg/ha Gusto Gold, 50 kg/ha urea
Herbicides, Insecticides & Fungicides	13/05/2015: 1 L/ha Chlorpyrifos, 2 L/ha Paraquat & Diquat, 0.12 kg/ha Pyroxasulfone, 1 L/ha Trifluralin 03/07/2015: 1 L/ha Bromoxynil & Pyrasulfotole, 0.3 L/ha Clopyralid, 0.15 L/ha Prothioconazole & Tebuconazole, 0.5 L/ha LVE MCPA, 0.4 L/ha Alpha-cypermethrin, 0.8 L/ha Esters of Canola oil, 0.3 L/ha Prothioconazole & Tebuconazole
Growing season rainfall	262mm

Results

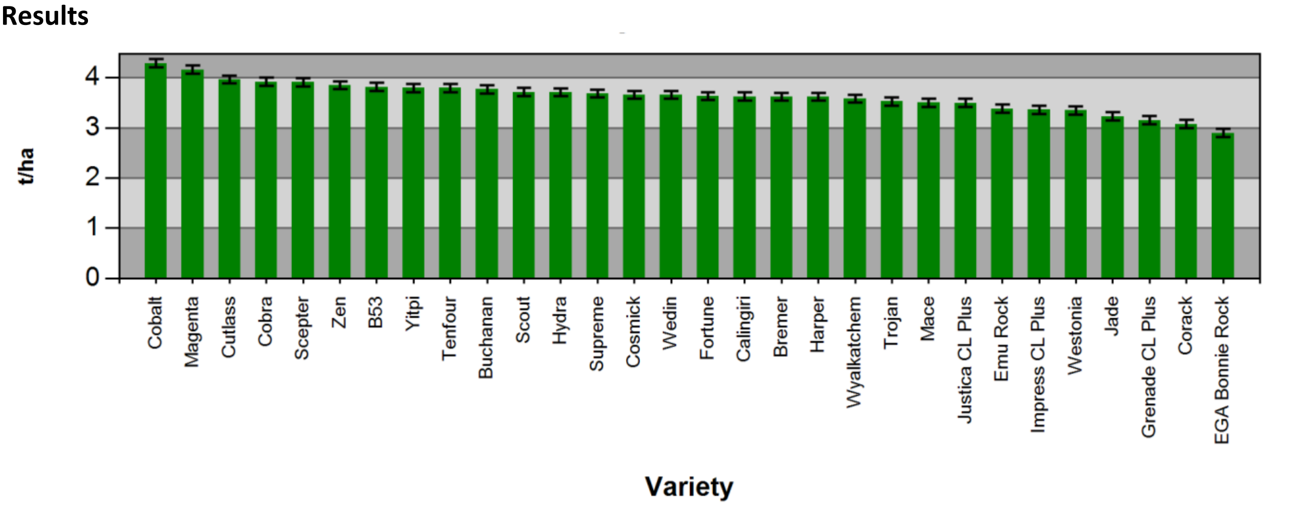

Figure 1: Yield comparison for wheat varieties sown at Coorow, 2015.

Table 1: Yield and grain quality data for wheat varieties grown at Coorow, 2015.

Variety Name	Yield (t/ha)	Site Mean (%)	Hectolitre Weight (kg/hL)	Protein (%)	Screenings (%)
Cobalt	4.29	117	79.8	11.4	1.25
Magenta	4.16	114	78.0	11.4	2.42
Cutlass	3.96	108	77.8	10.7	1.87
Cobra	3.92	107	78.8	11.6	1.90
Scepter	3.91	107	79.6	11.0	0.64
Zen	3.85	105	79.2	9.80	0.28
B53	3.81	104	80.0	10.8	2.74
Yitpi	3.79	104	78.8	11.5	1.93
Tenfour	3.79	104	78.4	11.4	2.11
Buchanan	3.77	103	77.6	12.8	0.92
Scout	3.71	101	79.8	11.1	1.42
Hydra	3.71	101	80.0	11.5	4.66
Supreme	3.68	101	78.6	11.3	1.34
Cosmick	3.66	100	79.0	11.7	3.10
Wedin	3.66	100	75.4	11.0	1.19
Fortune	3.63	99	76.6	12.5	0.69
Calingiri	3.63	99	78.6	11.5	2.29
Bremer	3.62	99	78.2	12.0	1.91
Harper	3.62	99	78.0	11.2	4.02
Wyalkatchem	3.58	98	78.4	11.8	0.85
Trojan	3.53	96	78.0	10.7	2.06
Mace	3.50	96	79.4	11.8	1.89
Justica CL Plus	3.50	96	75.0	12.1	1.66
Emu Rock	3.38	93	80.4	12.6	1.63
Impress CL Plus	3.36	92	78.0	12.6	0.85
Westonia	3.35	92	76.8	11.9	2.06
Jade	3.23	88	76.2	12.0	3.63
Grenade CL Plus	3.15	86	77.2	11.6	1.24
Corack	3.07	84	78.6	13.2	0.47
EGA Bonnie Rock	2.90	79	80.8	12.6	2.41
Site Mean (t/ha)	*3.66*				
CV (%)	*2.5*				
P value	*<0.001*				
LSD (t/ha)	*0.16*	*4*			

Comments

For more information please refer to www.nvtonline.com.au

Wheat National Variety Trial - Miling

Australian Crop Accreditation System Limited

Aim

To evaluate yield and quality of new and existing wheat varieties.

Background

The wheat National Variety Testing (NVT) is part of a multi crop evaluation program funded by the GRDC and is designed to evaluate wheat varieties entering the market that have gone through selection and evaluation within the various national breeding programs. The NVT wheat trials are just one source of information on which growers can base management decisions on retention release or adoption of new varieties. Growers must use more than one information source when making significant management decisions in relation to wheat varieties.

Trial Details

Property	Christian Lefroy, Miling
Plot size & replication	10m x 2.4m x replications
Soil type	Sandy loam
Soil pH ($CaCl_2$)	0-10cm: 5.3 10-60cm: 6.0
EC (dS/m)	0-10cm: 0.117 10-60cm: 0.047
Sowing date	12/05/2015
Seeding rate	75 kg/ha
Paddock rotation	2012 wheat, 2013 pasture, 2014 canola
Fertiliser	12/05/2015: 100 kg/ha Gusto Gold, 50 kg/ha urea
Herbicides, Insecticides & Fungicides	09/05/2015: 2 L/ha Paraquat & Diquat, 2 L/ha Trifluralin, 0.5 L/ha Chlorpyrifos, 18/06/2015: 1 L/ha Bromoxynil & Pyrasulfotole, 0.12 kg/ha Clopyralid as K, 0.7 L/ha Esters of Canola oil 02/07/2015: 0.5 L/ha Cloquintocet-Mexyl & Pinoxaden, 1 L/ha Bromoxynil & Pyrasulfotole, 0.3 L/ha Clopyralid, 0.3 L/ha Alpha-cypermethrin, 1 L/ha Esters of Canola oil 13/08/2015: 0.5 L/ha Esters of Canola oil, 0.3 L/ha Alpha-cypermethrin , 0.15 L/ha Prothioconazole & Tebuconazole
Growing season rainfall	250mm

Results

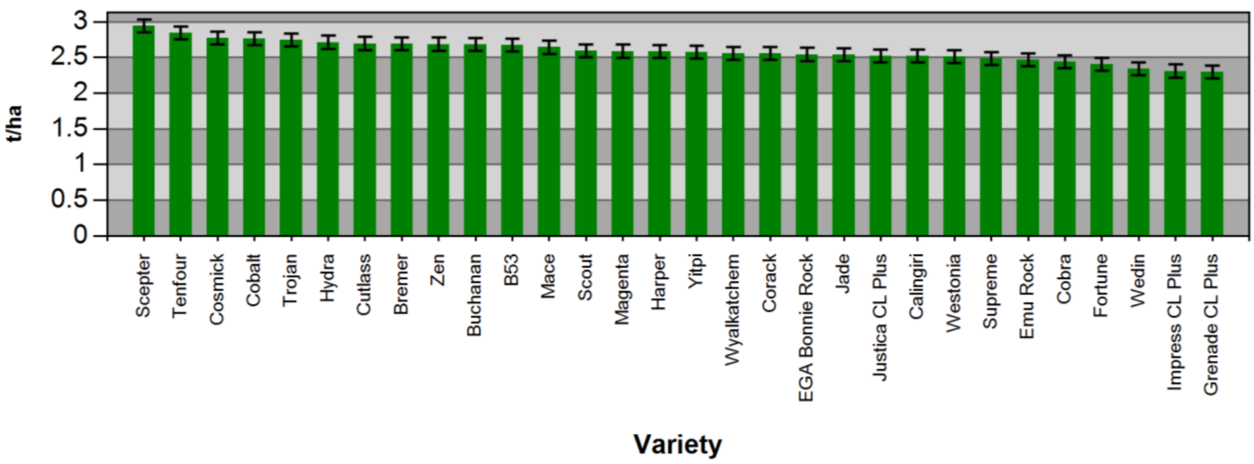

Figure 1: Yield comparison of wheat varieties sown at Miling, 2015.

Table 1: Yield and grain quality data for wheat varieties grown at Miling, 2015.

Variety	Yield (t/ha)	Site Mean (%)	Hectolitre Weight (kg/hL)	Protein (%)	Screenings (%)
Scepter	2.94	112	78.0	8.6	2.82
Tenfour	2.85	109	77.6	8.2	3.57
Cosmick	2.77	106	78.6	8.7	4.45
Cobalt	2.76	106	79.0	8.3	2.23
Trojan	2.75	105	76.0	8.2	2.46
Hydra	2.71	104	78.2	9.0	3.35
Cutlass	2.70	103	76.8	8.6	1.56
Bremer	2.69	103	79.0	8.6	2.39
Zen	2.69	103	77.2	8.6	2.04
Buchanan	2.68	103	81.6	8.3	3.44
B53	2.67	102	79.6	8.7	3.10
Mace	2.64	101	76.6	9.2	2.86
Scout	2.59	99	78.6	8.8	2.47
Magenta	2.59	99	77.2	8.7	3.03
Harper	2.58	99	72.6	9.4	3.17
Yitpi	2.57	98	73.8	9.3	4.61
Wyalkatchem	2.56	98	77.6	9.4	1.47
Corack	2.55	98	78.8	9.8	1.94
EGA Bonnie Rock	2.54	97	80.4	9.0	2.44
Jade	2.54	97	75.0	9.8	5.95
Justica CL Plus	2.52	96	74.8	9.3	1.89
Calingiri	2.52	96	78.4	8.9	2.61
Westonia	2.51	96	76.2	9.2	2.78
Supreme	2.48	95	76.6	9.3	1.36
Emu Rock	2.47	94	76.8	9.4	3.54
Cobra	2.44	93	74.2	9.8	1.63
Fortune	2.40	92	75.4	9.4	1.29
Wedin	2.34	89	72.4	9.4	3.68
Impress CL Plus	2.31	88	75.2	10	4.04
Grenade CL Plus	2.29	88	75.0	9.6	1.96
Site Mean (t/ha)	*2.62*				
CV (%)	*4.01*				
P value	*<0.001*				
LSD (t/ha)	*0.18*	*7*			

Comments

For more information please refer to www.nvtonline.com.au

Wheat National Variety Trial - Pithara

Australian Crop Accreditation System Limited

Aim

To evaluate yield and quality of new and existing wheat varieties.

Background

The wheat National Variety Testing (NVT) is part of a multi crop evaluation program funded by the GRDC and is designed to evaluate wheat varieties entering the market that have gone through selection and evaluation within the various national breeding programs. The NVT wheat trials are just one source of information on which growers can base management decisions on retention release or adoption of new varieties. Growers must use more than one information source when making significant management decisions in relation to wheat varieties.

Trial Details

Property	O.J. Butcher and Son, Pithara
Plot size & replication	10m x 2.4m x 3 replications
Soil type	Loam clay
Soil pH ($CaCl_2$)	0-10cm: 5.2 10-60cm: 6.0
EC (dS/m)	0-10cm: 0.400 10-60cm: 0.333
Sowing date	07/05/2015
Seeding rate	75 kg/ha
Paddock rotation	2013 wheat, 2014 wheat
Fertiliser	07/05/2015: 100 kg/ha Gusto Gold, 50 kg/ha urea
Herbicides, Insecticides & Fungicides	08/05/2015: 1.5 L/ha Glyphosate, 0.5 L/ha Chlorpyrifos, 2 L/ha Trifluralin 06/07/2015: 1 L/ha Bromoxynil & Pyrasulfotole, 0.3 L/ha Clopyralid, 0.15 L/ha Prothioconazole & Tebuconazole, 0.5 L/ha LVE MCPA, 0.4 L/ha Alpha-cypermethrin, 0.8 L/ha Esters of Canola oil 12/08/2015: 0.8 L/ha Propiconazole & Tebuconazole
Growing season rainfall	271mm

Results

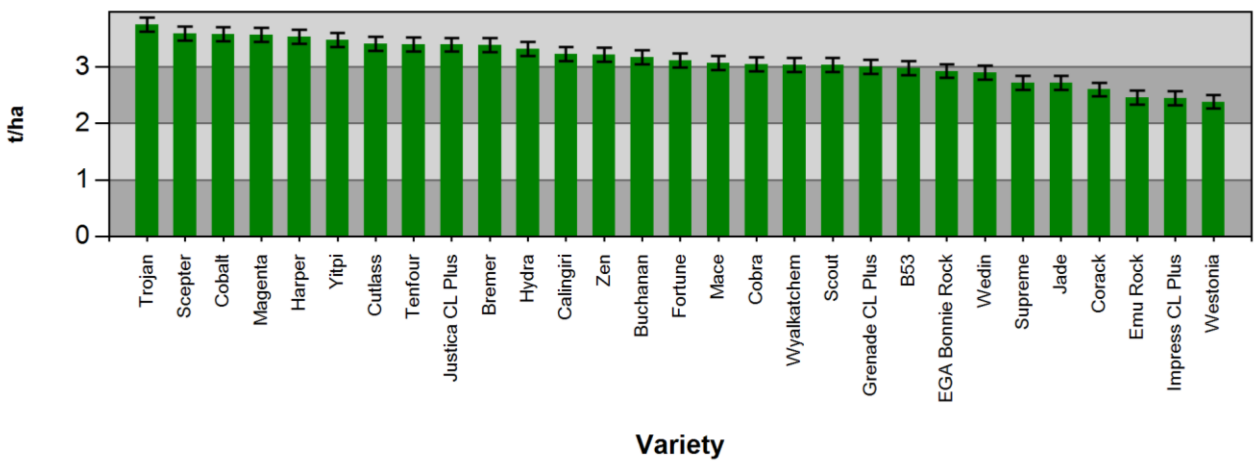

Figure 1: Yield comparison of wheat varieties sown at Pithara, 2015.

Table 1: Yield and grain quality data for wheat varieties grown at Pithara, 2015.

Variety	Yield (t/ha)	Site Mean (%)	Hectolitre Weight (kg/hL)	Protein (%)	Screenings (%)
Trojan	3.75	123	78.4	10.4	2.23
Scepter	3.59	118	79.2	10.3	1.79
Cobalt	3.59	118	80.6	10.4	1.32
Magenta	3.57	117	77.4	10.7	2.19
Harper	3.53	116	77.8	11.0	3.49
Yitpi	3.48	114	76.2	11.0	3.51
Cutlass	3.42	112	77.0	10.9	1.25
Tenfour	3.40	112	79.0	10.7	2.49
Justica CL Plus	3.40	111	77.0	11.4	1.80
Bremer	3.40	111	79.8	11.2	0.94
Hydra	3.33	109	78.8	11.0	2.86
Calingiri	3.23	106	78.4	10.9	1.08
Zen	3.22	106	77.6	11.1	1.43
Buchanan	3.17	104	77.0	10.5	2.55
Fortune	3.12	102	77.2	11.5	1.43
Mace	3.08	101	77.8	11.5	0.68
Cobra	3.05	100	76.8	11.7	2.15
Wyalkatchem	3.04	100	78.4	11.5	1.17
Scout	3.04	100	79.2	10.8	1.76
Grenade CL Plus	3.00	98	78.4	11.0	1.63
B53	2.98	98	79.8	10.7	2.78
EGA Bonnie Rock	2.93	96	77.6	12.3	4.02
Wedin	2.90	95	73.6	10.5	1.75
Supreme	2.73	89	79.2	11.2	1.92
Jade	2.72	89	75.2	11.2	3.20
Corack	2.60	85	79.0	12.3	1.19
Emu Rock	2.46	81	77.4	13.3	1.72
Impress CL Plus	2.44	80	76.6	13.5	0.96
Westonia	2.38	78	77.2	12.4	0.51
Site Mean (t/ha)	*3.05*				
CV (%)	*4.98*				
P value	*<0.001*				
LSD (t/ha)	*0.25*	*8*			

Comments

For more information please refer to www.nvtonline.com.au

Practice for Profit Trial

Lilly Martin, Research and Extension Agronomist, Liebe Group

Australian Government

Key Messages

- Higher rainfall in 2015 allowed the crop to capitalise on extra nutrient availability with the top three treatments (canola, wheat and field pea) under a high input rotation.
- Low input on continuous wheat rotation is returning the highest gross margin in this scenario.

Aim

To examine the difference in profitability between low and high input cropping practices over an extended period of time and to determine the effect these practices are having on soil carbon.

Background

The Practice for Profit trial is for the fifth season in a row, located on the Mills' property east of Dalwallinu. Since 2011 we have compared the following two scenarios:

- **Low input** treatments based on a farmer producing grain at the lowest possible cost, regardless of seasonal conditions.
- **High input** treatments to simulate a paddock with high yield potential matched with increased inputs to maximise yields and profitability.

2011 was the setup phase of the trial, the seeding and fertiliser rates were not blanket dependant on the rotation with the wheat treatment receiving high and low inputs, (Appendix B).

In 2013 the set rotation was not able to be planted due to a timing mismatch between rain and trial contractors resulting in the soil being too dry for the small trial seeding machinery to negotiate. The whole site was thus fallowed in 2013.

It is important to note that high and low inputs of this trial are considered on a seasonal basis, and on the back of a chemical fallow in 2013 all nutrient levels were high. On the trial to date the low input treatments have received maintenance levels of phosphorus (P) and nitrogen (N). The levels of P, potassium (K) and sulphur (S) will be monitored for the 2016 season and maintenance levels will be adjusted accordingly.

Trial Details

Property	Wenballa Farm, east Dalwallinu
Plot size & replication	8.8m x 12m x 3 replications
Soil type	Loamy clay
Soil pH ($CaCl_2$)	0-10cm: 5.7 10-20cm: 7.1 20-40cm: 7.5
EC (dS/m)	0-10cm: 0.107
Sowing date	08/05/2015
Seeding rate	See Table 2
Paddock rotation	See Table 1
Fertiliser	See Table 2
Herbicides, Fungicides & Insecticides	08/05/2015: 1.5 L/ha Glyphosate, 500 mL/ha Chlorpyrifos, 2 L/ha Trifluralin 29/07/2015: 150 mL/ha Prosaro, 400 mL/ha Alpha-cypermethrin, 300 mL/ha Lontrel, 1% Hasten 04/09/2015: 1 L/ha Velocity, 1% Hasten
Growing season rainfall	2015: 236mm, 2014: 187mm, 2013: fallow, 2012: 321mm, 2011: 232.8mm

Trial Layout

Table 1: Practice for Profit trial, rotation history and 2016 plan.

Treatment	2011	2012	2013	2014	2015	2016	Input Level
1	Wheat	Wheat	Fallow	Wheat	Wheat	Wheat	Low
2	Wheat	Wheat	Fallow	Wheat	Wheat	Wheat	High
3	Canola	Wheat	Fallow	Wheat	Wheat	Canola	Low
4	Canola	Wheat	Fallow	Wheat	Wheat	Canola	High
5	Volunteer Pasture (Spraytopped)	Wheat	Fallow	Wheat	Wheat	Volunteer Pasture	Low
6	Volunteer Pasture (Spraytopped)	Wheat	Fallow	Wheat	Wheat	Volunteer Pasture	High
7	Field Peas	Wheat	Fallow	Wheat	Wheat	Field Peas	Low
8	Field Peas	Wheat	Fallow	Wheat	Wheat	Field Peas	High

Note: Stated input levels are for all treatment years, except rotation crops in 2011 and 2016 (Appendix B).

Table 2: 2015 Practice for Profit input rates.

Treatment	Variety	Input	Sowing rate (kg/ha)	K – Till Banded (kg/ha)	Urea *TD IBS (kg/ha)	UAN 4 WA-S (L/ha)	2011 Rotation
1	Mace	Low	30	40	40	0	Wheat low
2	Mace	High	80	80	40	44	Wheat high
3	Mace	Low	30	40	40	0	Canola
4	Mace	High	80	80	40	44	Canola
5	Mace	Low	30	40	40	0	Vol Pasture
6	Mace	High	80	80	40	44	Vol Pasture
7	Mace	Low	30	40	40	0	Field Peas
8	Mace	High	80	80	40	44	Field Peas

*TD = Top Dressed, IBS = Incorporated By Seeding.

Results

Table 3 shows soil properties taken from the trial site from 2012-2015. In 2012, the site had an average topsoil (0-10cm) and subsoil (10-20cm) pH of 6.6 and 7.3 respectively. When this is broken down into the low and high inputs, the high input pH in the topsoil is 6.5 and the low is 6.7. The first two successive years of implementing the trial saw little acidification caused by the applied fertiliser treatments. However, the treatments impact on the pH levels can be observed in 2014 when they declined by an average of 0.9 units.

Table 3: Average organic carbon (OC) and pH ($CaCl_2$) across high and low input treatments taken from 2012-2015.

Year	Depth (cm)	Average pH ($CaCl_2$)	High Input pH ($CaCl_2$)	Low Input pH ($CaCl_2$)	Average OC (%)	High Input OC (%)	Low Input OC (%)
March 2012	0-10	6.6	6.5	6.7	0.66	0.68	0.64
	10-20	7.3	7.2	7.3	0.60	0.65	0.55
	20-30	8.0	8.0	8.1	0.42	0.43	0.41
July 2013	0-10	5.3	5.3	5.4	0.89	0.90	0.87
	10-20	7.1	7.1	7.1	0.48	0.48	0.46
	20-30	7.9	7.9	7.9	0.33	0.35	0.32
March 2014	0-10	5.7	5.5	5.9	0.89	0.90	0.89
	10-20	7.1	7.2	6.9	0.56	0.60	0.52
	20-30	7.5	7.5	7.4	0.51	0.53	0.53
November 2015	0-10	5.7	5.7	5.7	0.80	0.79	0.81
	10-20	6.9	6.8	6.9	0.52	0.52	0.51
	20-30	7.4	7.4	7.4	0.42	0.42	0.43

Note: 2013 was a chemical fallow across all plots.

Table 4: Average total carbon (t/ha) across high and low input wheat and field pea rotations (Treatments 1, 2, 7 & 8).

Treatment	Depth (cm)	2014 Total Carbon (t/ha)	2015 Total Carbon (t/ha)
Low Input	0-10	17.3	15.6
	10-20	21.5	19.9
	20-30	26.9	25.3
High Input	0-10	17.5	16.6
	10-20	25.5	20.4
	20-30	40.4	25.6

Organic carbon percentage increased in the topsoil (0-10cm) from 2012 to 2013 (Table 3), in both high and low treatments. By 2014 however, the high input organic carbon levels remained unchanged while the low input treatment increased soil organic carbon levels by 0.02%. This is likely to be related to the chemical fallow in 2013. By November 2015 the total carbon (t/ha) levels had declined over both treatments, with the high treatment declining at greater rate than the low input treatment, Table 4.

Table 5: Average yield, quality and grade of Mace wheat sown in 2015 at east Dalwallinu over the differing treatments.

Treatment	Yield (t/ha)	Moisture (%)	Hectolitre (g/hL)	Protein (%)	Grade
Canola High	3.30[a]	11.0	74.3	11.6[a]	H2
Field Peas High	3.30[a]	10.9	75.1	11.5[a]	H2
Wheat High	3.28[a]	11.0	76.0	11.0[abc]	APW1
Vol Pasture High	2.84[b]	10.6	74.7	11.4[ab]	APW1
Canola Low	2.77[b]	10.9	78.5	10.5[bcd]	APW1
Wheat Low	2.76[b]	11.1	76.4	9.90[d]	ASW1
Field Peas Low	2.54[bc]	10.8	78.2	10.3[cd]	APW2
Vol Pasture Low	2.16[c]	11.0	77.1	9.80[d]	ASW1
LSD (P=0.05)	*0.419*	*NS (0.31)*	*NS (4.27)*	*0.88*	
CV (%)	*8.35*	*1.6*	*3.2*	*4.67*	
P value	*0.0003*	*1.933*	*0.3412*	*0.0018*	

Note: Average screenings are not shown due to harvest error.

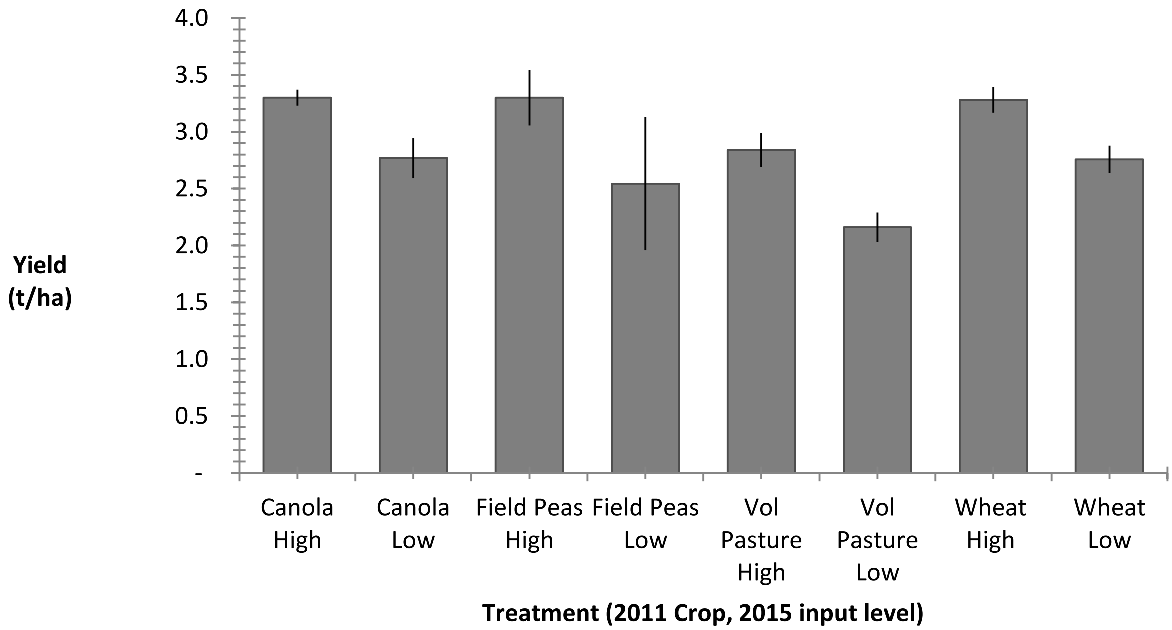

Figure 1: Average yield of Mace wheat grown at east Dalwallinu 2015. Error bars indicate standard deviation.

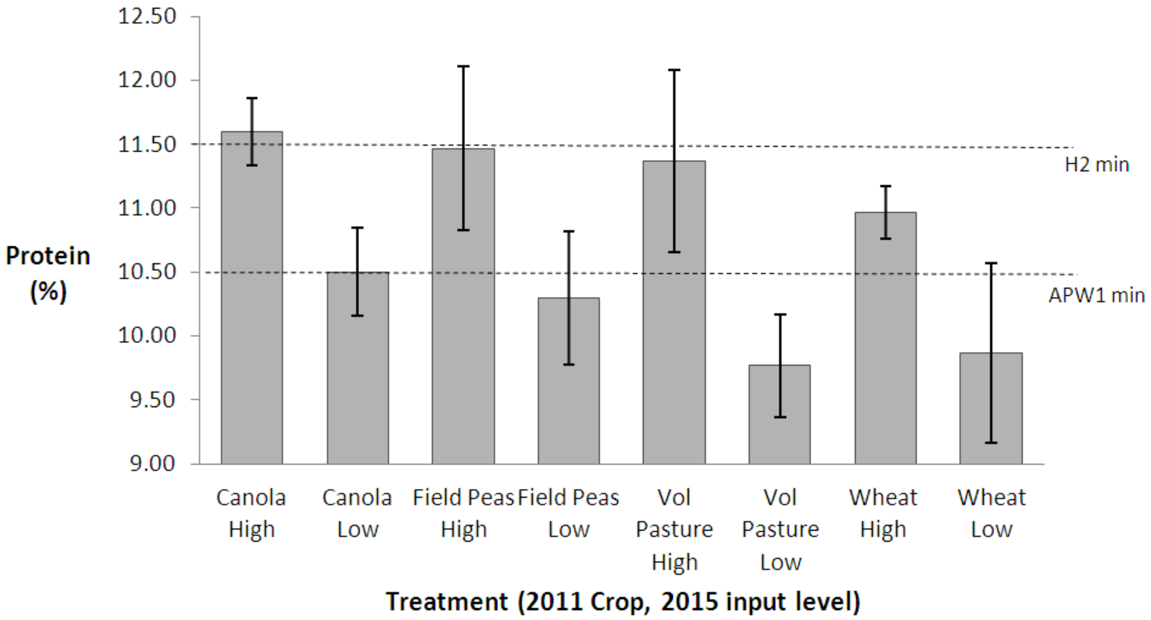

Figure 2: Average protein of Mace wheat grown at east Dalwallinu 2015. Dotted lines represent minimum CBH receival standards for protein.

Economic Analysis

Table 6: Economic analysis of each treatment over the 2011, 2012, 2014 and 2015 seasons.

	Gross Margin ($/ha)				
Treatment	**2015**	**2014**	**2012**	**2011**	**Cumulative Total**
Canola high	582	399	138	392	1511
Field Peas high	576	365	144	222	1307
Wheat high	566	305	66	440	1377
Canola low	509	329	303	303	1444
Wheat low	495	409	204	448	1556
Volunteer Pasture high	470	221	-159	61	593
Field Peas low	453	325	315	188	1281
Volunteer Pasture low	356	314	102	61	833

Note: More detail of income and cost figures can be seen in Appendix A.
2013 was a chemical fallow with all plots treated the same.

The 2011 treatments only varied input levels for the wheat rotation. The canola, field peas and volunteer pasture plots were treated as one input level with targeted nutrient inputs based on the rotation.

Costs taken into account include fertiliser and herbicide costs, CBH receival and handling fees ($38/t). The cost of wheat seed was also considered with the difference in input levels at 30 kg/ha and 80 kg/ha. The volunteer pasture plots, while not creating profit via yield in 2011 provide a value in sheep grazing; this was valued at $74/winter grazed hectare, assumed from district practice.

Income was based on grade of sample tested at CBH site and price based on AWB cash prices on November 19th 2015 (H2 @ $283/t, APW1 @ $278/t, APW2 @ $275/t and ASW1 @ $270/t) averaged from this year. Cost of application has not been included.

Comments

Analysis shows over the 2011, 2012, 2014 and 2015 seasons, wheat grown under a low input regime has consecutively returned the highest gross margin. The volunteer pasture high treatment has consecutively returned the lowest gross margin (Table 6 and Appendix A) except in 2015 where the volunteer pasture low treatment had the lowest return.

Cumulative gross margins for the volunteer pasture treatments are still significantly impacted by 2011 and 2012 results in which yields were below average. These treatments received no nitrogen in 2011 (Appendix B) and income was measured as grazing. In 2012 the reason for this significant variation was not determined, with no significant difference observed in soil sample results or weed burden. In 2015 the emergence on these treatments, was also particularly low and maybe as a result of the 2011 pasture rotation.

Now that the trial is into its fifth season changes in soil health are becoming apparent over the treatments. The pH and the total carbon levels are declining over both high and low inputs. The phosphorus bank is slowly being lowered and nitrate levels are currently at an average of 2 units. This trial will continue to follow the rotation plan shown in Table 1 to determine the compounding effect of high and low input regimes.

The decrease in soil pH from 2012 to 2013 could be attributed to the chemical fallow, when nitrogen was being mineralised but there was no plant uptake, causing acidification.

Acknowledgements
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Appendix

Appendix A: Economic analysis over four cropping seasons: 2011, 2012, 2014 and 2015 at east Dalwallinu.

	Income ($/ha)				Variable Costs ($/ha)				Gross Margin ($/ha)				
Treatment	**2015**	**2014**	**2012**	**2011**	**2015**	**2014**	**2012**	**2011**	**2015**	**2014**	**2012**	**2011**	**Cumulative Income**
Wheat low	752	584	328	699	257	175	124	251	495	409	204	448	1556
Canola high	928	667	371	539	346	269	233	147	582	399	138	392	1511
Canola low	766	493	427	443	257	164	124	140	509	329	303	303	1444
Field Peas low	912	487	440	350	346	257	124	161	566	305	315	188	1377
Wheat high	922	562	299	750	346	264	233	310	576	365	66	440	1307
Field Peas high	702	629	377	388	249	162	233	166	453	325	144	222	1281
Vol Pasture low	591	474	226	74	234	160	124	13	356	314	102	61	833
Vol Pasture high	799	469	73	74	329	248	232	13	470	221	-159	61	593

Note: 2013 was a chemical fallow.

Appendix B: 2011 trial inputs.

Treatment	2011	Input	Seed (kg/ha)	Gusto Gold (kg/ha)	Urea (kg/ha)
1	Wheat	Low	30	65	10
2	Wheat	High	80	65	65
3	Canola	Low	5	65	100
4	Canola	High	5	65	100
5	Volunteer Pasture	Low	0	0	0
6	Volunteer Pasture	High	0	0	0
7	Field Peas	Low	90	65	0
8	Field Peas	High	90	65	0

Yield Loss of Barley and Wheat Varieties to Fusarium Crown Rot

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Department of Agriculture and Food
GOVERNMENT OF WESTERN AUSTRALIA

Key Messages

- Yield loss to crown rot varied significantly among wheat and barley varieties ranging from 0.4 to 1.1 t/ha for wheat and 0.5 to 1.8 t/ha for barley.
- An understanding of the crown rot disease history of a paddock and choosing varieties with appropriate disease resistance ranking can improve crop yield substantially.

Aim

To evaluate the relative yield loss (tolerance) of commonly grown and newly released wheat and barley varieties to Fusarium crown rot.

Background

Fusarium crown rot, caused predominately by the stubble-borne fungus *Fusarium pseudograminearum*, is one of the major root and crown disease constraints on cereal production in Australia. In 2009 it was estimated to cost Australian grain growers $97 million annually in wheat and barley (Murray and Brennan, 2009, 2010). WA's losses to this disease were estimated at that time to be $7 million annually. In 2014, many growing regions in WA were impacted by crown rot, exacerbated by dry weather conditions during grain fill. For example, reports from Merredin indicated that crown rot affected 30-50% of wheat paddocks.

Several new wheat varieties have been released recently with improved tolerance to crown rot. No experimental field evidence is currently available to grain growers on the effect of crown rot on variety yields in WA. Hence, there is an on-going need to evaluate wheat and barley varieties to demonstrate to growers the economic benefits of adoption of varietal selection in paddocks with high crown rot pressure.

Trial Details

Property	Wongan Hills Research Station			
Plot size & replication	10m x 1.8m x 4 replications			
Trials & Treatments	Two trials – wheat and barley trial 12 wheat varieties – Calingiri, Cobra, Corack, Emu Rock, Harper, Justica, Mace, Magenta, Trojan, Westonia, Wyalkatchem, Yitpi 12 barley varieties – Bass, Baudin, Commander, Compass, Fathom, Flinders, Granger, Hindmarsh, La Trobe, Litmus, Mundah, Scope Uninoculated and inoculated with *F. pseudograminearum* paired plots for each variety			
Soil type	Yellow brown sand			
Soil pH ($CaCl_2$)	0-30cm: 4.7	30-60cm: 5.5	60-90cm: 5.7	90-120cm: 5.8
EC (dS/m)	0-30cm: 0.020	30-60cm: 0.019	60-90cm: 0.021	90-120cm: 0.025
PreDicta B DNA soil test for soilborne diseases	Below detection level for crown rot tests			
Sowing date	20/05/2015			
Seeding rate	75 kg/ha			
Paddock rotation	2012 wheat, 2013 wheat, 2014 lupin			
Fertiliser	20/05/2015: 80 kg/ha Macropro Plus 01/07/2015: 50 kg/ha urea			
Herbicides, Insecticides & Fungicides	20/05/2015: 1.5 L/ha Treflan, 2 L/ha Spray.Seed 250, 2.5 L/ha Boxer Gold 23/06/2015: 670 mL/ha Velocity 13/08/2015: 300 mL/ha Amistar Xtra			
Growing season rainfall	294mm (20 May to 30 October)			

Results

Grain yield for both barley and wheat were good, averaging 3.9 t/ha for wheat and 4.3 t/ha for barley in the uninoculated plots. All barley and wheat varieties had some level of yield reductions (Figure 1 and 2) in plots inoculated with crown rot and significant differences were evident between varieties. In the barley trials, Litmus, La Trobe and Hindmarsh had the lowest yield reductions from crown rot at less than 0.6 t/ha, with Litmus having significantly higher yields than any other variety in the presence of crown rot (Figure 1). Compass, Granger, and Scope were the most heavily impacted by crown rot losing over 1.4 t/ha yield to the disease. In the absence of the disease, grain yield of Litmus, the highest yielding variety under crown rot (inoculated), and Compass was not significantly different.

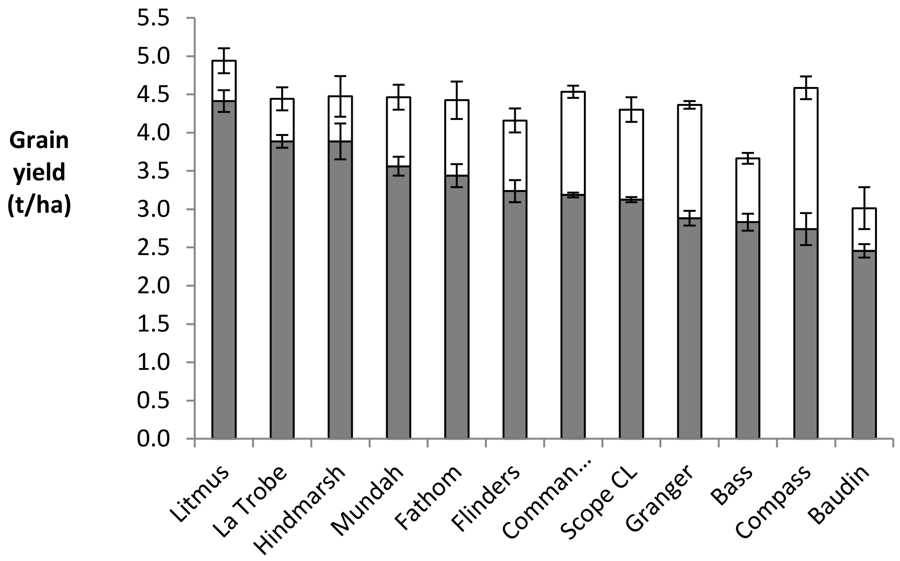

Figure 1: Grain yield for 12 barley varieties in nil (white bars) and *Fusarium pseudograminearum* inoculated (grey bars) plots at Wongan Hills in 2015. NVT crown rot resistance rankings are not available.

In wheat, Emu Rock had the lowest yield loss of 0.36 t/ha (approximately half the total loss that occurred in Mace) from crown rot, and also had the highest yield in crown rot inoculated plots, significantly greater than Corack, Calingiri, Wyalkatchem and Justica. The varieties Justica, Wyalkatchem, Magenta, and Calingiri had over 0.9 kg/ha yield loss to the disease.

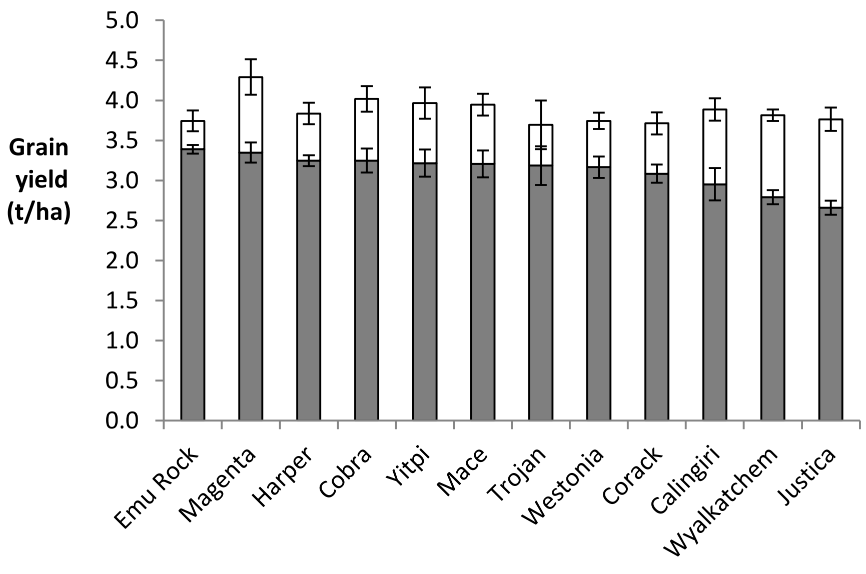

Figure 2: Grain yield for 12 wheat varieties in nil (white bars) and *Fusarium pseudograminearum* inoculated (grey bars) plots at Wongan Hills in 2015. NVT resistance rankings for Emu Rock and Trojan are moderately susceptible (MS), Magenta is MS to susceptible (MSS), and remaining varieties are susceptible to crown rot.

Comments
This is the second year of inoculated crown rot field experiments to evaluate yield loss in barley and wheat varieties in WA. As in 2014, all varieties of barley or wheat were found to be affected by the disease and all had some level of yield reduction, however, significant differences between varieties were evident (see Huberli *et al*. (2015) for 2014 results). In both years, Emu Rock has had the lowest actual yield loss and has been the highest yielding in the presence of disease, while Justica was the lowest yielding in crown rot inoculated plots with the highest actual yield loss. For barley, Litmus, Hindmarsh and La Trobe have been the best performers under crown rot and Compass has had the largest yields loss to the disease in 2014 and 2015.

Yield losses for barley and wheat ranged substantially with the worst performers in barley losing over 1.4 t/ha and in wheat over 0.9 t/ha to the disease. For wheat, the resistance rankings have been determined through the NVT screening system, and all varieties with high yield losses in 2015, except Magenta, are susceptible. For barley, resistance rankings have not yet been determined. This is the second year of these trials, and further testing next year will result in a final analysis of the three years' yield losses.

The results show that variety choice under high crown rot disease pressure can have an impact on yield. For example, with added crown rot inoculum, Emu Rock yielded 0.18 t/ha (not significant) and 0.3 t/ha (significant) more than Mace in 2015 and 2014, respectively. However, in the plots without crown rot, Mace out-yielded Emu Rock by 0.2 t/ha in both years (statistically significant in 2014).

These preliminary results indicate that understanding the crown rot disease history of a paddock and choosing varieties with appropriate disease resistance ranking can improve crop yield substantially.

References
Murray, G.M. and Brennan, J.P. (2009). Estimating disease losses to the Australian wheat industry. *Australasian Plant Pathology* 38: 558-570.

Murray, G.M. and Brennan, J.P. (2010). Estimating disease losses to the Australian barley industry. *Australasian Plant Pathology* 39: 85-96.

Hüberli, D., Connor, M. and Gajda, K. (2015) Yield loss to Fusarium crown rot: is there a better choice among barley and wheat varieties? In: Australasian Plant Pathology Society Conference Handbook, 14 - 16 September, Fremantle, Western Australia. Download PDF conference paper, poster, and presentation: http://researchrepository.murdoch.edu.au/28457/

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Impress Wheat vs Scope Barley Demonstration: Assessing Imidazolinone Crop Weed Control

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Aim

To assess whether imidazolinone tolerant wheat or barley provides better weed control and which gives the best economic return.

Background

Tight rotations and herbicide resistance has led to weeds becoming increasingly difficult to manage. The conventionally bred Clearfield^{TM} technology provides imidazolinone (IMI) tolerance, allowing flexibility in using the broad-spectrum IMI-herbicides without risk of crop damage. This opens up the IMI-group to be used to control brome and other grass weeds in a cereal crop and removes the risk of any plant-back crop damage from IMI use the previous season.

Impress CL Plus is a high yielding Clearfield Plus APW wheat registered for label rates of Intervix. It is early-mid maturing, similar to Wyalkatchem. Scope CL is a high yielding Clearfield malt barley suitable with early to mid-maturity. These variety options provide flexibility in Intervix use, enabling a Clearfield barley to follow a Clearfield wheat, without risk of residual-herbicide crop damage. The use of Clearfield technology must be used as part of integrated weed management (IWM) program to ensure the longevity of the Group B chemistry in our farming systems.

The Carter family (located in Xantippe) were having trouble getting on top of brome and barley grass and decided to try the Clearfield barley variety Scope and wheat variety Impress. Impress and Scope were planted in the same problem paddock with the aim of comparing yield and weed control.

This demonstration was conducted using farmer equipment. Farm scale demonstrations are a valuable way to explore new varieties, products, or practices, complimenting results which are produced through more scientifically rigorous small plot trials.

Demonstration Details

Property	Xantippe Farm, Xantippe	
Plot size & replication	30ha Scope, 20ha Impress planted side by side, single replication	
Soil type	Heavy red clay	
Soil pH ($CaCl_2$)	0-10cm: 6.5	10-40cm: 8.3
EC (dS/m)	0-10cm: 0.11	10-40cm: 0.22
Sowing date	26/05/2015	
Seeding rate	50 kg/ha (Impress wheat) 30 kg/ha (Scope barley)	
Paddock rotation	2013 wheat, 2014 pasture	
Fertiliser	Impress –	26/05/2015: 35 kg/ha MAP 10/07/2015: 20 L/ha Flexi-N
	Scope –	26/05/2015: 40 kg/ha MAP 10/07/2015: 20 L/ha Flexi-N
Herbicides, Insecticides & Fungicides	Impress –	12/05/2015: 2 L/ha Glyphosate, 0.25% Hot-Up 26/05/2015: 1.2 L/ha Trifluralin, 10 g/ha Glean, 2 L/ha Paraquat 25/06/2015: 375 mL/ha Intervix, 400 mL/ha LVE-MCPA 10/07/2015: 145 mL/ha Tilt, 200 mL/ha Chlorpyrifos
	Scope –	12/05/2015: 2 L/ha Glyphosate, 0.25% Hot-Up 26/05/2015: 2.8 L/ha Trifluralin, 150 g/ha Metribuzin, 2 L/ha Paraquat 25/06/2015: 375 mL/ha Intervix, 400 mL/ha LVE-MCPA 10/07/2015: 145 mL/ha Tilt, 200 mL/ha Chlorpyriphos
Growing season rainfall	319mm	

Results

This was an unreplicated farmer demonstration, thus interpretations of results are to be made with caution.

Table 1: Yield, quality and grade of Scope barley and Impress wheat, Xantippe 2015.

Variety	Yield (t/ha)	Hectolitre Weight (kg/hL)	Protein (%)	Screenings (%)	Grade
Scope	1.5	60.79	12.8	51.01	BFED1
Impress	1.2	78.86	10.8	1.73	APW1

Comments

The Carters were pleased with the yields for both the Scope and Impress. They were also pleased with the overall weed control on the target weeds like mustard, marshmallow and radish. There was poor ryegrass control; however IMI herbicides only offer suppression of that weed. Yields were down compared to other parts of the farm but this was likely due to time of sowing and emergence, not the variety.

Acknowledgements

The Carter family for implementing and managing the demonstration.

Paper reviewed by: Jessica Smith, Agronomist.

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Zen vs. Mace Wheat – Case Study

Elly Wainwright, R&D Coordinator, Liebe Group

Aim
To assess whether Zen noodle wheat has a place in rotation when yield and quality are compared to Mace Australian hard wheat.

Background
The Carlshausen's had previously grown Calingiri noodle wheat but abandoned the variety in 2015 due to bad lodging in the 2014 season and consistent 0.1 t/ha lower yields than Mace. In 2015 they wanted to see if the new noodle variety Zen was able to match Mace (the only wheat currently grown on their property) in terms of yield and quality. Mace is a short to mid maturity Australian hard wheat with Wyalkatchem major parent and Stylet minor parent. Zen is a mid to long maturity Australian noodle wheat bred from Calingiri and Wyalkatchem.

Mace and Zen were compared in two locations of the same paddock. The soil type was similar at the two locations, but varied in their elevation.

This demonstration was conducted using farmer equipment. Farm scale demonstrations are a valuable way to explore new varieties, products, or practices, complimenting results which are produced through more scientifically rigorous, small plot trials. Please refer to NVT for a replicated view of the varieties in your area.

Demonstration Details

Property	E.G. Carlshausen & Co., west Dalwallinu
Plot size & replication	640m x 12.2m x unreplicated
Soil type	Sandy loam
Soil pH ($CaCl_2$)	0-10cm: 5.6 10-20cm: 5.1 20-30cm: 4.8
Sowing date	03/05/2015
Seeding rate	70 kg/ha Mace, 50 kg/ha Zen
Paddock rotation	2012 wheat, 2013 wheat, 2014 lupin
Fertiliser	03/05/2015: 20 kg/ha MOP, 40 kg/ha AgFlow 12/06/2015: 70 kg/ha urea 08/07/2015: 180 g/ha Zinc
Herbicides, Insecticides & Fungicides	03/05/2015: 2 L/ha Gramoxone, 2.5 L/ha Boxer Gold, 25 g/ha Monza, 200 mL/ha Chlorpyrifos 08/07/2015: 500 mL/ha Paragon Xtra, 300 mL/ha Bromicide MA, 150 mL/ha Folicur 13/08/2015: 150 mL/ha Tebuconazole, 150 mL/ha Alpha-cypermethrin
Growing season rainfall	253mm (73mm: February-March)

Results
This was an unreplicated farmer demonstration, thus interpretations of results are to be made with caution.

Table 1: Averaged yield and quality of Mace and Zen, west Dalwallinu in 2015.

Treatment	Yield (t/ha)	Protein (%)	Screenings (%)	Hectolitre Weight (kg/hl)	Grade
Mace	3.05	9.1	2.4	81.5	ASW
Zen	3.25	10.1	1.8	81.5	ANW1

Comments
The Carlshausen's were pleased with the yield and quality of Zen and plan to use it in their rotation in the 2016 season. Zen out-yielded Mace by 6% (0.2 t/ha) on both sections of the paddock (3.65 vs 3.48 t/ha

(bottom of slope) and 2.84 vs 2.62 t/ha (top of slope)). Although Mace has a slightly better resistance rating (MSS vs SVS (provisional assessment)), the Carlshausen's noted that Zen held up better to the powdery mildew that was prevalent in the district in the 2015 season. Zen remained greener for longer which is likely due to its slightly longer maturity.

Acknowledgements
The Carlshausen family for managing the demonstration and sharing the information gathered from it.

Paper reviewed by: Boyd Carter, Grower.

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Barley National Variety Trial - Ballidu

Blair Humphry, Graduate Research Agronomist, Kalyx Australia

Key Messages

- Rosalind demonstrated a clear yield advantage in this trial and at 2.5 t/ha it was almost 0.5 t/ha ahead of the second ranked group average of Mundah, La Trobe, Litmus, Hindmarsh and Compass.
- The growing season at Ballidu was underscored by two large rainfall events that bracketed an extended dry period during July and a dry finish with 4mm recorded for September and October accompanied by increasing heat stress with multiple days above 30°C.
- This year was most suited to the earlier maturing varieties which were better able to utilise available moisture.
- Grower decisions on variety replacement or retention should not be based solely on 2015 NVT data, but should include consideration of relative variety performance across locations, long term yield predictions and local farmer experience.

Background

The National Variety Trial (NVT) program is a national program of comparative crop variety testing with standardised trial management, data generation, collection and dissemination. The program is supported by the Australian Government and growers through the GRDC and is managed by the Australian Crop Accreditation System Limited (ACAS). The NVT aims to generate independent information for growers about newly released crop varieties. The NVT system has been developed to complement the plant breeding programs. Breeders will make their release decisions prior to nominating lines for testing programs. NVT will only be testing lines close to commercial release.

Site selection is made across the main soil types and rainfall zones and where possible the trials are located with active grower groups to provide a focal point for grower group research sites. The trials are sown and harvested as close to or before district grower practice to ensure variety performance is similar to that seen by growers on their farms. The entries include current varieties and lines being considered for commercial release. Performance is benchmarked against district standards and quality check varieties. Field assessments of emergence, vigour and days to flowering and opportunistic assessments such as disease and lodging are conducted. All varieties undergo quality analysis against current receival standards.

Trial Details

Property	Ardoch, east Ballidu
Plot size & replication	1.76m x 12m x 3 replications
Soil type	Yellow sandy loam
Soil pH ($CaCl_2$)	0-10cm: 5.5 10-20cm: 5.5 20-30cm: 4.8
EC (dS/m)	0-10cm: 0.203 10-20cm: 0.072 20-30cm: 0.060
Sowing date	24/05/2015
Seeding rate	65 kg/ha
Paddock rotation	2012 pasture, 2013 wheat, 2014 canola
Fertiliser	24/05/2015: 50 kg/ha urea (top dressed), 100 kg/ha Gusto Gold (deep banded)
Herbicides & Insecticides	23/05/2014: 2 L/ha Roundup, 2 L/ha Trifluralin, 0.5 L/ha Chlorpyrifos 23/06/2015: 1 L/ha Velocity, 0.3 L/ha Axial, 1% Hasten 08/07/2015: 0.3 L/ha Axial, 1 L/ha Velocity, 0.5% Adigor 24/07/2015: 150 mL/ha Prosaro, 1% Hasten
Growing season rainfall	243mm

Results

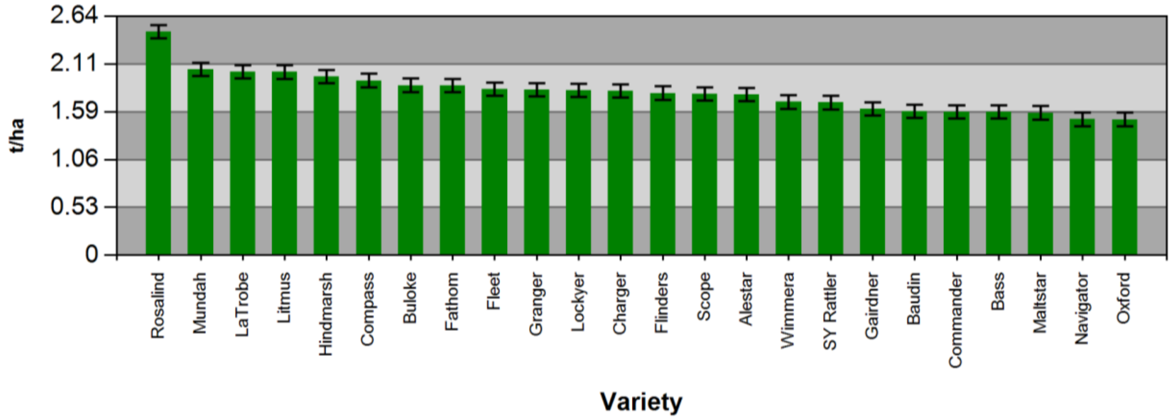

Figure 1: Yield comparison of barley varieties sown at east Ballidu, 2015.

Table 1: Agronomic assessments and yield, east Ballidu 2015.

Variety	Early growth score (1=Extremely poor 9=Excellent)	Establishment (0=None 9=Maximum)	50% Head Emergence (year day)	Yield (t/ha)	Percentage of site mean (%)
Rosalind	8	9	248	2.47	136
Mundah	8	9	246	2.05	113
LaTrobe	8	9	247	2.02	111
Litmus	8	9	247	2.02	111
Hindmarsh	7	8	246	1.97	109
Compass	8	8	248	1.93	106
Buloke	8	9	249	1.88	103
Fathom	7	8	248	1.87	103
Fleet	8	9	266	1.83	101
Granger	8	9	269	1.83	100
Lockyer	8	9	270	1.82	100
Charger	8	9	250	1.81	100
Flinders	7	9	269	1.79	98
Alestar	8	9	268	1.78	98
Scope	7	8	250	1.78	98
SY Rattler	7	8	267	1.69	93
Wimmera	7	8	269	1.69	93
Gairdner	7	9	266	1.61	89
Baudin	7	8	269	1.59	87
Bass	7	9	270	1.58	87
Commander	8	9	270	1.58	87
Maltstar	7	9	269	1.57	86
Navigator	7	9	274	1.50	82
Oxford	7	8	273	1.50	82
Site Mean (t/ha)				*1.82*	
CV (%)				*4.63*	
P value				*<0.001*	
LSD (t/ha)				*0.15*	

Note: Year day 246 is equivalent to the 2nd September and day 274 is equivalent to the 30th September.

Table 2: Barley grain quality, east Ballidu 2015.

Variety	Hectolitre weight (kg/hL)	Plump Grain (>2.5mm sieve) (%)	Protein (%)	Screenings (<2.2mm sieve) (%)	Screenings (<2.5mm sieve) (%)
Rosalind	67.2	79.7	9.0	3.6	20.3
Mundah	66.4	85.8	9.6	2.4	14.2
LaTrobe	68.4	79.7	9.6	2.7	20.3
Litmus	77.8	92.6	9.9	1.3	7.4
Hindmarsh	67.4	74.0	9.6	4.1	26.0
Compass	66.2	94.4	9.4	1.1	5.6
Buloke	67.0	86.1	10.4	1.5	13.9
Fathom	64.0	87.5	10.3	1.5	12.5
Fleet	61.6	96.4	9.8	0.8	3.6
Granger	67.4	89.9	10.3	1.7	10.1
Lockyer	66.6	97.3	10.5	0.3	2.7
Charger	62.4	69.8	9.4	5.4	30.2
Flinders	68.4	86.5	10.9	2.1	13.5
Alestar	63.0	81.3	9.7	3.1	18.7
Scope	67.2	97.8	10.1	0.3	2.2
SY Rattler	78.0	58.2	9.6	10.3	41.8
Wimmera	66.2	94.3	10.1	1.1	5.7
Gairdner	66.0	86.5	10.5	2.2	13.5
Baudin	66.4	86.8	10.6	1.9	13.2
Bass	66.0	87.2	10.8	1.9	12.8
Commander	65.0	89.9	10.4	2.2	10.1
Maltstar	66.2	57.4	9.4	7.1	42.6
Navigator	64.6	94.8	10.9	1.3	5.2
Oxford	66.2	52.7	9.8	9.4	47.3

Comments

The trial was sown into adequate moisture on the 24th May following 14mm of rainfall in the 16 days before sowing, ensuring an even establishment across the site with good early vigour. Rainfall for June-August was above the long term average, 200mm compared to 160mm, however most of this occurred in 2 rainfall events that bracketed an extended dry period during July. The 70mm recorded on 31st July did mean there was useful soil moisture through August however, a second dry spell occurred during September and October with only 4mm rainfall recorded.

This year was suited to the early maturing varieties which were better able to utilise available moisture and possessed development patterns that were less impacted by the extended dry periods through the season. The shorter season varieties reached head emergence around the 5th-8th September, meaning they were more likely to respond to the late July rainfall, whilst the longer season varieties reached head emergence up to 25 days later, coinciding with a drying soil and increasing heat stress with multiple days above 30^{o}C.

Rosalind, a feed variety developed by InterGrain, demonstrated a clear yield benefit in this trial, 0.42 t/ha above the second highest yielding variety and 0.65 t/ha greater than the site average of 1.8 t/ha. It has also performed well at other low rainfall sites in WA this year, being at least 0.4 t/ha better than the site mean, but it was not always the highest yielding entry. Although it performed well this year the long term yield analysis for Agzone 2 shows that Compass, La Trobe and Hindmarsh may be better adapted with an average 5% yield advantage.

Mundah, La Trobe, Litmus, Hindmarsh and Compass formed a second tier of varieties that performed well but in 2015 they were clearly below Rosalind with an average yield of 2 t/ha. Mundah is a very early feed variety that was released in 1995 and is still popular with growers. It performed well at this site but yield potential can be constrained by its early maturity and newer varieties such as La Trobe and Hindmarsh are recording more consistent stable yields in Agzone 2 with an average 15% improvement over Mundah for the last 5 years.

Litmus is an early maturing acid soil tolerant barley that performed above the site average at all low rainfall sites this year. It also expresses the blue aleurone gene, so growers need to be aware that not all receival sites will accept this variety and its future is not certain. Compass has also performed well in lower yielding areas with equivalent yield to Hindmarsh in the long term yield (2005-2014) for Agzone 2; 3.07 t/ha compared to 2.95 t/ha.

IGB1334T is an early maturing 2 gene imidazolinone (IMI) tolerant barley released by InterGrain that is available to growers in 2016. It has improved lodging resistance and head retention compared to Scope CL, with a maturity similar to La Trobe. IGB1334T is a shorter season variety compared to Scope CL and may be better suited to this area.

Grain quality was generally good and screenings were unexpectedly low given the dry finish to the season, the majority of varieties ranging 2–20%, which may reflect roots accessing stored moisture following the large rainfall event recorded 31st July. The reason for the higher screenings of Hindmarsh compared to La Trobe is not obvious. The early harvest of the trial also meant that varieties such as Buloke and Scope did not experience head loss.

Acknowledgements
Thanks to the Hood family for their co-operation and use of their land.
Thanks to Liebe Group for their co-operation during the year, the GRDC and ACAS.

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Barley National Variety Trial - Buntine

Australian Crop Accreditation System Limited

Aim

To evaluate yield and quality of new and existing barley varieties.

Background

The barley National Variety Testing (NVT) is part of a multi crop evaluation program funded by the GRDC and is designed to evaluate barley varieties entering the market that have gone through selection and evaluation within the national breeding programs. The NVT barley trials are just one source of information on which growers can base management decisions on retention, release or adoption of new varieties. Growers must use more than one information source when making significant management decisions in relation to barley varieties.

Trial Details

Property	Niribi Farm, west Buntine	
Plot size & replication	10m x 2.2m x 3 replications	
Soil type	Loam	
Soil pH ($CaCl_2$)	0-10cm: 6.2	10-60: 4.7
EC (dS/m)	0-10cm: 0.110	10-60: 0.047
Sowing date	23/05/2015	
Seeding rate	65 kg/ha	
Paddock rotation	2014 canola	
Fertiliser	23/05/2015: 100 kg/ha Gusto Gold, 50 kg/ha urea	
Herbicides, Insecticides & Fungicides	23/05/2015: 0.30 L/ha Chlorpyrifos, 0.12 kg/ha Pyroxasulphone, 2 L/ha Trifluralin, 2 L/ha Glyphosate 360, 0.35 L/ha 2,4-D Ester 08/07/2015: 1 L/ha Esters of Canola oil, 0.3 L/ha Cloquintocet-Mexyl & Pinoxaden, 0.4 L/ha Alpha-cypermethrin, 0.5 L/ha LVE MCPA, 0.12 kg/ha Clopyralid, 1 L/ha Bromoxynil & Pyrasulfotole 27/07/2015: 0.15 L/ha Prothioconazole & Tebuconazole, 0.7 L/ha Esters of Canola oil 02/09/2015: 1 L/ha Bromoxynil & Pyrasulfotole, 0.6 L/ha Esters of Canola oil	
Growing season rainfall	264mm	

Results

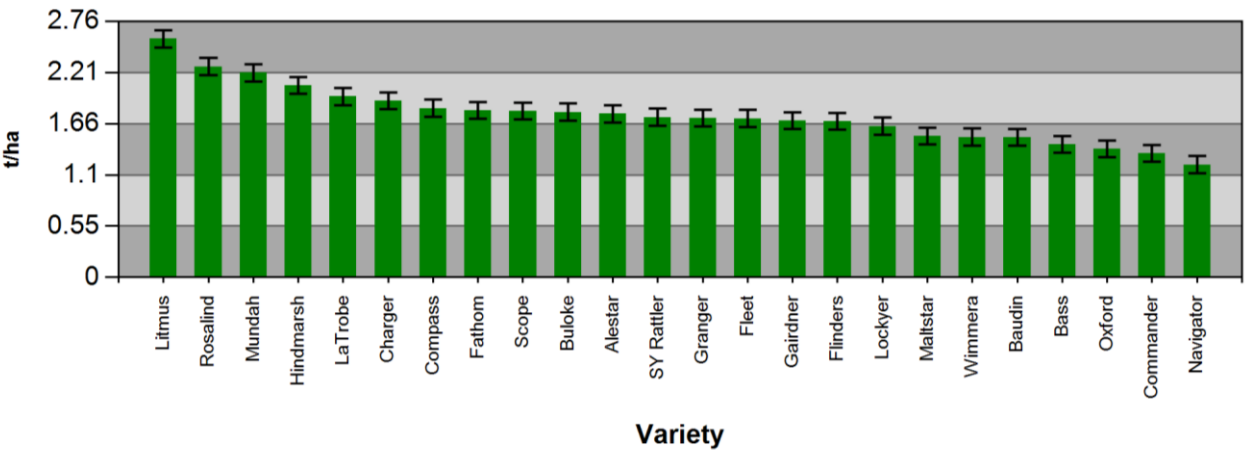

Figure 1: Yield comparison for barley varieties sown at Buntine, 2015.

Table 1: Yield and grain quality data for barley varieties grown in Buntine, 2015.

Variety	Yield (t/ha)	Percentage of site mean	Hectolitre weight (kg/hL)	Protein (%)	Screenings 2.2 (%)	Screenings 2.5 (%)
Litmus	2.57	147	68.2	11.3	1.2	10.0
Rosalind	2.27	130	65.0	10.4	6.8	34.1
Mundah	2.20	126	65.0	11.3	2.1	14.0
Hindmarsh	2.07	118	67.0	10.6	5.2	33.0
LaTrobe	1.95	112	66.6	10.7	4.8	31.9
Charger	1.90	109	64.0	9.9	3.3	27.5
Compass	1.82	105	66.2	10.5	2.3	19.7
Fathom	1.80	103	63.8	10.9	2.9	23.5
Scope	1.79	103	67.2	12.0	2.4	20.6
Buloke	1.78	102	65.4	12.0	2.8	7.0
Alestar	1.76	101	66.6	11.3	4.4	28.5
SY Rattler	1.73	99	65.6	11.0	14.8	53.2
Granger	1.72	98	68.0	12.0	5.4	34.2
Fleet	1.71	98	60.2	11.5	2.0	13.2
Gairdner	1.69	97	66.6	11.8	6.2	35.8
Flinders	1.68	96	67.4	12.5	4.5	37.0
Lockyer	1.63	93	65.8	11.6	3.1	26.4
Maltstar	1.52	87	68.0	11.6	9.9	48.0
Baudin	1.51	87	67.0	12.0	4.6	31.1
Wimmera	1.51	87	69.6	12.2	4.3	30.1
Bass	1.43	82	66.2	12.2	4.1	33.6
Oxford	1.38	79	67.6	11.6	10.6	45.0
Commander	1.34	77	66.0	12.0	3.4	19.0
Navigator	1.22	70	68.4	12.2	3.1	20.4
Site Mean (t/ha)	*1.74*					
CV (%)	*5.83*					
P value	*<0.001*					
LSD (t/ha)	*0.18*	*10*				

Comments

For more information please refer to www.nvtonline.com.au

Barley Variety Demonstration – Case Study

Jenni Clausen, R&D Coordinator, Liebe Group

Aim

To compare and confirm if Litmus barley is a good choice for Gowrie farm against Hindmarsh and Scope, across varying sands.

Background

Litmus is aluminium tolerant therefore, it is a good option for growing on acid sands. The acid-tolerant gene is linked to a gene for blue aleurone expression, resulting in receival issues for Litmus (due to Australia's pledge to supply only white barley) limiting it to a feed variety.

Despite the complications surrounding the market for Litmus, the Strickland's have found it to be a good fit for their cropping system and have had good yield responses in the past. This year, they wanted to confirm their previous successes.

This demonstration was conducted using farmer equipment. Farm scale demonstrations are a valuable way to explore new varieties, products, or practices, complimenting results which are produced through more scientifically rigorous small plot trials. The varieties tested include those that are widely grown in the area. Please refer to the barley NVT for a replicated view of the varieties in your area.

Demonstration Details

Property	Gowrie, east Pithara
Plot size & replication	13.4m x 750m x single replicate
Soil type	Wodjil sand, sandy loam, and higher producing sand
Soil pH ($CaCl_2$)	0-15cm: 5.1-5.3 15-40cm: 4.7-5.3
Sowing date	05/05/2015
Seeding rate	50 kg/ha
Paddock rotation	2013 wheat, 2014 wheat
Fertiliser	05/05/2015: 35 kg/ha DAPSZC, 45 kg/ha urea (deep banded) 02/07/2015: 20 L/ha UAN July: 25 kg/ha urea
Amelioration	2009: 2 t/ha Lime (incorporated with offsets discs to 15cm) 2014: 1 t/ha Dolomite (not incorporated)
Herbicides, Insecticides & Fungicides	04/05/2015: 1.5 L/ha Glyphosate540, 80 mL/ha Encore 05/05/2015: 2.5 L/ha Trifluralin 05/05/2015: 4 L/t EverGol Prime on Hindmarsh and Litmus (Scope bare) 02/07/2015: 900 mL/ha Jaguar, 600 mL/ha LVE570, 120 mL/ha Tebuconazole 18/08/2015: 250 mL/ha Propiconazole, 60 mL/ha Alpha Forte, 200 mL/ha Chlorpyrifos
Growing season rainfall	260mm

Results

This was an unreplicated farmer demonstration, thus interpretations of results are to be made with caution.

Table 1: Average yield and quality of barley varieties, total yield across three sands at Gowrie farm, 2015.

Treatment	Yield (t/ha)	Protein (%)	Screenings (%)	Grade
Hindmarsh	3.79	10.9	23.5	BFOD2
Scope	3.84	10	28	MALT2
Litmus	4.58	11.1	16	BFED1*

*BFED1 grade is the only option for Litmus, however, would have made MALT1, if available.
Yield results taken from yield map, Figure 1. Average across whole strip, three soil types.

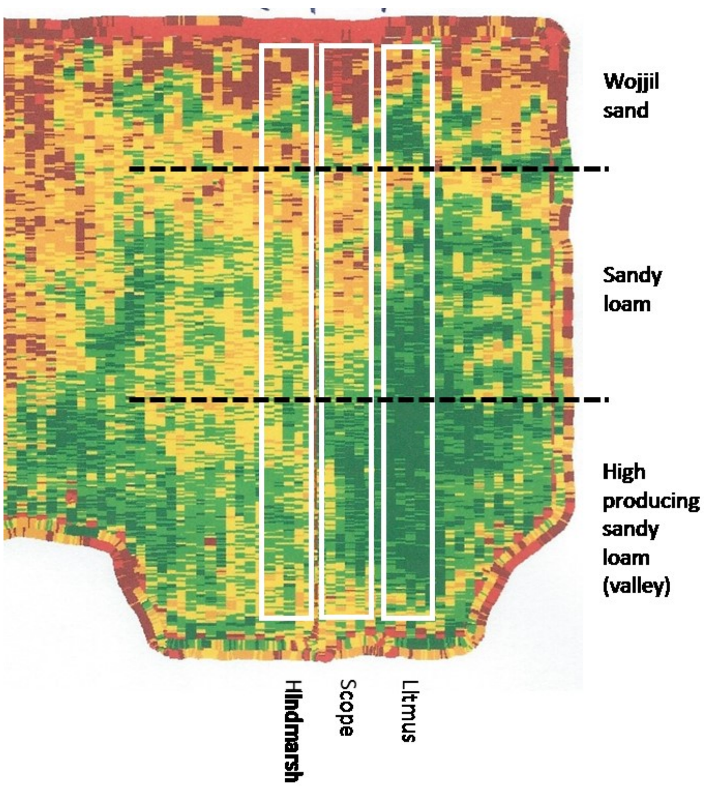

Figure 1: Yield map of the trial paddock on Gowrie farm, east Pithara 2015. Rest of paddock sown to Hindmarsh (left), Litmus (right)

Comments

In this particular season, Litmus out-yielded Hindmarsh and Scope by approximately 600 kg/ha in the demonstration paddock. This result confirmed to the Strickland's that Litmus is a good variety choice for their farm. The yield differences between Scope and Hindmarsh were negligible, due to the nature of the demonstration (unreplicated and variability of paddock).

Although Litmus is coined as an acid-tolerant variety, Ben and Rob theorise the success they have with growing it on their farm may be due to incorporating lime through the topsoil. This is to give the seedling a chance to establish before the roots reach soil with a lower pH i.e. at 15-40cm.

Acknowledgements

Thank you to the Strickland family for sharing your informal demonstration information.

Paper reviewed by: Ty Henning, Tek Ag.

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Barley Swathing, East Wubin - Case Study

Jenni Clausen, R&D Coordinator, Liebe Group

Aim

To evaluate the practicality of swathing barley in a favourable growing season.

Background

Swathing barley is practiced in the high rainfall zones of southern Western Australia. It allows for an earlier harvest and quick drying of the barley crop, minimising losses associated with uneven maturity, a wet harvest, lodging, and head loss. Swathing is another tool that is available to growers at harvest allowing them to play the back end of the season and minimise risk of yield losses due to environmental factors. Swathing can also be utilised as a weed management tool, slashing weeds before seed set.

Higher rainfall this year resulted in high biomass and yield potential in Scope barley at the Carter's property, east Wubin. This provided an ideal opportunity to try barley swathing and assess its fit in an area in which it is not common practice.

The Carter's used the same swathing set-up they use for canola. The crop was cut low (approximately 120mm) and windrowed at a 45° angle to the crop rows (Figure 3) in the first week of October. This was in order for the windrows to sit on top of the stubble enabling ease of pick up (third week of October). The amount of heads retained in the headlands (windrow sitting on the same direction as the stubble) was compared with the 45° angle swathing method.

Demonstration Details

Property	KL Carter and Co, east Wubin
Plot size & replication	Whole paddock, no replication
Soil type	Heavy red river flats
Soil pH ($CaCl_2$)	10-20cm: 5.5 20-30cm: 6.3
EC (dS/m)	10-20cm: 0.04 20-30cm: 0.17
Sowing date	23/03/2015
Seeding rate	40 kg/ha Scope
Paddock rotation	2012 wheat, 2013 barley, 2014 wheat
Fertiliser	23/03/2015: 50 kg/ha AgStar 19/06/2015: 37.5 L/ha Flexi-N 22/08/2015: 15 L/ha Flexi-N, 0.1 kg/ha Zinc
Herbicides, Insecticides & Fungicides	23/03/2015: 0.12 L/ha $AuSu_2$, 0.1 L/ha Garlon, 0.51 L/ha Li700, 1.42 L/ha RoundUp Power Max. 22/08/2015: 0.2 L/ha Alpha-Duo, 0.2 L/ha Chlorpyrifos, 0.2 L/ha Tilt
Growing season rainfall	207.5mm

Comments

There were a lot of heads retained in the windrow running in the same direction as the crop. This was a result of the windrow sitting on the ground and not on top of the stubble; the barley that lay too low did not feed into the header well and therefore was not harvested effectively (remnants Figure 1). The 45° swathed barley, on the other hand, allowed for the majority of the cut barley to be collected (remnants Figure 2). One of the 45° windrows was harvested in the opposite direction to which is was cut; this resulted in a lot more heads missed on the ground as opposed to being harvested in the same direction the swathes were cut. The Carter's theorise that this was because the pick-up front was running over the heads before it could pick them up.

Figure 1: Leftover barley from harvested windrow that was swathed in same direction as crop rows (in headland), 2015.

Figure 2: Majority of straw remaining after harvest of windrows, 2015.

Figure 3: 45° angle of windrows against the direction of the crop rows, 2015.

If the Carter's were to try swathing barley again, they would modify the setup slightly to ensure that more barley could be picked up. This might be a modification on the feeder angle, making the windrows narrower, and a narrower tyne spacing at seeding. As this was unplanned at seeding, their standard 12 inch spacings were used. A maximum of 10 inch row spacing is recommended for swathing barley.

The Carter's found no advantage to swathing the barley this year, perhaps if it had been a wetter finish it may have been more beneficial as a preventative to the potential lodging. Swathing barley at the 45° angle negates tramlining, which is another consideration for anybody contemplating it on their property. Swathing did cost more in fuel use and labour. The Carter's estimate the extra cost to be around $10/ha.

For more information on barley swathing in WA, visit DAFWA's Barley production – harvest and grain quality article at:
https://www.agric.wa.gov.au/barley/barley-production-harvest-and-grain-quality?page=0%2C1

Acknowledgements
Thank you to the Carter family for sharing the information.

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Canola & Pulses Research Results

Old Canola Variety Performance

William Tan, Research Agronomist, Kalyx Australia

Key Messages

- Latest released variety ATR Snapper recorded the greatest yield and had the highest oil content at 0.95 t/ha and 45% oil content.
- Tanami (released 2006) recorded the lowest yield and also the lowest oil content, averaging 0.57 t/ha and 41.5% oil.
- Older varieties Tanami and Cobbler yielded significantly less than Snapper, demonstrating how newer varieties with similar agronomic attributes can be more profitable.

Aim

To compare the performance of older TT canola varieties (Tanami, Cobbler, Crusher and Snapper) under normal growing conditions in the Ballidu region.

Background

Some canola varieties which are no longer commercially available are still popular in WA, particularly in low rainfall areas. Tanami (2006 release) was bred for these lower rainfall areas and, along with Telfer, is still being grown despite the release of newer varieties Sturt and Stingray. Cobbler, which was released in 2008, is another variety that has maintained popularity mostly due to its elastic flowering window, but has been superseded by several varieties. Snapper and Crusher are the newest of the varieties tested in this trial released in 2011 and 2010 respectively. Snapper and Cobbler are early-mid maturing, while Crusher is a mid-maturing line and Tanami is a variety of early maturity.

Trial Details

Property	Ardoch, east Ballidu		
Plot size & replication	10m x 1.32m x 3 replications		
Soil type	Sandy loam		
Soil pH ($CaCl_2$)	0-10cm: 4.4	10-20cm: 4.3	20-30cm: 4.5
EC (dS/m)	0-10cm: 0.178	10-20cm: 0.088	20-30cm: 0.114
Sowing date	05/05/2015		
Seeding rate	50 plants/m^2		
Paddock rotation	2012 wheat, 2013 lupins, 2014 wheat		
Fertiliser	05/05/2015: 150 kg/ha MAXam, 100 kg/ha Gusto Gold banded 17/07/2015: 100 kg/ha urea		
Herbicides, Insecticides & Fungicides	04/05/2015: 2 L/ha Spray.Seed, 3 L/ha Trifluralin, 0.3 L/ha Alpha-cypermethrin, 1 L/ha Chlorpyrifos 05/05/2015: 100 kg/ha Gusto Gold + Impact 08/06/2015: 1.1 kg/ha Atrazine, 400 mL/ha Clethodim, 0.3 kg/ha Clopyralid, 300 mL/ha Quizalofop, 2% Enhance 30/06/2015: 300 mL/ha Alpha-cypermethrin, 1.1 kg/ha Atrazine, 2% Hasten		
Growing season rainfall	243mm		

Results

Table 1: Average yield and quality results of old canola varieties, east Ballidu 2015.

Variety	Oil (%)	Yield (t/ha)	Admix (%)	Best Grade
Tanami	41.5[b]	0.57[c]	1.92	CAN1
Cobbler	42.6[b]	0.77[b]	1.76	CAN1
Crusher	42.0[b]	0.84[ab]	2.55	CAN1
Snapper	45.1[a]	0.95[a]	2.64	CAN1
LSD	*1.98*	*0.13*		
P value	*0.022*	*0.004*		
Site Mean Oil (%)	*42.8*			
Site Mean Yield (t/ha)	*0.78*			
Site Mean Admix (%)	*2.22*			

Comments

The trial was sown dry on the 5th May and rainfall was limited for the remainder of May with the monthly total at about half the long term average (22mm in 2015). These conditions resulted in a low germination rate. Although plant numbers were below the target of 50 plants/m^2 this was typical of what growers in the area reported this year and plant numbers were considered compatible with farmer expectations for 2015. The total rainfall for the 2015 growing season (April-October) was 243mm compared to the long term average of 265mm. The season was punctuated by heavy rainfall events on the 22nd June and 31st July, which were critical times for the canola. The lack of rainfall in September and October limited yields and differences between varieties would most likely have increased had there been more rainfall during the flowering/pod fill period.

The two newer varieties, Snapper and Crusher, provided the greatest yield; Snapper had the highest yield at 0.95 t/ha and was significantly greater than both Cobbler and Tanami but not significantly different to Crusher, which yielded 0.84 t/ha. Tanami was significantly lower yielding than all other varieties. These yield results and variety rankings are consistent with the long term NVT data for Agzone 2.

All canola made CAN1 grade with all plots recording oil well over 40%. Snapper resulted in the highest oil content at 45.1%, these improvements in oil content are further reason for growers to consider newer varieties. All varieties, with the exception of Tanami, would have received premiums based on the oil content.

Acknowledgements

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Retaining F2 TT Canola Seed in Low Rainfall Areas – How Much Does Hybrid Vigour Degrade and can this be Overcome by Agronomy?

Dr Bob French, Senior Research Officer, DAFWA, Merredin

Key Messages

- The best current open-pollinated TT canola varieties have as good or better yield potential than hybrids.
- Canola crops grown from farm-retained hybrid canola can yield 15% less seed than new F1 hybrid seed with about 1% less oil.
- Keeping the density of crops grown from retained F2 hybrid seed above 30 plants/m² can result in similar gross margins to crops grown from new F1 hybrid seed in environments with yield potential around 1 t/ha, but this may not occur at all sites.

Aim

To measure the loss of hybrid vigour after one generation of keeping hybrid canola seed and to test ways of minimising its economic impact.

Background

With only one Australian seed company (Nuseed) now pursuing development of open pollinated (OP) triazine tolerant (TT) canola varieties there are concerns 80% of WA growers who currently grow TT OP varieties may be forced into hybrid varieties. Given that recent CSIRO research in WA suggests little economic benefit of hybrids where yield potential is less than 1.3 t/ha, it is inevitable that low rainfall growers will look to reduce seed costs by retaining hybrid seed. We wish to determine how much yield and oil they will lose by using retained hybrid TT seed, and if adjusting seed rates, grading seed and/or using mixes of F1 and F2 seed will compensate for this loss.

Trial Details

Property	Ardoch, east Ballidu
Plot size & replication	20m × 1.54m × 3 replications
Soil type	Brown sandy loam over clay at 50cm
Soil pH ($CaCl_2$)	0-10cm: 4.6 10-20cm: 4.8 20-30cm: 5.7
EC (dS/m)	0-10cm: 0.364 10-20cm: 0.158 20-30cm: 0.147
Sowing date	28/04/2015
Seeding rate	0.7 to 3.0 kg/ha, depending on treatment (Table 1)
Paddock rotation	2012 wheat, 2013 lupins, 2014 wheat
Fertiliser	28/04/2015: 100 kg/ha Macropro Plus 01/07/2015: 50 L/ha Flexi-N
Herbicides & Insecticides	28/04/2015: 2 L/ha Spray.Seed, 1.5 L/ha Trifluralin, 1.1 kg/ha Simazine, 100 mL/ha Talstar 08/06/2015: 100 mL/ha Le-Mat 16/06/2015: 1.1 kg/ha Atrazine 24/08/2015: 100 mL/ha Transform 16/10/2015: 3 L/ha Reglone
Growing season rainfall	243mm

Treatments

We compared fresh F1 seed of the hybrid canola variety Hyola 450TT from two seasons (2014 and 2015) with F2 seed retained from a trial at Wongan Hills in 2014. We also tested large (>1.8mm) and small (<1.8mm) fractions of the retained F2 seed, and mixtures of various proportions of retained F2 seed with fresh 2015 F1 seed. The OP variety Bonito was also included as a control. Each seed lot was tested at target densities of 20 and 40 plants/m². Table 1 gives seed sizes, germination, and seed rates used for each treatment.

Table 1: Seed properties and seed rates of each treatment in this experiment.

Seed source	Seeds per kg	Germination (%)	Seed rate for 20 plants/m² (kg/ha)	Seed rate for 40 plants/m² (kg/ha)
Bonito	230,000	98	1.18	2.37
F1 2014	181,000	88	1.48	2.96
F1 2015	235,000	97	1.03	2.06
F2	303,000	99	0.78	1.57
F2 large	256,000	100	0.92	1.84
F2 small	320,000	100	0.73	1.47
F1:F2 25:75			0.85	1.69
F1:F2 50:50			0.91	1.82
F1:F2 75:25			0.97	1.94

Gross margins were calculated assuming production costs of $260/ha + seed costs and a grain price of $513/tonne with an oil bonus of 1.5% of value for each % over 42. Seed costs were calculated assuming a seed price of $24/kg for fresh F1 hybrid seed and $2/kg for retained OP and F2 hybrid seed.

Results

Crop establishment averaged 74% and 78% of the target respectively for 20 and 40 plant/m² targets (see Table 2). Field establishment (the ratio of crop establishment to germinable seeds sown) was the same for all treatments and averaged 65% in this trial.

The highest yielding variety was open-pollinated Bonito but F1 Hyola 450TT from 2014 was not far behind. F1 Hyola 450TT from 2015 was lower yielding than either of these but the difference was not statistically significant. However, Bonito had a higher gross margin than Hyola 450TT because of its lower seed cost and slightly higher oil content.

Seed yield averaged over both densities of crops grown from retained F2 Hyola 450TT seed was 15% less than the average of the two sources of F1 seed and oil content was 1.2 percentage units lower. This resulted in $50.50 lower gross margin for the retained F2 seed despite its lower seed cost. Grading F2 seed and only using the larger fraction improved yield and gross margin slightly compared to ungraded F2 seed, but this was not statistically significant. Mixing fresh F1 seed with retained F2 seed increased yield, oil, and gross margin in proportion to the amount of F1 seed in the mixture, but there were no treatments with gross margin greater than using fresh F1 seed.

While the effect of target density did not change between seed types increasing target density from 20 to 40 plants/m² led to significant increases in yield (Figure 1) and oil (average 0.5 percentage units overall). However, in the case of fresh F1 seed from 2014 (where yield did not increase with density) this was not enough to compensate for the extra seed cost and gross margin declined. All other gross margins increased with density (Figure 2). At a target density of 40 plants/m² gross margins of retained F2 hybrid seed treatments, apart from small seed, were very similar to that of fresh F1 hybrid seed.

Table 2: Crop establishment, yield and quality, and gross margin for canola crops grown from F1 hybrid seed compared with OP and retained F2 hybrid seed. Values for yield, oil and gross margin averaged across target densities.

Seed source	Crop establishment (target 20 plants/m²)	Crop establishment (target 40 plants/m²)	Yield (kg/ha)	Oil (%)	Gross margin ($/ha)
Bonito	14	40	1062[a]	45.8	294[a]
F1 2014	15	33	1044[a]	45.4	244[ab]
F1 2015	18	27	977[ab]	45.2	211[b]
F2	14	25	864[b]	44.1	177[b]
F2 large	15	32	913[b]	44.3	204[b]
F2 small	13	30	751[c]	43.7	115[c]
F1:F2 25:75	13	31	874[b]	44.4	176[b]
F1:F2 50:50	18	32	916[b]	44.6	191[b]
F1:F2 75:25	14	31	1031[a]	45.3	249[ab]
LSD (P=0.05)	*8.4*		*106*	*0.48*	*57.2*
P value	*<0.001*		*<0.001*	*<0.001*	*<0.001*
CV (%)	*39.3*		*9.6*	*0.9*	*22*

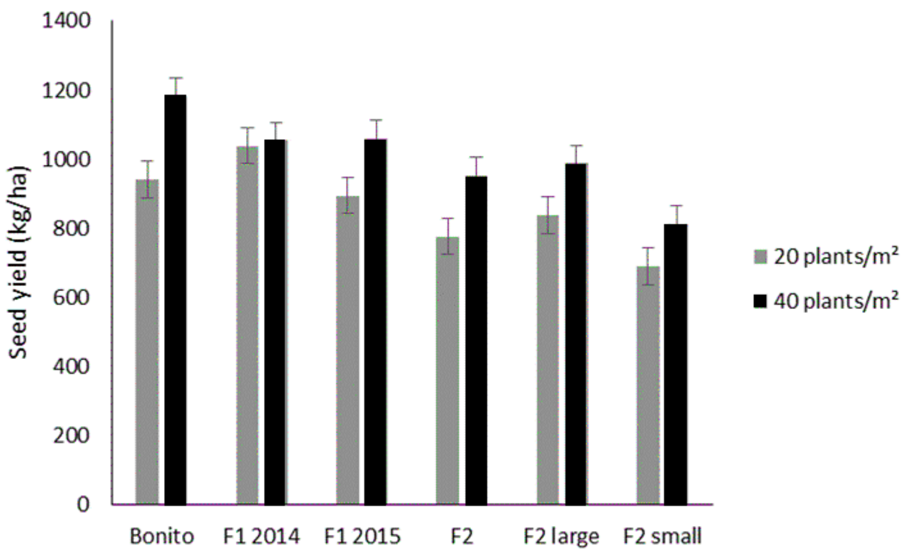

Figure 1: Effect of density on seed yield of OP compared to F1 and retained F2 hybrid canola at Ballidu in 2015.

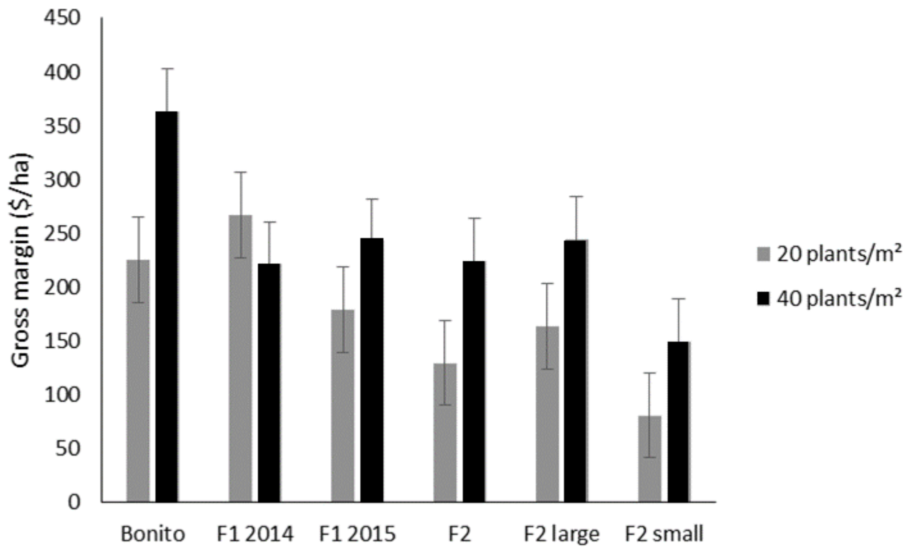

Figure 2: Effect of density gross margin of OP compared to F1 and retained F2 hybrid canola at Ballidu in 2015.

Comments

The yield penalty of retaining hybrid seed ranged from about 10% to about 30% in a series of five trials conducted in low rainfall agricultural environments in WA in 2015, with an average of 19%, consistent with the 15% found here. Although the gross margins were similar for F1 and F2 hybrid seed at the higher density, at some sites gross margin was less for all F2 treatments than for F1 seed.

When a hybrid population begins to segregate genetically as when F2 seed is retained, the population becomes more variable. This can affect traits other than yield and oil, such as disease resistance, so the proportion of blackleg susceptible plants will increase in an F2 population, allowing disease levels to build up (this will be more important in medium and high rainfall environments). Flowering time becomes more variable as there is a greater mix of early and late plants. In another trial with the same design at Grass Patch F2 hybrid canola reached 50% flowering 2.5 days later than F1 canola. Plant height also becomes more variable. Another factor is that up to 25% of F2 plants will be male sterile. This means they will produce no pollen of their own and rely on pollination from adjacent plants to set seed. We recorded 15% male sterile plants in F2 plots in this trial. These considerations should also be taken into account when deciding whether to retain F2 hybrid seed or purchase fresh F1 seed.

Yield, oil, and gross margin responded to increased planting density in this trial. So growers retaining F2 hybrid canola seed should be sure to use enough seed to establish at least 30 plants/m^2. Higher densities will also improve crop competitiveness against weeds. This also applies to OP varieties like Bonito. They should also remember that not all germinable seeds become established plants. The strike rate observed in this trial (65%) is a typical value for field establishment in Western Australia.

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The Hood family and the Liebe Group for their interest in this work and for providing the trial site. Shari Dougall and Bruce Thorpe, DAFWA, Wongan Hills, for trial management; Laurie Maiolo and Salzar Rahman, DAFWA, Merredin, for technical assistance; Stephanie Boyce and Jo Walker, DAFWA, Geraldton, for measuring seed oil contents; Mark Seymour and Jackie Bucat, DAFWA, Esperance and South Perth, for helpful discussions. GRDC for funding the research.

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Yield and Cost Implications of Seed Size in Shallow Planted Canola

Hugh Trenorden, Area Sales, Nuseed

Key Messages

- Seed size did not have a significant effect on canola yield when planted 15-20mm deep.
- Cost differential of establishing a canola plant stand can be substantial.

Aims

- To confirm if seed size has any significant effect on yield in shallow seeding (15-20mm) situations that are common in Western Australia's sandy soils.
- Determine the economic implications on seed size assuming yield is the same.

Background

Canola varieties have progressed considerably in the last five years in relation to early vigour. Previous studies have shown larger seed is the preferred option (e.g. Riethmuller *et al.*, 2002); however, new hybrid varieties and pedigree open pollinated varieties with smaller seed size have been observed to perform well in the field under shallow seeding conditions.

Trial sites selected were located in Binnu and Goomalling. The Binnu trial had only the Bonito treatments while the Goomalling trial tested both Bonito and Wahoo treatments. The treatments were procured using the same method from a selected seed lot of each variety (Table 1). The three seed classes had seeding rates adjusted to account for seed size. A plant population of 35-45 plants/m^2 was targeted assuming a paddock establishment of 60-70%.

Table 1: Treatment seed size and method of separation.

Seed Classification	Seed Size (seeds per kg)	Method of separation
Small	360,000	Passed through 1.5mm slotted sieve
Medium	290,000	Passed through 1.8mm slotted sieve but not the 1.5mm
Large	235,000	Didn't pass through 1.8mm slotted sieve

Note: Pedigree seed typically ranges between 150,000 and 350,000 seeds per kg each year.

Trial Details

Location	NAG Main Trial Site, Binnu	Goomalling, Berring Road
Plot size & replication	10m x 1.55m x 3 replications	8m x 1.75m x 3 replications
Soil type	Deep sand	Sand over clay
Soil pH ($CaCl_2$)	Data unavailable	0-10cm: 5.1
EC (dS/m)	Data unavailable	0-10cm: 0.176
Sowing date	15/04/2015	30/04/2015
Seeding rate	1.6 kg/ha Small seed, 2 kg/ha Medium seed & 2.4 kg/ha Large seed	
Paddock rotation	Data unavailable	2012 canola, 2013 wheat, 2014 wheat
Fertiliser	Data unavailable	30/04/2015: 100 kg/ha DAP NP, 20 kg/ha Sulphate of Potash 24/06/2015: 90 kg/ha urea
Herbicides & Fungicides	Data unavailable	30/04/2015: 2 L/ha Roundup, 2 L/ha Trifluralin, 1 L/ha Lorsban 24/06/2015: RR varieties: 900 g/ha Roundup TT varieties: 2.2 L/ha Atrazine+Select 25/06/2015: 400 mL/ha Prosaro 25/08/2015: 400 mL/ha Prosaro
Growing season rainfall	220mm	230mm

Results

Plant establishment (PE) counts were taken at the 6-8 leaf stage of development. PE ranged between 34% and 78% between locations and varieties. The Wahoo seed was observed to have lower vigour than the Bonito initially but recovered to create comparable plot plant stand by spring.

Table 2: Plant establishment counts/m^2 at Goomalling and Binnu, 2015.

Seed Lot	Plants/m^2	Establishment (%)
Small Bonito Goomalling	45.0	78
Small Wahoo Goomalling	19.5	34
Small Bonito Binnu	23.0	40
Medium Bonito Goomalling	44.5	77
Medium Wahoo Goomalling	29.0	50
Medium Bonito Binnu	20.0	34
Large Bonito Goomalling	42.5	75
Large Wahoo Goomalling	32.0	57
Large Bonito Binnu	27.0	48

Yield Results

There was a significant difference between the yield results of the two varieties at Goomalling but there was no significant difference in yield due to seed size at either site.

Table 3: Yield results (t/ha) at Goomalling and Binnu, 2015.

Treatment & Location	Small Seed (t/ha)	Medium Seed (t/ha)	Large Seed (t/ha)
Bonito Goomalling	1.508	1.494	1.536
Wahoo Goomalling	1.179	1.222	1.113
Bonito Binnu	0.912	1.088	0.980

Cost Analysis

The cost of seed in the canola market varies widely so a range of seed costs have been included to show the cost implications of the differing canola types.

Table 4: Average cost of canola seed $/ha 2015.

Seed Cost per kg	Seeding Rate kg/ha		
	1.6	2.0	2.4
$5	$8	$10	$12
$15	$24	$30	$36
$25	$40	$50	$60
$35	$56	$70	$84

Comments

Consistent with field observations, there was not found to be a significant effect on yield in shallow seeding conditions between small, medium and large seed. The cost implications became more noticeable the higher the cost of seed per kg. The management implications for farmers planting retained open pollinated seed vs hybrid pedigree seed may be different due to this.

Reference:

Riethmuller, G.P., Carmody, P.C. and Walton, G.H. 2002. Improved canola establishment, yield and oil with large seed on sandplain soil in Western Australia, found 15/12/2015 from http://www.australianoilseeds.com/__data/assets/pdf_file/0014/4550/Improved_canola_establishment,_yield_and_oil_with_large_seed_in_WA.pdf

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Canola Variety Demonstration - Pithara

Elly Wainwright, R&D Coordinator, Liebe Group

Aim

To compare Roundup Ready (RR) Hybrids, Hyola® 404RR and 43Y23 (RR), with open pollinated (OP) triazine tolerant (TT) varieties, ATR Bonito and Sturt TT, for yield, oil and gross margin performance.

Background

Advanta Seeds is conducting broadacre evaluations across Australia to determine optimum growing zones, adaptability, and gross margin analysis of hybrid triazine tolerant (TT), hybrid Roundup Ready® (RR) and hybrid Roundup-triazine tolerant (RT) versus purchased or farmer retained open pollinated (OP) TT varieties. These results will form part of the National Hyola ICS database.

TT varieties allow growers to use triazine chemistries (Group C) in-season to provide residual control on broadleaf weeds and suppress some grasses. RR canola gives growers the opportunity to gain early knockdown weed control through application of glyphosate (Group M) where two sprays may be applied before the six leaf stage is reached. Both Group C and M herbicides have moderate risk of resistance development. Their combined use within one season offers two complimentary modes of action (MOA) for weed management.

The demonstration was sown into a paddock with known ryegrass problems at the McIlroy's property in Pithara. Brad McIlroy had not grown RR and RT varieties previously and wanted to compare yield with TT varieties as well as assessing their function in alleviating ryegrass through more in-season herbicide options. However, in this demonstration the comparison was made between only RR hybrids and OP TT varieties.

This demonstration was conducted using farming equipment. Broad-scale demonstrations are a valuable way to explore new varieties, products or practices, complimenting results which are produced through more scientifically rigorous, replicated small plot trials.

Demonstration Details

Property	Glendawn, Pithara
Plot size & replication	9.1m x 1000m x single replication
Soil type	Red loam
Soil pH ($CaCl_2$)	0-10cm: 6.5
Sowing date	28/04/2015: 43Y23 & Hyola 404RR, 29/04/2015: ATR Bonito & Sturt TT
Seeding rate	43Y23: 2.22 kg/ha, Hyola 404RR: 2.35 kg/ha, ATR Bonito: 4 kg/ha, Sturt TT: 4 kg/ha
Paddock rotation	2012 oats, 2013 pasture, 2014 wheat
Fertiliser	28/04/2015: 110 kg/ha AGRAS 26/06/2015: 75 kg/ha urea
Herbicides & Insecticides	25/03/2015: 1.5 L/ha Roundup, 80 mL/ha Garlon 27/03/2015: 1.5 L/ha Spray.Seed 28/04/2015: 400 mL/ha Chlorpyrifos, 2 L/ha Trifluralin 29/04/2015: 100 mL/ha Talstar 03/06/2015: On TT varieties only 500 mL/ha Select, 200 mL/ha Chlorpyrifos, 200 mL/ha Alpha-cypermethrin 08/06/2015: On RR varieties only: 0.9 kg/ha Roundup 24/06/2015: On RR varieties only: 0.9 kg/ha Roundup , 200 mL/ha Chlorpyrifos, 200 mL/ha Alpha-cypermethrin
Growing season rainfall	200mm

Results

This was an unreplicated farmer demonstration, thus interpretations of results are to be made with caution.

Table 1: Plant establishment counts per m^2 conducted three months after sowing (15/07/2015).

Variety	Plants/m^2
43Y23 (RR)	17
Hyola® 404RR	17
ATR Bonito	27
Sturt TT	23

Table 2: Yield, quality and delivery grade of TT and RR canola varieties sown at Pithara, 2015.

Variety	Yield (t/ha)	Oil (%)	Protein (%)	Grade
43Y23 (RR)	1.31	46.3	18.2	CAG 1
Hyola® 404RR	1.25	48.9	18.8	CAG 1
ATR Bonito	1.18	49.2	19.2	CAN 1
Sturt TT	1.05	45.1	20.6	CAN 1

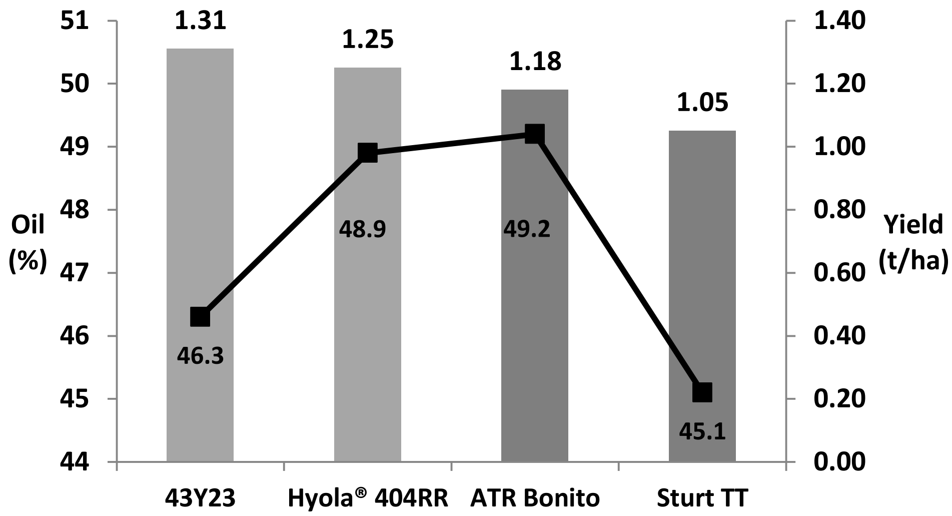

Figure 1: Yield and oil results from canola varieties sown at Pithara, 2015.

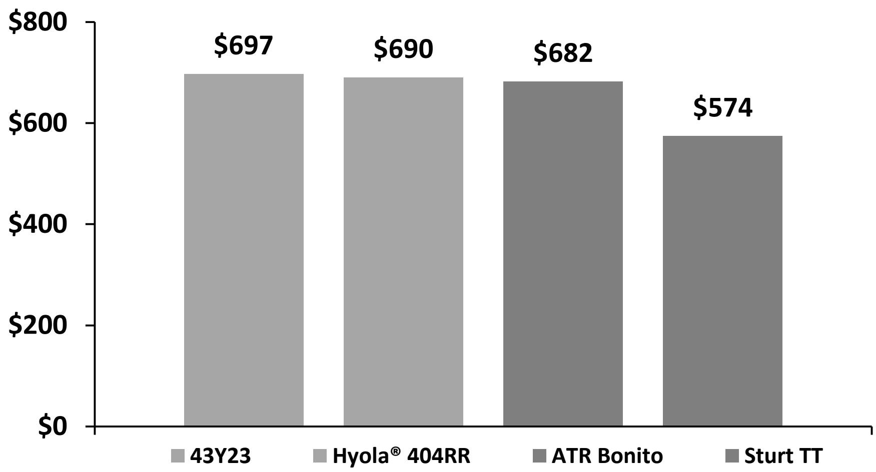

Figure 2: Gross returns based on $500/MT (CAG1) and $522/MT (CAN1) from canola varieties sown at Pithara, 2015.

Comments

In this demonstration both RR hybrid varieties provided a higher percentage of plant establishment (35% to 40% of seed sown) vs OP TT varieties (only achieved 20% to 25% of seed sown) which is consistent with hybrid vs OP comparative published findings from industry and private replicated plot trial research. Despite the hybrid lower seeding rates and overall lower total plants established per m^2 (25% to 35% lower established plants/m^2) than the OP TT varieties, the RR Hybrids still out-yielded the OP TT varieties by between 5% to 20% higher.

Brad was pleased with the harvested yield and weed control levels provided from the RR hybrids, specifically with reference to ryegrass. He noted that at the time of selling the grain there was only a $22 price differential between the RR (GM or CAG1) and TT (CAN1) varieties. Overall, Brad was very happy with the performance of RR hybrids and intends to use them in his future rotations for both yield and weed control purposes.

Although the gross returns $/ha were close between varieties (not including the higher cost for hybrid vs OP seed), the extra weed control in the RR system should be valued in $/ha as part of an overall farm integrated weed management systems approach within the actual growing season and the additional cost savings in subsequent cropping seasons.

Acknowledgements
Thank you to the McIlroy family for hosting and managing the demonstration.

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Lupin National Variety Trial - Ballidu

Australian Crop Accreditation System Limited

Aim

To evaluate yield and quality of new and existing lupin varieties.

Background

NVT is a national program of comparative crop variety testing with standardised trial management, data generation, collection and dissemination. The program is supported by the Australian Government and growers through the Grains Research and Development Corporation and is managed by the Australian Crop Accreditation System Limited.

Trial Details

Property	Ardoch, east Ballidu		
Plot size & replication	1.54m x 10m x 4 replications		
Soil type	Sand		
Soil pH ($CaCl_2$)	0-10cm: 4.4	10-20cm: 4.3	20-30cm: 4.5
EC (dS/m)	0-10cm: 0.178	10-20cm: 0.088	20-30cm: 0.114
Seeding date	28/04/2015		
Seeding rate	100 kg/ha, 220mm row spacing		
Paddock rotation	2012 wheat, 2013 lupins, 2014 wheat		
Fertiliser	28/04/2015: 80 kg/ha Big Phos		
Herbicides & Insecticides	28/04/2015: 100 mL/ha Talstar, 2 L/ha Spray.Seed 250, 2 L/ha Trifluralin, 1 L/ha Outlook, 1.1 kg/ha Simazine 08/06/2015: 100 mL/ha Le-Mat 16/06/2015: 100 g/ha Metribuzin, 100 mL/ha Brodal 07/07/2015: 500 mL/ha Clethodim, 1% Hasten 26/08/2015: 0.3 kg/ha Pirimicarb		
Growing season rainfall	243mm		

Results

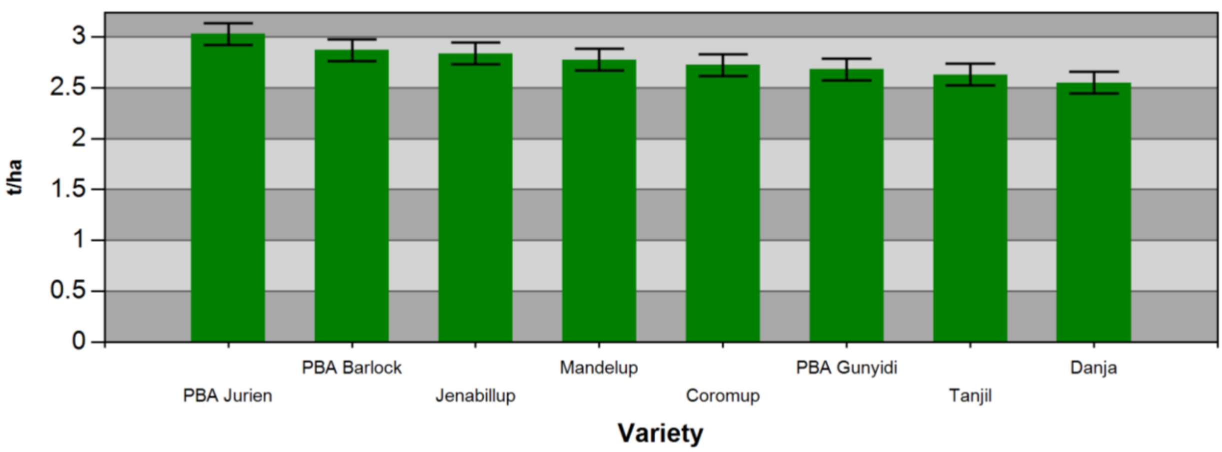

Figure 1: Yield comparison of lupin varieties sown at Ballidu, 2015.

Table 1: Yield of lupin varieties sown in Ballidu, 2015.

Variety Name	Yield (t/ha)	Site Mean (%)
PBA Jurien	3.03	113
PBA Barlock	2.87	107
Jenabillup	2.84	106
Mandelup	2.77	103
Coromup	2.72	101
PBA Gunyidi	2.68	100
Tanjil	2.63	98
Danja	2.55	95
Site Mean (t/ha)	*2.68*	
CV (%)	*5.48*	
P value	*<0.001*	
LSD (t/ha)	*0.21*	*8*

Comments

For more information please refer to www.nvtonline.com.au

Lupin National Variety Trial – Wongan Hills

Australian Crop Accreditation System Limited

Aim

To evaluate yield and quality of new and existing lupin varieties.

Background

NVT is a national program of comparative crop variety testing with standardised trial management, data generation, collection and dissemination. The program is supported by the Australian Government and growers through the Grains Research and Development Corporation and is managed by the Australian Crop Accreditation System Limited.

Trial Details

Property	Wongan Hills Research Station
Plot size & replication	10m x 1.54m x 4 replications
Soil type	Sandy loam over loam
Soil pH ($CaCl_2$)	0-10cm: 7.6 10-30cm: 7.7
EC (dS/m)	0-10cm: 0.153 10-30cm: 0.493
Sowing date	05/06/2015
Fertiliser	01/04/2015: 80 kg/ha Big Phos Manganese
Herbicides & Insecticides	10/02/2015: 0.8 L/ha Glyphosate, 0.8 L/ha 2,4-D Ester, 0.01 L/ha Soyal Phospholipids + Propionic Acid, 0.05 L/ha Triclopyr 19/03/2015: 1 L/ha Glyphosate, 0.5 L/ha 2,4-D Ester, 0.01 L/ha Soyal Phospholipids + Propionic Acid 21/04/2015: 1 L/ha Glyphosate, 0.03 L/ha Carfentrazone-ethyl 12/05/2015: 1.1 kg/ha Simazine, 2 L/ha Paraquat+Diquat, 2 L/ha Trifluralin, 1 L/ha Dimethenamid-P 06/07/2015: 0.15 L/ha Diflufenican, 0.1 L/ha Omethoate
Growing season rainfall	201mm

Results

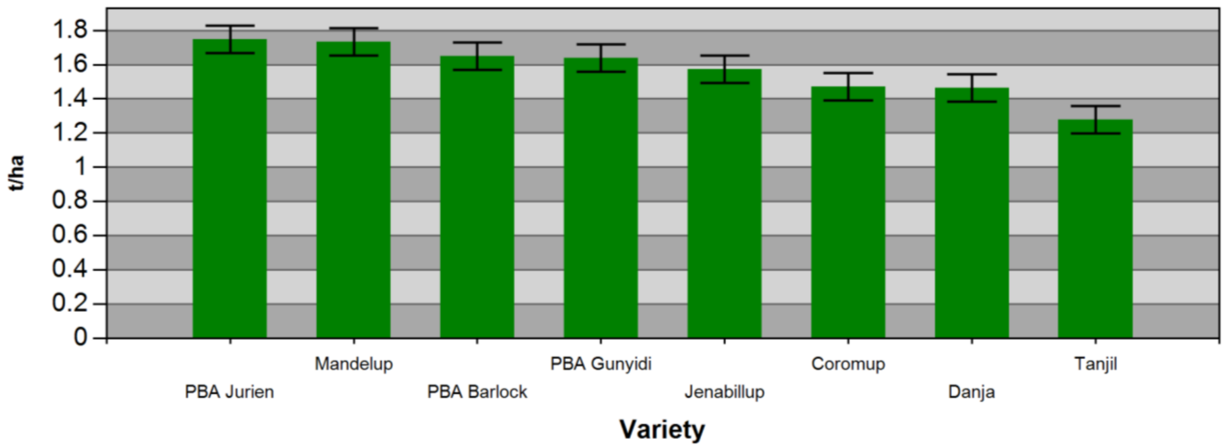

Figure 1: Yield comparison of lupin varieties sown at Wongan Hills, 2015.

Table 1: Yield of lupins varieties sown in Wongan Hills, 2015.

Variety Name	Yield (t/ha)	Site Mean (%)
PBA Jurien	1.75	119
Mandelup	1.73	118
PBA Barlock	1.65	112
PBA Gunyidi	1.64	111
Jenabillup	1.57	107
Coromup	1.47	100
Danja	1.46	99
Tanjil	1.28	87
Site Mean (t/ha)	*1.47*	
CV (%)	*7.38*	
P value	*<0.001*	
LSD (t/ha)	*0.16*	*11*

Comments

For more information please refer to www.nvtonline.com.au

Chickpea National Variety Trial – Wongan Hills

Australian Crop Accreditation System Limited

Aim

To evaluate yield and quality of new and existing chickpea varieties.

Background

National Variety Trials (NVT) is a national program of comparative crop variety testing with standardised trial management, data generation, collection and dissemination. The program is supported by the Australian Government and growers through the Grains Research and Development Corporation (GRDC) and is managed by the Australian Crop Accreditation System Limited.

Trial Details

Property	Wongan Hills Research Station
Plot size & replication	10m x 1.54m x 4 replications
Soil type	Sandy loam over loam
Soil pH ($CaCl_2$)	0-10cm: 7.6 10-60cm: 7.7
EC (dS/m)	0-10cm: 0.2 10-60cm: 0.5
Sowing date	26/05/2015
Fertiliser	26/05/2015: 80 kg/ha DAP
Herbicides, Insecticides & Fungicides	26/05/2015: 0.3 L/ha Chlorpyrifos, 1.5 L/ha Trifluralin, 2 L/ha Paraquat + Diquat 27/05/2015: 0.1 L/ha Bifenthrin, 0.1 L/ha Isoxaflutole 26/06/2015: 0.3 kg/ha Flumetsulam 13/07/2015: 0.01 L/ha Esters of Canola oil, 0.5 L/ha Clethodim 27/08/2015: 200 mL/ha Alpha-cypermethrin, 2 L/ha Chlorothalonil 20/10/2015: 3 L/ha Diquat
Growing season rainfall	201mm

Results

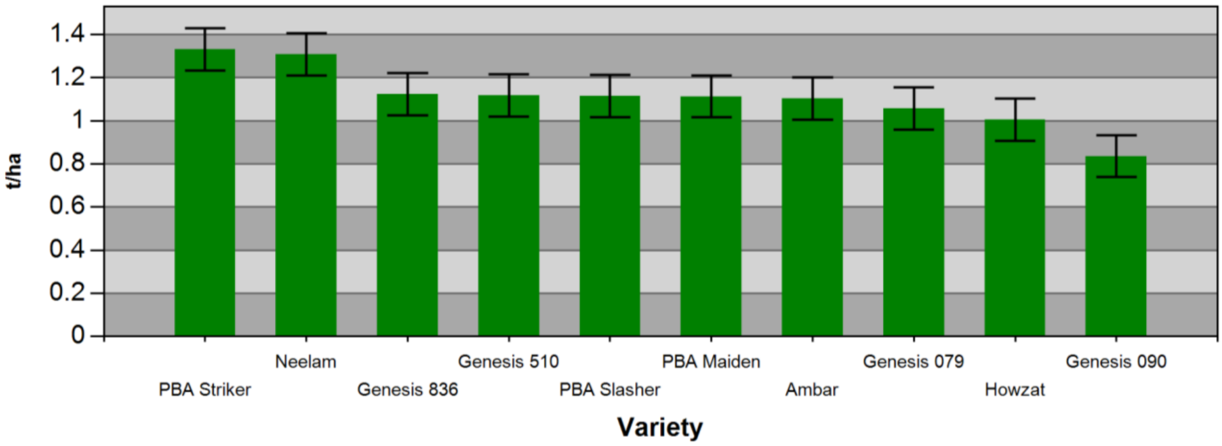

Figure 1: Yield comparison of chickpea varieties sown in Wongan Hills, 2015.

Table 1: Yield of chickpea varieties sown at Wongan Hills, 2015.

Variety Name	Yield (t/ha)	Site Mean (%)
PBA Striker	1.33	120
Neelam	1.31	118
Genesis 836	1.12	101
Genesis 510	1.12	101
PBA Slasher	1.11	100
PBA Maiden	1.11	100
Ambar	1.10	99
Genesis 079	1.06	95
Howzat	1.00	90
Genesis 090	0.84	75
Site Mean (t/ha)	*1.11*	
CV (%)	*11.39*	
P value	*<0.001*	
LSD (t/ha)	*0.2*	*18*

Comments

For more information please refer to www.nvtonline.com.au

Field Pea National Variety Trial – Wongan Hills

Australian Crop Accreditation System Limited

Aim

To evaluate yield and quality of new and existing field pea varieties.

Background

NVT is a national program of comparative crop variety testing with standardised trial management, data generation, collection and dissemination. The program is supported by the Australian Government and growers through the Grains Research and Development Corporation and is managed by the Australian Crop Accreditation System Limited.

Trial Details

Property	Wongan Hills Research Station
Plot size & replication	10m x 1.54m x 4 replications
Soil type	Sandy loam over loam
Soil pH ($CaCl_2$)	0-10cm: 7.6 10-60cm: 7.7
EC (dS/m)	0-10cm: 0.2 10-60cm: 0.5
Sowing date	26/05/2015
Fertiliser	26/05/2015: 80 kg/ha DAP
Herbicides, Insecticides & Fungicides	26/05/2015: 0.3 L/ha Chlorpyrifos, 1.5 L/ha Trifluralin, 2 L/ha Paraquat + Diquat 27/05/2015: 0.1 L/ha Bifenthrin, 0.07 kg/ha Imazethapyr 26/06/2015: 0.03 kg/ha Flumetsulam 13/07/2015: 0.01 L/ha Esters of Canola oil, 0.5 L/ha Clethodim 27/08/2015: 0.2 L/ha Alpha-cypermethrin, 2 L/ha Chlorothalonil
Growing season rainfall	201mm

Results

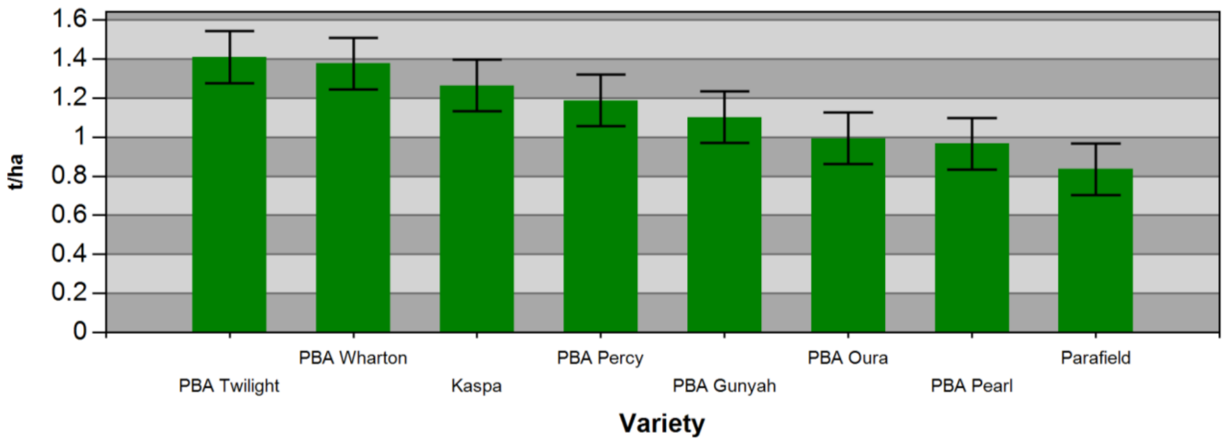

Figure 1: Yield comparison of field pea varieties sown at Wongan Hills, 2015.

Table 1: Yield of field pea varieties sown at Wongan Hills, 2015.

Variety Name	Yield (t/ha)	Site Mean (%)
PBA Twilight	1.41	111
PBA Wharton	1.38	108
Kaspa	1.26	99
PBA Percy	1.19	93
PBA Gunyah	1.10	87
PBA Oura	0.99	78
PBA Pearl	0.97	76
Parafield	0.84	66
Site Mean (t/ha)	*1.27*	
CV (%)	*14.45*	
P value	*<0.001*	
LSD (t/ha)	*0.26*	*21*

Comments

For more information please refer to www.nvtonline.com.au

Crop Sequencing Results

Focus Paddocks Track Soil Diseases & Weeds

Martin Harries, Research Officer, DAFWA

Key Messages

- Overall the vast majority of Liebe paddocks were maintained in a productive state for wheat.
- In the Liebe area land use was 70% cereal, 25% break crop and 5% pasture.
- Increasing incidence of root disease is a concern.
- The level of rhizoctonia DNA decreased over the growing season under canola crops.

Aim

The aim of the Focus Paddock project was to compile information on the suitability and productivity of crop and pasture sequences across the WA Wheatbelt. We measured physical attributes of the soil, weed populations and incidence of root disease over six years.

Background

The survey was conducted within the cropping zone of south-western WA with the same 184 paddocks surveyed each year from 2010–15. Paddocks were selected to encompass a range of crop and pasture sequences representative of the wider industry. The paddocks covered a broad geographical area encompassing 14 agro-ecological zones and several common soil types. For the Liebe Group we had sites clustered at three locations: Coorow, Maya and Dalwallinu. It was anticipated that some growers at first might have viewed the survey as an opportunity to investigate poor-performing paddocks. To ensure this did not bias the selection of sample sites we stipulated that paddocks typical of the farm be nominated, not the worst paddock or the best paddock.

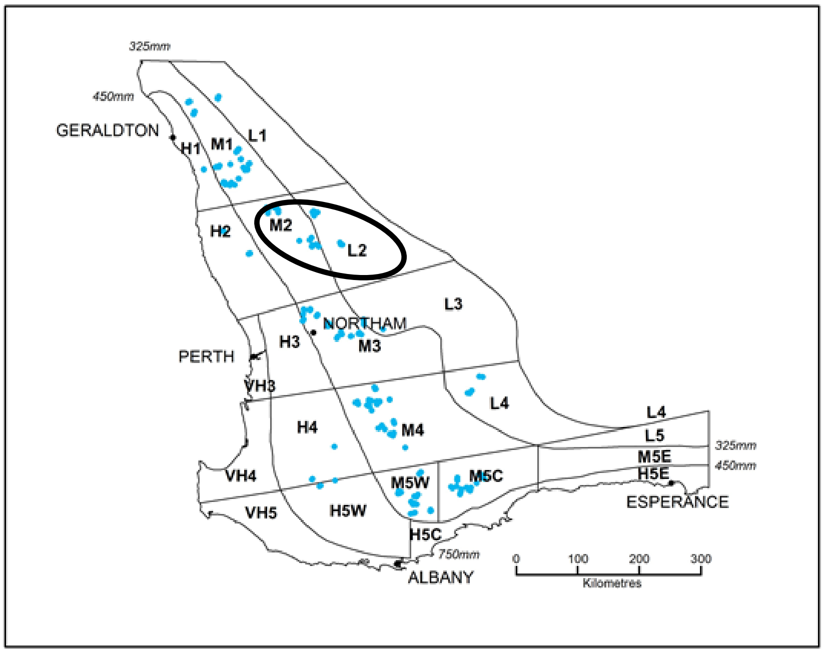

Figure 1: Paddock locations within the cropping zone of south-western Australia where the Focus Paddock survey was undertaken, 2010–15. Numbers refer to agricultural regions Northern (1 and 2), Central (3 and 4) and Southern (5). Liebe paddocks are highlighted in the circle.

We defined sampling sites as one-hectare areas with average paddock production, as advised by the grower. The hectare area started at least 30m from the edge of the paddock to avoid edge effects and any anomalous management. Each hectare area was divided into four pseudo replicates to ensure sampling across the entire area but samples were bulked for analysis. Samples of soil, plants and weed seed as well as measurements of weed populations were taken four times during the year: before sowing, 3-4 weeks after emergence, at anthesis and at crop maturity.

Results

Wheat made up the majority (58%) of land uses in the 184 paddocks monitored. Of the other crops, canola was the next most frequently used (14%) followed by lupin (7%) and barley (6%). Pastures were used 12% of the time. The remaining paddocks were used to produce a range of pulse crops and oats, and as fallow. In the northern region 66% of paddocks were sown to wheat, this compared to 58% in the central region and 47% in the southern region. Cereals made up almost 70% of land use across the northern region; Liebe, Mingenew-Irwin, Yuna and West Midlands groups (Table 1).

Table 1: Break down of land uses of Focus Paddocks in the Northern Region.

Land use	No of paddocks	%
Wheat	230	65.9
Canola	49	14.0
Pasture	23	6.6
Lupin	34	9.7
Barley	4	1.1
Oat	1	0.9
Pea	3	0.9
Chickpea	2	0.6
Fallow	1	0.3
Total	349	100

Disease

The level of soil pathogens increased across the Focus Paddocks from 2010 to 2015. For the Liebe Group paddocks there were increases in the amount of take-all, crown rot and *P.neglectus* (root lesion nematode) and rhizoctonia levels (Figure 2). Given the high amount of cereals being grown it is unsurprising that crown rot and take-all increased. It should also be noted that take-all is suppressed in acid soils (below pH 4.7 $CaCal_2$) and many paddocks were limed which increased pH over the period of the study. *P.neglectus* also increased; again this is expected as host species including the cereals and canola made up around 80% of land use.

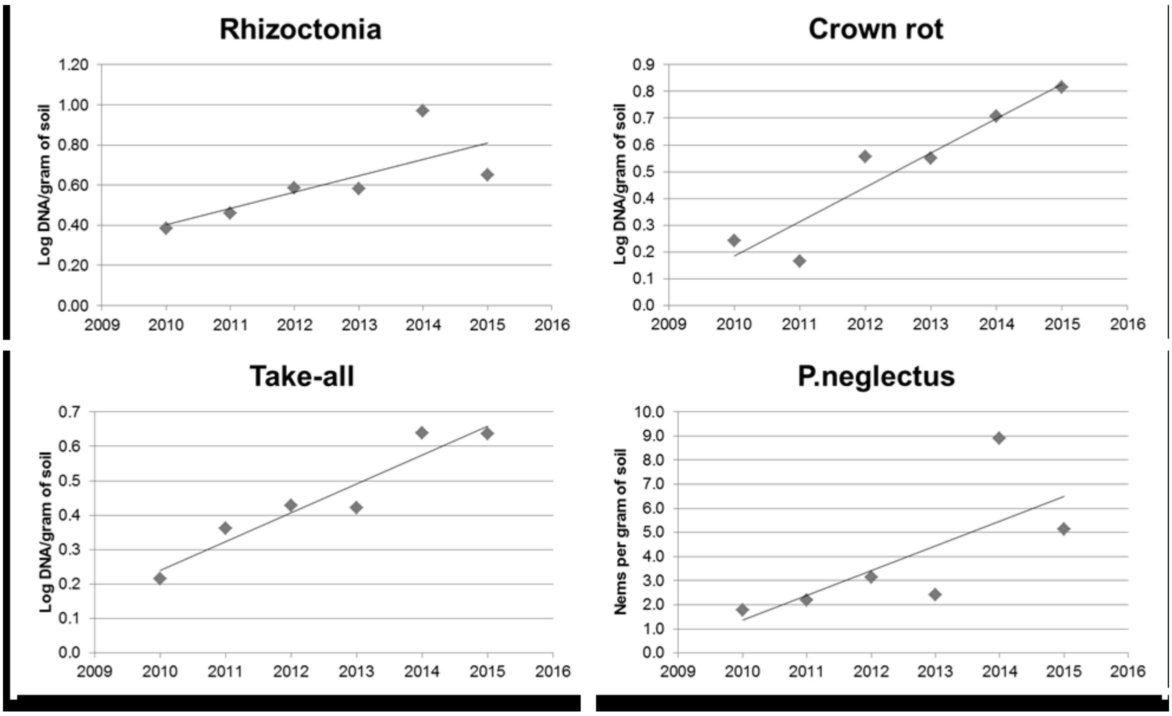

Figure 2: The average concentration of pathogen DNA in soil from the Liebe Group paddocks, 6 years of survey data.

When we look at whether the pathogens increased under each land use we found that canola was a poor host of rhizoctonia (Figure 3). The level of rhizoctonia DNA decreased over the growing season under canola crops. This was a new finding as it was thought that the host range of rhizoctonia was so wide that crop rotation could not be used to manage it. We also found that canola hosted *P.neglectus* better than field pea or lupin so if growers were switching from lupin and field pea to canola the risk of *P.neglectus* increasing was greater (Figure 3). This highlights the need to understand which crops host which diseases when planning crop and pasture rotations.

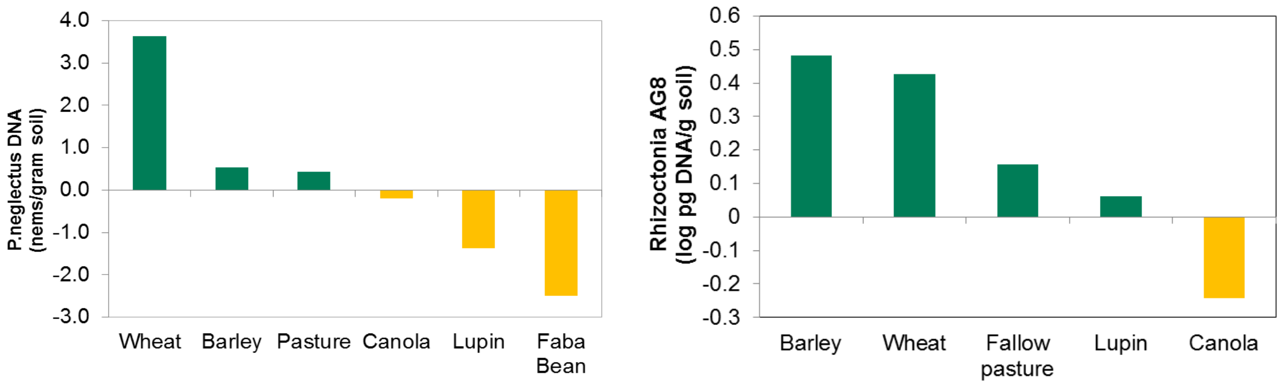

Figure 3: The effect of different land use on rhizoctonia and *P.neglectus* inoculum over the growing season, averages of all focus paddocks across the state.

Weeds

The weed level was reasonably low at the start of the project with 9 grass weeds/m^2 for the Liebe paddocks in 2010. Numbers of weeds have fluctuated quite widely with the highest being recorded after sowing in 2012 at 59 grass weeds/m^2 after a wet winter in 2011. This germination was quite well controlled with a reduction to 17 grass weeds/m^2 by the end of the 2012 season. In contrast a large germination of weeds in 2013, 38 grass weeds/m^2 was not well controlled with a spring weed count of 35 grass weeds/m^2. Since the poor in-crop control of 2013, control has been good with grass weeds counted after seeding reducing to 15/m^2 in 2014 and 7/m^2 in 2015, back to 2010 levels.

The Liebe results are very similar to the overall results across the study where there were 7 grass weeds/m^2 at the start of the study and a slight increase to 10/m^2 as of June 2015. The same trends occurred over years, with poor in-crop control in 2013 in Liebe paddocks. When looking at the impact of different land uses the results indicated that weeds increased in wheat (Figure 4) even though it was sown to clean paddocks, 10 weeds/m^2 at 4-6 weeks after establishment (prior to selective herbicide applications). In canola paddocks there were on average 26 weeds/m^2 after establishment but this dropped to 7/m^2 by harvest. Oaten hay and pasture gave the best weed control and reduced weeds from around 40 plants/m^2 to around 3/m^2 at the end of the season. The pastures in the survey were either very productive legume based pastures or well managed low input pastures, almost all were chemical fallows in many cases. The results show that generally there was a very low tolerance of weed blow-outs.

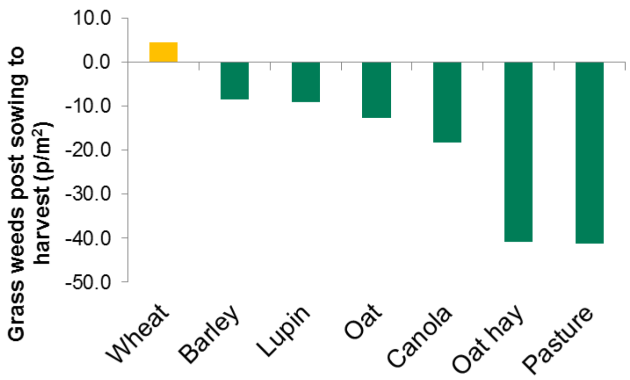

Figure 4: The effect of land use on grass weeds/m^2 state wide over the span of the project.

Comments

Farming systems in WA have undergone significant changes in the early part of the 21st century. The necessity to control seed banks of herbicide resistant weeds, changes in commodity prices and technological and agronomic challenges and developments have changed the typical rotations used. For example in 1999 grain legumes were sown over 2.1 million hectares and by the start of the project in 2010 the area sown was at approximately 0.6 million hectares. Over the same period sheep numbers declined from 23 million head to 13.9 million head and canola production increased from 0.39 to 1.1 million hectares.

The survey results reflect these changes in farming systems and the regional differences that would be expected. Importantly we have been able to pick up changes in paddock biology associated with this shift in farming system. While weeds are a constant challenge on the whole they are being well managed. The increased incidence of root diseases is a concern, as is the low level of legumes, which reduces soil nitrogen in some paddocks.

Whilst there are some concerns with the current rotations, overall the vast majority of paddocks monitored were maintained in a suitable condition for wheat production by using break crops and pastures employed at around 30% of land use.

For more information go to the DAFWA Focus Paddock web page and scroll down for links https://www.agric.wa.gov.au/grains-research-development/focus-paddocks-project-%E2%80%93-profitable-crop-and-pasture-sequencing or search focus paddocks on the DAFWA web site.

Acknowledgements

Thanks again to the Liebe Group staff who did a magnificent job on this project and to the farmers who generously gave their time. Also to Jo Walker from DAFWA Geraldton for coordinating and assisting with the field work and Wayne Parker DAFWA Geraldton as the group contact.

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Fertiliser, Herbicide & Fungicide Research Results

Wheat Response to Seed Rate and Nitrogen

Bob French, Senior Research Officer, DAFWA, Merredin

Department of **Agriculture** and **Food**

GOVERNMENT OF WESTERN AUSTRALIA

Key Messages

- In a high yield potential season, seeding wheat at 60 kg/ha gave higher yield and gross margin than at 30 kg/ha, but there was no gain from increasing the rate to 90 kg/ha.
- On a soil with low nitrogen levels, in a high yield potential season, wheat yield and protein responded to 50 kg/ha of applied nitrogen.
- Grain protein was very low so the crop would have responded to even higher nitrogen rates.

Aim

To define the nitrogen and crop density responses of current wheat varieties in a low rainfall cropping environment, and their interaction.

Background

Low rainfall wheat farmers typically use seeding rates in the range of 40-50 kg/ha, giving crop densities of 80-100 plants/m². In more marginal environments seeding rates may be as low as 30 kg/ha to minimise the risk of crops using too much soil water before grain fill and 'haying-off' in spring. However, this could limit the ability of the crop to respond to good seasons when they occur. It could also limit the potential of the crop to respond to nitrogen (N) fertiliser as well. When choosing seeding rate farmers need to strike a compromise between the risk of crops haying-off when seasonal conditions are poor and missing out on yield potential when they are good. Different wheat varieties can vary in their response to seed rate and N application differently, so there is a need to test these variables with current wheat varieties.

Trial Details

Property	George and Adam Storer, North Koorda			
Plot size & replication	10m × 1.54m x 3 replications			
Soil type	Alkaline red shallow loamy duplex (WA soil group 503)			
Soil pH ($CaCl_2$)	0-10cm: 5.4	10-20cm: 5.5	20-30cm: 5.9	30-40cm: 6.3
EC (dS/m)	0-10cm: 0.071	10-20cm: 0.083	20-30cm: 0.096	30-40cm: 0.203
Soil mineral N sampled 08/04/2015 (mg/kg)	0-10cm: 14 Total N in top 40cm: 36 kg N/ha	10-20cm: 6	20-30cm: 5	30-40cm: 7
Sowing date	13/05/2015			
Seeding rate	See treatments			
Paddock rotation	2012 canola, 2013 wheat, 2014 volunteer pasture			
Fertiliser	13/05/2015: 120 kg/ha CSBP Super CZM N fertiliser: See treatments			
Herbicides	13/05/2015: 2 L/ha Spray.Seed, 118 g/ha Sakura 26/06/2015: 300 mL/ha Axial, 0.5% Adigor 14/07/2015: 1 L/ha Velocity, 1% Hasten			
Growing season rainfall	225mm (141.5mm in February, March, April)			

Treatments

6 wheat cultivars (Calingiri, Corack, Emu Rock, Mace, Magenta, Wyalkatchem) × 4 N rates (0, 10, 30, 50 kg/ha) × 3 seed rates (target densities 60, 120, 180 plants/m²). N rates were applied as 10kg N/ha at seeding with an additional 20 or 40kg N/ha as Flexi-N at mid-tillering (23 June) to give the appropriate rate. Seed rates were chosen to give the target densities on the basis of seed size and germination percentage, but approximately 30, 60, and 90 kg/ha to give 60, 120, and 180 plants/m² respectively.

Results

Assuming 30% of summer rainfall is available to the crop, 80mm is lost by soil surface evaporation, and a transpiration efficiency of 20 kg/ha/mm, the yield potential at this site was predicted to be 3.75 t/ha. All cultivars achieved this yield at the highest N rate with some exceeding it. Variety, plant density, and N rate all had significant effects on grain yield, but there were no significant interactions between any of these factors (Table 1). Grain protein responded only to N rate but protein levels were low across all cultivars, even with 50 kg/ha of applied N. Screenings were low, but there were significant differences between cultivars, with Emu Rock and Magenta being higher than the others. Screenings did not respond to N rate or plant density. Hectolitre weight was high; it differed between cultivars (Corack and Emu Rock were highest) and declined slightly with increasing N rate but this effect was marginal.

Table 1: Yield and quality response of six wheat cultivars to N at Koorda, 2015 (averaged over densities).

Variety	N rate (kg/ha)	Yield (t/ha)	Protein (%)	Screenings (%)	Hectolitre Weight (kg/hL)
Calingiri	0	3.11	8.8	1.4	80.8
Calingiri	10	3.09	9.0	1.4	80.8
Calingiri	30	3.44	9.3	1.5	80.7
Calingiri	50	3.70	9.8	1.4	80.2
Corack	0	3.34	8.6	1.5	83.6
Corack	10	3.59	8.7	1.4	83.6
Corack	30	4.02	8.7	1.5	83.0
Corack	50	4.17	9.2	1.4	82.9
Emu Rock	0	3.12	8.6	3.2	83.1
Emu Rock	10	3.39	8.8	3.2	83.1
Emu Rock	30	3.81	8.9	2.4	83.0
Emu Rock	50	3.99	9.4	2.9	82.6
Mace	0	3.03	8.0	1.4	81.6
Mace	10	3.29	8.3	1.5	81.8
Mace	30	3.86	8.9	1.4	82.2
Mace	50	4.01	9.4	1.6	82.1
Magenta	0	3.30	8.1	1.9	81.1
Magenta	10	3.51	8.3	2.4	80.5
Magenta	30	3.65	8.9	2.5	79.8
Magenta	50	3.77	9.4	2.6	79.3
Wyalkatchem	0	3.16	8.6	1.3	82.5
Wyalkatchem	10	3.32	8.6	0.9	82.3
Wyalkatchem	30	3.75	8.9	1.3	82.2
Wyalkatchem	50	3.94	9.4	1.9	82.0
LSD (P=0.05)		*0.31*	*0.61*	*0.52*	*0.9*
P value for variety		*0.005*	*0.19*	*< 0.001*	*<0.001*
P value for N rate		*<0.001*	*<0.001*	*0.92*	*0.003*
P value for N rate × variety		*0.12*	*0.18*	*0.008*	*0.17*
CV (%)		*8.3*	*4.3*	*27.3*	*1.0*

Table 2: Yield and quality response of six wheat cultivars to density at Koorda, 2015 (averaged over N rates).

Variety	Target plant density (#/m^2)	Yield (t/ha)	Protein (%)	Screenings (%)	Hectolitre Weight (kg/hL)
Calingiri	60	3.11	8.8	1.5	80.8
Calingiri	120	3.09	9.0	1.4	80.6
Calingiri	180	3.44	9.3	1.4	80.6
Corack	60	3.34	8.6	1.5	83.1
Corack	120	3.59	8.7	1.5	83.2
Corack	180	4.02	8.7	1.3	83.5
Emu Rock	60	3.12	8.6	2.8	82.7
Emu Rock	120	3.39	8.8	2.9	82.9
Emu Rock	180	3.81	8.9	3.0	83.4
Mace	60	3.03	8.0	1.8	81.8
Mace	120	3.29	8.3	1.4	81.9
Mace	180	3.86	8.9	1.3	82.0
Magenta	60	3.30	8.1	2.4	80.8
Magenta	120	3.51	8.3	2.2	79.6
Magenta	180	3.65	8.9	2.5	80.2
Wyalkatchem	60	3.16	8.6	1.3	82.1
Wyalkatchem	120	3.32	8.6	1.0	82.1
Wyalkatchem	180	3.75	8.9	1.0	82.5
LSD (P=0.05)		*0.31*	*0.61*	*0.47*	*0.8*
P value for variety		*0.005*	*0.19*	*< 0.001*	*< 0.001*
P value for density		*< 0.001*	*0.64*	*0.13*	*0.11*
P value for density × variety		*0.86*	*0.35*	*0.25*	*0.09*
CV (%)		*8.3*	*4.3*	*27.3*	*1.0*

Gross margins were calculated using a price of $270/tonne for ASW1 and production costs ranging from $252/ha to $364/ha depending on fertiliser application and seed rate. Although Calingiri did not yield as well as other cultivars and its gross margin was therefore lower there was no significant cultivar effect on gross margins. Increasing N rate from nil to 30 kg/ha increased gross margin by $99/ha on average. Further increasing N rate to 50 kg/ha increased it by a further $17/ha. Increasing density from 60 to 120 plants/m² also increased gross margin by $39/ha but further increasing it to 180 plants/m² did not lead to any further increase.

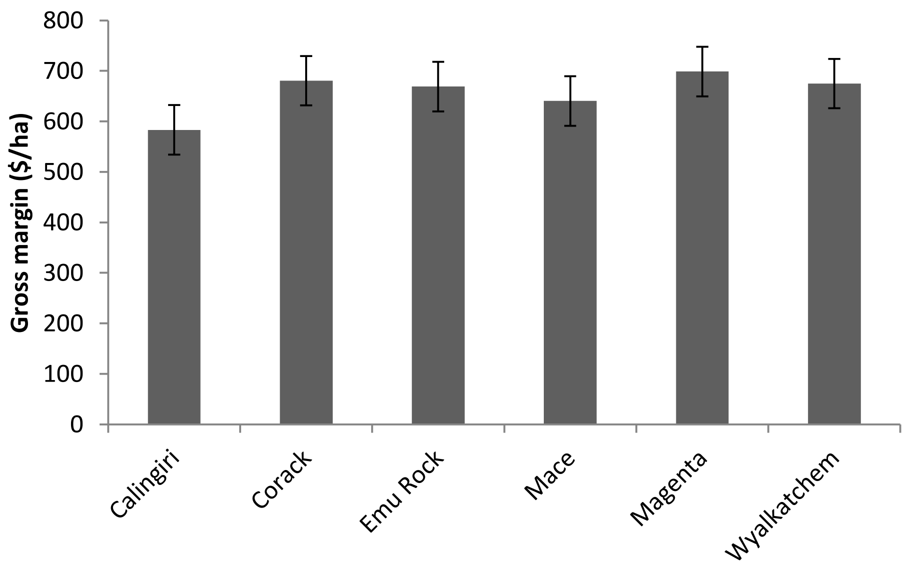

Figure 1: Gross margins of 6 wheat cultivars grown at Koorda in 2015 (averaged over N and density treatments).

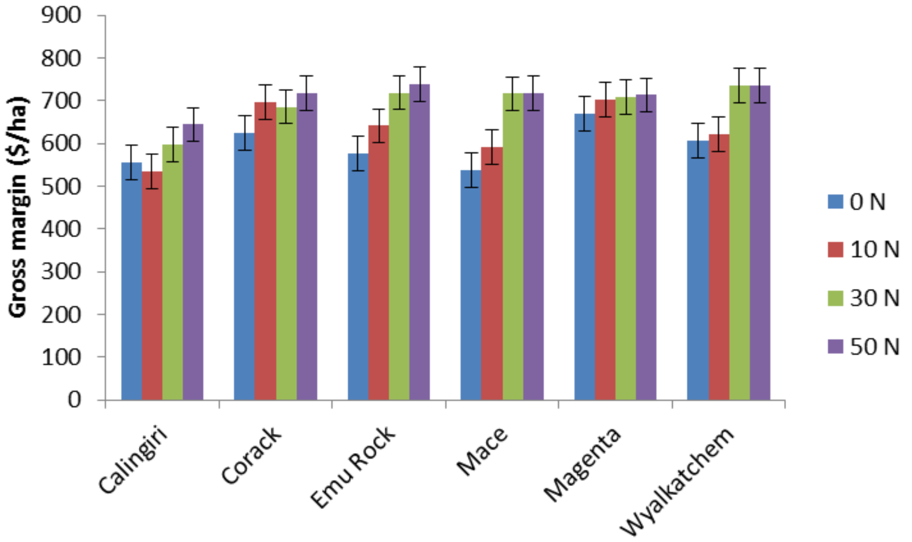

Figure 2: How gross margins of 6 wheat cultivars grown at Koorda in 2015 respond to N application (averaged over density treatments).

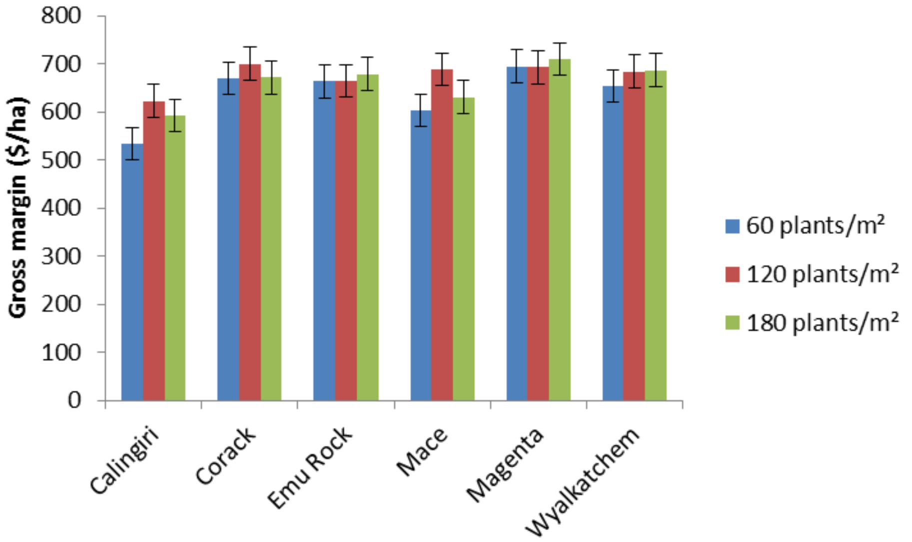

Figure 3: How gross margins of 6 wheat cultivars grown at Koorda in 2015 respond to plant density (averaged over N treatments).

Comments

Despite 2015 not being a low rainfall season these results are relevant to our question as the area north-east of Koorda is typically a low rainfall environment and seasons such as 2015 do occur. In fact spring at this site was dry; there was only 3.5mm rain in September and none in October. The density responses suggest that 60 plants/m² (about 30 kg/ha) was too low for this season, but there was little advantage increasing density from 120 to 180 plants/m² (60 to 90 kg/ha) even in this high yield potential season. This site had low starting N, and with organic carbon of 0.7% in the top 10cm, limited capacity to provide N by mineralisation. There was a strong response to applied N and, given the very low grain protein levels, it is likely there would have been further responses to higher rates. The highest yielding treatment in Table 1 (Corack with 50kg N/ha) had 61 kg/ha of grain N (yield multiplied by N in grain protein). Therefore even with the applied fertiliser, the soil would have to supply N to satisfy the needs of the grain. More would be required for the N content of the straw.

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Flexi-N Timing and Potassium Placement

Angus McAlpine, Dalwallinu Area Manager, CSBP

Key Messages

- Improved nitrogen uptake from Flexi-N (FN) banded at seeding compared to applying nitrogen before seeding.
- Additional nitrogen in June was very profitable.
- There was no response to potassium.

Aim

To compare the effectiveness of Flexi-N applied before seeding, banded below the seed and applied post seeding, and to determine the benefits of banded potassium.

Background

Intensive cropping rotations and the movement (e.g. windowing), removal (e.g. hay) and burning of stubbles within paddocks has increased the occurrence of potassium (K) deficiencies. Furthermore the increased incidence of drought stress conditions in season limits the effectiveness of topdressed fertilisers (and availability of soil nutrient reserves), and increases the dependence upon banded fertiliser inputs. Adequate K nutrition is important to maximise water and nutrient use efficiency.

Trial Details

Property	Ardoch, East Ballidu
Plot size & replication	20m x 2.5m x 3 replications
Soil type	Grey yellow sand
Soil pH ($CaCl_2$)	See soil test results below
EC (dS/m)	See soil test results below
Sowing date	20/05/2015
Seeding rate	60 kg/ha Mace wheat
Paddock rotation	2012 pasture, 2013 wheat, 2014 canola
Fertiliser	01/04/2015: 40 kg/ha Muriate of Potash 20/05/2015: treatments as below 29/06/2015: 50 L/ha Flexi-N (treatments 5,6,7,8 only)
Herbicides	20/05/2015: 1.8 L/ha Roundup Powermax, 118 g/ha Sakura, 300 mL/ha Lontrel 29/06/2015: 800 mL/ha Velocity + oil
Growing season rainfall	237mm (April-September)

Soil Test Results

Depth (cm)	pH ($CaCl_2$)	EC (dS/m)	OC (%)	Nit N (mg/kg)	Amm N (mg/kg)	P (mg/kg)	PBI	K (mg/kg)	S (mg/kg)
0-10	6.2	0.17	0.6	16	2	26	22	45	72
10-20	4.8	0.04	0.2	1	2	34	18	30	12
20-30	5.1	0.02	0.1	1	1	3	27	43	18
30-40	5.8	0.02	0.1	1	1	3	28	49	14
40-50	6.3	0.02	0.2	1	1	6	32	32	9

Results

Table 1: The effect of fertiliser on yield and quality at Ballidu in 2015.

	Treatment								Harvest			
Trt	April (kg/ha)	IBS* (L/ha)	Band (L/ha)	Banded (kg/ha)	Z23 (L/ha)	N	P	K	Yield (t/ha)	Prot. (%)	HL Wt (kg/hL)	Scr. (%)
1	-	-	-	-	-	0	0	0	1.22[d]	8.3[c]	76	5
2		-	-	80 K-Till Extra Plus	-	8	8	11	1.53[c]	8.2[c]	76	4
3	-	50 FN**	-	80 K-Till Extra Plus	-	29	8	11	1.80[b]	8.5[bc]	77	4
4	-	-	50 FN	80 K-Till Extra Plus	-	29	8	11	1.91[b]	8.7[b]	77	5
5	-	-	-	80 K-Till Extra Plus	50 FN	29	8	11	1.90[b]	8.2[c]	76	4
6	-	-	50 FN	58 Agstar Extra	50 FN	50	8	0	2.20[a]	9.5[a]	77	4
7	-	-	50 FN	80 K-Till Extra Plus	50 FN	50	8	11	2.14[a]	9.4[a]	78	4
8	40 MoP	-	50 FN	58 Agstar Extra	50 FN	50	8	20	2.12[a]	8.9[b]	76	3
								P value	*<0.001*	*<0.001*	*0.13*	*0.55*
								LSD	*0.20*	*0.47*	*NS*	*NS*

*IBS = Incorporated by sowing, **FN = Flexi N

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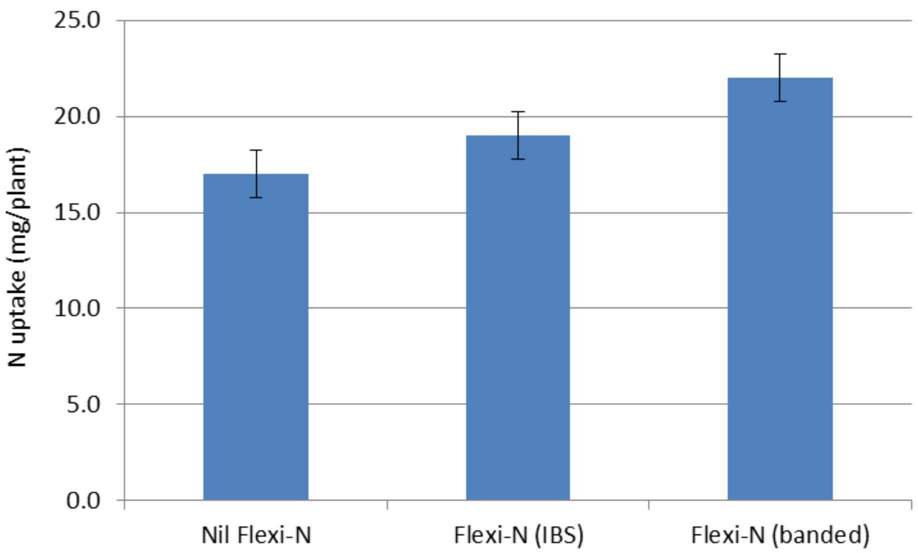

Figure 1: Nitrogen (N) uptake to 14 July at Ardoch, east Ballidu.

Economic Analysis

Table 2: Economic analysis of fertiliser treatments ($/ha) at Ballidu, 2015.

	Treatment					Harvest	Fertiliser Economics		
Trt	April (kg/ha)	IBS* (L/ha)	Band (L/ha)	Banded (kg/ha)	Z23 (L/ha)	Yield (t/ha)	Response ($/ha)	Cost ($/ha)	Profit ($/ha)
1	-	-	-	-	-	1.22[d]	-	-	-
2		-	-	80 K-Till Extra Plus	-	1.53[c]	76	67	8
3	-	50 FN**	-	80 K-Till Extra Plus	-	1.80[b]	140	105	35
4	-	-	50 FN	80 K-Till Extra Plus	-	1.91[b]	168	100	67
5	-	-	-	80 K-Till Extra Plus	50 FN	1.90[b]	164	105	59
6	-	-	50 FN	58 Agstar Extra	50 FN	2.20[a]	236	117	119
7	-	-	50 FN	80 K-Till Extra Plus	50 FN	2.14[a]	222	139	83
8	40 MoP	-	50 FN	58 Agstar Extra	50 FN	2.12[a]	218	150	68
					P value	*<0.001*			
					LSD	*0.20*			

Economics based on current fertiliser list prices including freight, $250/t for wheat.
*IBS = Incorporated by sowing, **FN = Flexi N

Comments
Plant tests showed that banding Flexi-N at seeding improved the plant uptake of nitrogen (N) compared to the IBS treatment (Figure 1). Harvest results also indicated increased effectiveness from banded Flexi-N but differences were not statistically significant.

The most profitable treatments had a 50 L/ha Flexi-N top up in June. Low grain protein indicated that yield potential was not achieved and that the crop may have responded to more N.

The site was not K responsive. Soil tests only indicated marginal K and plant tests confirmed that K was not limiting.

CSBP trials have shown that soil sampling to 30cm gives a better prediction of K requirements than just sampling the surface 10cm.

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Banding Potassium Increases Potassium Use Efficiency

James Easton, Field Research Manager, CSBP

Key Messages

- In both years, banding potassium was a much more effective and profitable strategy than topdressing MoP.
- Topdressing 40 kg/ha MoP was ineffective in both years and there was limited residual benefit from 80 kg/ha MoP topdressed in the first year.
- There was no economic benefit from increasing potassium inputs by blending MoP with K-Till Extra.

Aims

- To compare the effectiveness of potassium banded with K-Till Extra to MoP topdressed over two years
- To determine the effect of potassium supply on nitrogen response.

Background

Potassium (K) is important for efficient use of water and other nutrients. K deficiencies have become more common with intensive cropping and removal or movement of stubble within paddocks.

This trial was set up in 2014 to compare the effectiveness of banded K to topdressed MoP. It was continued in 2015 to determine the residual value of the topdressed potash.

Trial Details

Property	Tremlett, east Carnamah		
Plot size & replication	20m x 2.5m x 3 replications		
Soil type	Yellow loamy sand		
Soil pH ($CaCl_2$)	0-10cm: 6.4	10-20cm: 4.5	20-30cm: 4.6
EC (dS/m)	0-10cm: 0.13	10-20cm: 0.04	20-30cm: 0.04
Sowing date	21/04/2015		
Seeding rate	3 kg/ha 23Y43 RR canola, 2014: 64 kg/ha Mace wheat		
Paddock rotation	2012 canola, 2013 wheat, 2014 wheat		
Fertiliser	See treatment list (Table 1) 29/06/2015: 65 L/ha Flexi-N on treatments 3-6, 8		
Herbicides & Insecticides	21/04/2015: 1.5 L/ha Trifluralin, 300 mL/ha Lorsban		
Growing season rainfall	204mm		

Results

Table 1: The effect of fertiliser on wheat (Mace) yield in 2014 and canola (23Y43 RR) yield in 2015, east Carnamah.

			2014 & 2015					2014	2015
Trt	**IBS** (kg/ha)**	**Banded (L/ha)**	**Banded (kg/ha)**	**Post (L/ha)**	**N**	**P**	**K**	**Wheat (t/ha)**	**Canola (t/ha)**
1	-	-	-	-	0	0	0	1.36[c]	1.26
2	-	-	89 Big Phos	-	0	12	0	1.48[bc]	1.37
3	-	50 Flexi-N	85 Agstar Extra	65 Flexi-N	60	12	0	1.64[b]	1.33
4	-	54 Flexi-N	100 K-Till Extra	65 Flexi-N	60	12	11	1.97[a]	1.78
5	-	54 Flexi-N	100 K-Till Extra + 18 MoP	65 Flexi-N	60	12	20	1.80[ab]	1.62
6	40 MoP	50 Flexi-N	85 Agstar Extra	65 Flexi-N	60	12	20	1.61[b]	1.34
7*	-	-	89 Big Phos	-	0	12	0 (40)	1.41[c]	1.37
8*	-	50 Flexi-N	85 Agstar Extra	65 Flexi-N	60	12	0 (40)	1.62[b]	1.54
							P value	*<0.001*	*0.13*
							LSD	*0.19*	*0.36*

*80 kg/ha MoP topdressed in 2014, **IBS = Incorporated by sowing

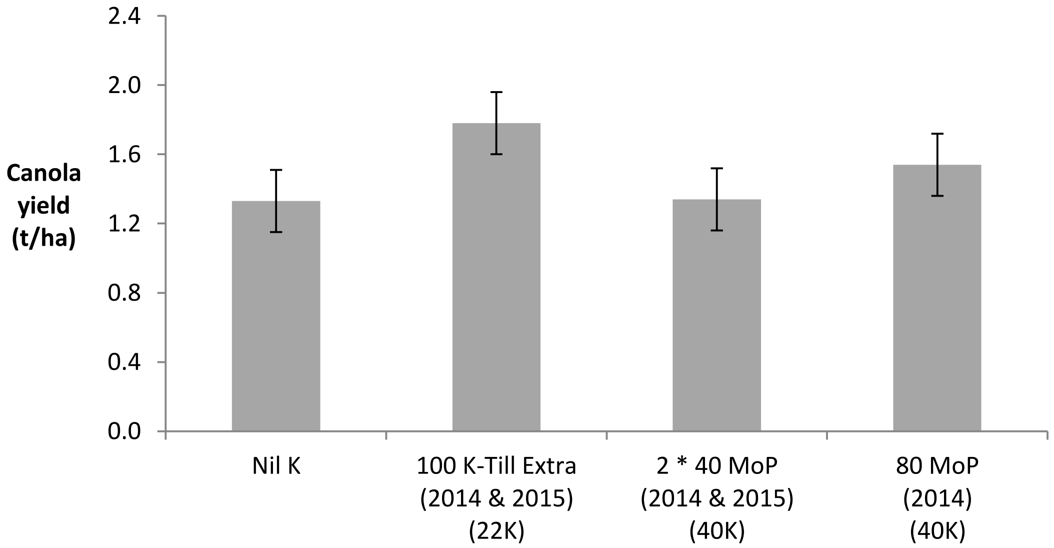

Figure 1: Canola response to potassium (K) treatments in 2015, east Carnamah.

Table 2: Economic analysis of K treatments ($/ha) for 23Y43 canola, east Carnamah 2015.

	2014 & 2015							2015 Fertiliser Economics			
Trt	**IBS (kg/ha)**	**Band (L/ha)**	**Band (kg/ha)**	**Post (L/ha)**	**N**	**P**	**K**	**Yield (t/ha)**	**Response ($/ha)**	**Cost ($/ha)**	**Profit ($/ha)**
1	-	-	-	-	0	0	0	1.26	-	-	
2	-	-	89 Big Phos	-	0	12	0	1.37	55	52	3
3	-	50 FN	85 Agstar Extra	65 FN	60	12	0	1.33	35	154	-119
4	-	54 FN	100 K-Till Extra	65 FN	60	12	11	1.78	260	174	86
5	-	54 FN	100 K-Till Extra/18 MoP	65 FN	60	12	20	1.62	180	187	-7
6	40 MoP	50 FN	85 Agstar Extra	65 FN	60	12	20	1.34	40	188	-148
7*	-	-	89 Big Phos	-	0	12	0 (40)	1.37	55	52	3
8*	-	50 FN	85 Agstar Extra	65 FN	60	12	0 (40)	1.54	140	154	-14
							P value	*0.13*			
							LSD	*0.36*			

*80 kg/ha MoP applied in 2014, **Incorporated by sowing
Economics based on current fertiliser list prices (+ freight and spreading) and $500/t for canola.

Table 3: Economic analysis of K treatments (with 60 kg N/ha applied) ($/ha) for Mace wheat, east Carnamah 2014.

				2014 K Economics			
Trt	**IBS** (kg/ha)**	**Band (kg/ha)**	**K**	**Yield (t/ha)**	**Response ($/ha)**	**Cost ($/ha)**	**Profit ($/ha)**
3	-	85 Agstar Extra	0	1.64[bc]	-	-	-
4	-	100 K-Till Extra	11	1.97[a]	83	20	62
5	-	100 K-Till Extra + 18 MoP	20	1.80[ab]	40	34	6
6	40 MoP	85 Agstar Extra	20	1.61[c]	-7	29	-37
8*	-	85 Agstar Extra	0 (40)	1.62[bc]	-5	29	-34
			P value	*<0.001*			
			LSD	*0.186*			

*80 kg/ha MoP applied in 2014, **Incorporated by sowing
Economics based on current fertiliser list prices (+ freight and spreading) and $250/t for wheat.

Table 4: Economic analysis of K treatments in 2015 canola and 2 year profit (with 60 kg N/ha applied).

				2015 K Economics				
Trt	**IBS** (kg/ha)**	**Band (kg/ha)**	**K**	**Yield (t/ha)**	**Response ($/ha)**	**Cost ($/ha)**	**Profit ($/ha)**	**2 Year K Profit ($/ha)**
3	-	85 Agstar Extra	0	1.33	-	-	-	-
4	-	100 K-Till Extra	11	1.78	225	20	205	267
5	-	100 K-Till Extra + 18 MoP	20	1.62	145	34	111	118
6	40 MoP	85 Agstar Extra	20	1.34	5	29	-24	-61
8*	-	85 Agstar Extra	0 (40)	1.54	105	0	105	71
			P value	*0.13*				
			LSD	*0.36*				

*80 kg/ha MoP applied in 2014, **Incorporated by sowing
Economics based on current fertiliser list prices (+ freight and spreading), $250/t for wheat and $500/t for canola.

Comments

K was more limiting than nitrogen (N) at this site, but K had to be banded to be effective.

In 2014 wheat, there was no response to up to 80 kg/ha MoP topdressed before sowing, but there was a 0.33 t/ha response to K banded with 100 kg/ha K-Till Extra.

In 2015 canola, there was a 0.45 t/ha response to K supplied with K-Till Extra (applied in 2014 and 2015). There was no response to K where 40 kg/ha MoP was applied in 2014 and 2015 - despite nearly twice as much K being supplied.

In both years, there was no benefit from blending additional potash with the K-Till Extra.

There was little response to N in both years - with or without 80 kg/ha MoP topdressed in 2014.

The most profitable treatment was 100 kg/ha K-Till Extra. Additional N was unprofitable.

This trial highlights the importance of getting the balance right between N and K inputs, and the benefits of banding K to profitable crop production.

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Large Increases in Soil pH can Improve the Availability of Soil Phosphorus if the Supply of Other Nutrients is Adequate

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Key Messages

- An interaction between soil pH and phosphorus fertiliser is most likely when:
  - There are no other major nutritional constraints to crop growth.
  - A large change (>0.5 pH units) has been made to subsurface pH by lime application.
- When the two criteria above have been met, an interaction between soil pH and phosphorus fertiliser can lead to greater availability of soil phosphorus.

Aim

To determine whether increased soil pH improves soil phosphorus (P) availability to crops.

Method

All experiments had a split-plot design. Lime rate was the main treatment and nutrient rate was the sub-treatment. Lime treatments were applied in 2012. The Wongan Hills and Northam sites were managed as chemical fallows between 2012 and 2015 while the Doodlakine and Merredin sites were cropped each year.

Four field experiments done in 2015 examined the interaction between soil pH and P fertiliser (Table 1). The experiments included 2 designs: (1) soil pH x P fertiliser level x potassium (K) fertiliser level (soil pH x P x K) and (2) soil pH x P fertiliser level in 2015 (soil pH x P). There were 2 experiments for each design. The trials with Design 1 were single-year experiments and the trials with design 2 will be re-sown in 2016 to examine the effect of soil pH on the residual value of P fertiliser applied in 2015. For all experiments, the soil pH treatments were created by applying 0, 2.5 and 5 t of lime sand /ha in May 2012. Barley cv. LaTrobe was sown at all sites in 2015. A summary of agronomic management of the experiments is shown in Table 1. P treatments (Design 1: 0, 4, 8, 16, 32 kg P/ha, Design 2: 0, 5, 10, 20, 40 kg P/ha) were applied as double superphosphate (18% P) and K treatments (0, 80 kg K/ha) were top-dressed at seeding as muriate of potash (50% K).

Table 1: Summary of agronomic management of field experiments.

Design	Location	Sowing date (2015)	Sowing rate (kg/ha)	Nitrogen applied (kg N/ha)
1. Soil pH x P x K	Wongan Hills	19th May	80	30
	Merredin	27th May	60	25
2. Soil pH x P	Northam	14th May	80	50
	Doodlakine	28th May	60	35

Basal applications of nutrients were applied to remove the effect of nutrients not included in the experimental design. A micronutrient compound fertiliser was applied at seeding to provide 2.75, 2.5, 0.5 and 0.25 kg/ha of manganese, zinc, copper and boron, respectively. At Wongan Hills and Northam, the P treatments and micronutrients were drilled 2cm below the seed and at Merredin and Doodlakine the nutrients were placed on top of the furrow. At Wongan Hills and Merredin, 20 kg S/ha was applied as gypsum at seeding. At Northam, 80 kg K and 33 kg S/ha was applied at seeding and at Doodlakine 40 kg K and 17 kg S/ha were applied at seeding as sulphate of potash.

Soil nutrient levels

The soils at the Northam and Wongan Hills sites were Tenosols and the Colwell P and K at these sites was above critical ranges for P (20 to 31 mg/kg) and K (32 to 52 mg/kg). The soils at the Merredin and

Doodlakine sites were Kurosols (duplex soil with acidic B horizon) and the Colwell P and K at these sites were also above the appropriate critical ranges for P (20 to 25 mg/kg) and K (35 to 45 mg/kg). Compared to other sites, the nitrate N and ammonium N at Wongan Hills were high due to the chemical fallow for the 3 years and mineralised N that had accumulated during that period.

Table 2: Some soil chemical properties for depth 0 to 10 cm for the field sites, 2015.

Site	Soil Type	Colwell P (mg/kg)	PBI	Colwell K (mg/kg)	Organic carbon (%)	Nitrate N (mg/kg)	Ammonium N (mg/kg)
Wongan Hills	Tenosol	31	14	67	0.95	55	11
Merredin	Kurosol	38	77	71	1.52	11	4
Northam	Tenosol	37	20	47	0.38	12	1
Doodlakine	Kurosol	55	39	199	1.2	20	3

Note: Data shown are means of 9 blocks (3 lime treatments x 3 replicates).

Results

Soil chemical properties for 2015 experiments

Lime applied in 2012 increased the soil pH in 2015 at all sites although the increase in soil pH (1.0 unit) was largest at Wongan Hills. At Wongan Hills, application of 2.5 t/ha lime increased soil pH at 0-10, 10-20 and 20-30 cm by 0.60, 0.33 and 0.33 units compared to 0 t/ha lime, respectively. Application of 5 t/ha lime caused a greater increase to a greater depth: soil pH at 0-10, 10-20 , 20-30 and 30-40 cm increased by 1.03, 0.60, 0.43 and 0.30 units compared to 0 t/ha lime, respectively. At Northam, application of 2.5 and 5 t/ha lime increased soil pH at 0-10cm by 0.45 and 0.48 units compared to 0 t/ha lime, respectively. The greatest change in subsoil pH at Northam occurred at 20-30cm; it increased by 0.35 pH units in the 5 t/ha lime treatment. At Doodlakine, application of 2.5 and 5 t/ha lime increased soil pH at 0-10cm by 0.60 and 0.77 units compared to 0 t/ha lime, respectively. At this site, soil pH at 10-20cm was increased by only 0.17 units by the 5 t/ha treatment. The smallest increase in soil pH 0-10cm occurred at Merredin although it had the highest initial soil pH (5.8). Application of 2.5 and 5 t/ha lime increased soil pH at 0-10cm by 0.27 and 0.47 units, respectively and by 0.23 pH units at 10-20cm for the 5 t/ha lime treatment.

Table 3: Soil pH ($CaCl_2$) measured March 2015.

Soil depth (cm)	Rate of lime applied in 2012 (t/ha)											
	Wongan Hills			Merredin			Northam			Doodlakine		
	0	2.5	5	0	2.5	5	0	2.5	5	0	2.5	5
0-10	4.37	4.97	5.40	5.80	6.07	6.27	5.50	5.95	5.98	5.33	5.93	6.10
10-20	4.07	4.40	4.67	4.37	4.40	4.60	4.97	5.05	5.18	4.33	4.40	4.50
20-30	4.20	4.53	4.63				4.70	4.85	5.05			
30-40	4.80	4.93	5.10				4.97	5.05	5.25			
40-60	5.63	5.57	5.73				5.37	5.45	5.55			
sed		0.15			0.13			0.16			0.34	

Note: Samples could not be retrieved from soil depths below 20 cm at Merredin and Doodlakine. Values are means of 3 replicates. sed is the standard error of the difference between means.

Shoot nutrient concentration for 2015 experiments

Shoot nutrient concentrations at anthesis were above critical levels for most nutrients at Wongan Hills but below critical levels for most nutrients at Northam, Merredin and Doodlakine (Table 4). Zinc was deficient at Northam, Merredin and Doodlakine which may be due to long dry periods limiting timely access to the micronutrient fertiliser that was applied.

Grain yield for all experiments (2012 to 2015)

A significant lime x P interaction occurred at Wongan Hills ($P<0.1$). The interaction between the P dose-response curves for the 0 and 2.5 t/ha lime treatments was negative; the differences were greatest at 0 P and the curves converged as P level increased. The interaction between the dose response curves for the 2.5 and 5 t/ha treatments was also negative. The most important difference in grain yield occurred at 0 kg P; it was 2029, 3376 and 3698 kg ha for the 0, 2.5 and 5 t lime/ha treatments, respectively. Lime rate, P rate and K rate all had significant main effects; the mean for the 0, 2.5 and 5 t of lime /ha was 2932, 3815 and 4316 kg/ha respectively. The mean for the 0, 4, 8, 16 and 32 kg P/ha were 3034, 3743, 3487, 3832 and 4344 kg/ha, respectively. The mean for the 0 and 80 kg K/ha treatments was 3570 and 3805 kg/ha, respectively.

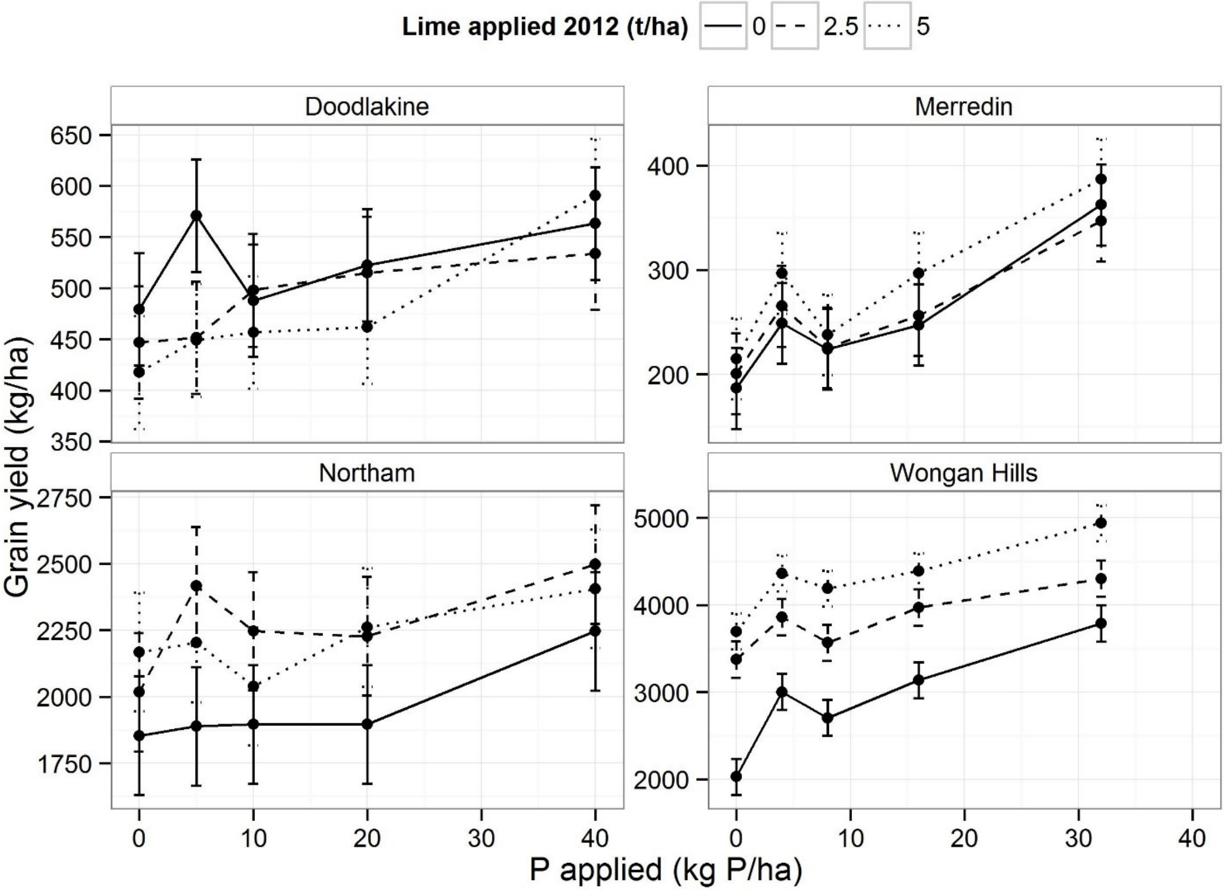

Figure 1: Grain yield response to phosphorus applied at seeding for field experiments in 2015. The figures for Wongan Hills and Merredin are the mean response of the 0 and 80 K treatments. Error bars are standard error.

Table 4: Summary of lime x phosphorus experiments, including experiments from 2012 & 2014 ordered by the level of interaction observed.

Year	Location	Species	0 P		32 P		Grain yield interaction		delta	Whole shoot nutrient concentration at anthesis										
			-lime	+lime	-lime	+lime	Amount (kg/ha)	Sig	pH 10-20 cm	B	Ca	Cu	Fe	Mg	Mn	P	K	S	N	Zn
2015	Wongan Hills	Barley	2,029	3,698	3,788	4,939	518	-	0.60	⊤	⊥	⊤	⊥	–	⊥	–	–	⊥	–	⊥
2014	Merredin	Wheat	1,232	1,498	1,950	1,991	225	*	0.56	–	–	⊤	–	–	⊥	⊥	⊤	–	–	–
2014	Wongan Hills	Wheat	2,616	2,454	2,850	2,514	174	*	0.56	–	⊥	⊤	⊥	⊥	⊥	⊥	⊥	⊥	⊥	⊥
2015	Northam	Barley	1,854	2,167	2,246	2,406	153	n.s.	0.21	⊤	⊥	⊤	⊥	–	⊥	⊥	⊥	⊥	–	⊤
2012	Wongan Hills	Wheat	1,295	1,681	1,937	2,316	7	n.s.	0.51	⊥	–	⊤	⊥	–	–	⊤	⊤	–	⊤	⊤
2015	Merredin	Barley	186	215	362	386	5	n.s.	0.23	⊤	–	⊤	⊥	–	⊥	⊤	–	–	–	⊤
2015	Doodlakine	Barley	479	417	563	590	-89	n.s.	0.17	⊥	–	⊤	⊥	–	–	–	⊥	–	–	⊤

Note: The grain yield interaction is calculated as the difference in grain yield between the +lime and –lime treatments at 0 P minus the difference in grain yield between the +lime and –lime treatments at 32 P. Significance levels (Sig) of P<0.001, P<0.01, P<0.05 and P<0.1 are indicated by ***, **, * and – respectively. Adequate, marginal and deficient concentration of each nutrient at anthesis is indicated by ⊥, – and ⊤ respectively, based on mean concentrations at each site and critical values by Reuter and Robinson (1997).

At Merredin in 2015, there was a significant main effect of P and K and a significant P x K interaction. The mean grain yield for the 0, 4, 8, 16 and 32kg P/ha was 201, 270, 229, 267 and 365 kg/ha, respectively. The mean grain yield for the 0 and 80kg K/ha treatment was 233 and 299 kg/ha, respectively. There was also a significant, positive P x K interaction for grain yield; the 80kg K/ha treatment was 27 kg/ha higher than the

0kg K/ha when 0 P was applied and increased to a 102 kg/ha difference when 32kg P was applied (data not shown).

P treatment had a significant effect on grain yield at Northam and Doodlakine. At Northam, the mean grain yield for the 0, 5, 10, 20 and 40kg P/ha was 2012, 2169, 2060, 2128 and 2383 kg/ha, respectively and at Doodlakine, the mean grain yield for the 0, 5, 10, 20 and 40kg P/ha was 448, 490, 481, 499 and 563 kg/ha, respectively.

There was a common pattern of a decrease in grain yield when P fertiliser level was increased from 4 to 8kg P/ha (Wongan Hills and Merredin) or from 5 to 10kg P/ha (Northam and Doodlakine) although the decrease in grain yield was not always significant. This does not seem to be related to soil pH or lime treatment. At Northam there was no decrease in yield from 5 to 10kg P in the 0 t/ha lime treatment (pH 5.5) but there was a decrease in grain yield from 5 to 10kg P/ha in the 0 t/ha lime treatment at Doodlakine. A comparison of soil chemical properties for each lime treatment at each site and the corresponding decrease in grain yield from 5 to 10 or 4 to 8kg P/ha did not show any meaningful relationships. Our analysis of the yield loss at 8 or 10kg P/ha is ongoing.

A comparison of the experiments shown in Table 4 suggests that a significant lime x P interaction for grain yield is dependent upon changes to soil pH by lime treatments and on zinc (Zn) nutrition (Table 3). In the 3 experiments where a significant lime x P interaction has occurred, there was a significant lime x depth interaction for soil pH (not shown here) and soil pH at 10-20cm was >0.5 pH units higher in the +lime treatment compared to the –lime. Also, shoot Zn concentration was adequate or marginal where a significant lime x P interaction occurred but deficient at sites where the lime x P interaction was not significant. The occurrence of a significant increase in soil pH 10-20cm and adequate Zn concentration in shoots is probably a coincidence and restricts our capacity to quantify how these factors interact. For example, it is likely that where shoot Zn concentration is deficient, the lime x P interaction for grain yield is constrained, but a combination of soil pH levels and Zn application levels are required to quantify this N and K supply affected the lime x P interaction for wheat in 2014 (not shown here). At Wongan Hills, soil K supply was reduced by lime application and there was no grain yield response to P application in the +lime treatments. By contrast, in the -lime treatments, there was no restriction to soil K availability and there was a grain yield response to P application. At Merredin, the type of lime x P interaction that occurred was dependent on the rate of N applied (data not shown). Where 0kg N/ha was applied a cross-over interaction occurred; grain yield was higher in the +lime compared to -lime when 0kg P/ha was applied and was higher in the -lime when 32kg P/ha was applied. When 15kg N/ha was applied, a positive interaction occurred; the yield gap between the P response curves for the +lime and -lime increased as the level of P applied increased. Where 30 and 45kg N/ha was applied, a negative interaction occurred.

Some important considerations are starting to emerge for making decisions about lime and P fertiliser rate. Soil pH in 10-20cm appears to be an important factor; a shift from below ~ pH 4.5 to above this level increases yield potential and uptake of soil P. Our measurements of root growth and soil P availability in 2014 suggest that the soil pH x P interaction is being driven by changes to root growth in the subsoil rather than pH-induced changes to soil P. Also, we have observed a significant grain yield response to P fertiliser in our experiments where soil P (Colwell P) in the 0-10cm layer was above critical ranges. Soil pH appears to be an important factor in the mismatch between predicted and observed response to P fertiliser; the difference between predicted response to P fertiliser and the actual response is greater at low soil pH.

Conclusion

Our work suggests that increasing soil pH can lead to a more efficient use of soil P and reduce level of yield response to P fertiliser. However, we suggest there are two important caveats to this conclusion. Firstly, the supply of all other plant essential nutrients needs to be non-limiting and secondly, the pH increase in the subsurface should be large (>0.5 pH units).

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This article is a copy of the paper 'Large increases in soil pH can improve the availability of soil phosphorus if the supply of other nutrients is adequate' which has been submitted to the 2016 Research Updates, Perth.

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Integrated Weed Management Demonstrations to Improve Adoption of Wild Radish Control Practices at Dalwallinu

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Key Messages

- Application of double knockdowns (DKD) and post-emergent (PO) herbicides from diverse modes of action at early and late stages provided excellent radish control (92 to 100%) in a wheat-wheat rotation.
- Application of integrated weed management (IWM) including DKD, PO herbicides from diverse modes of action, seed catching and wind row burning, provided superior radish control in 2014, leading to a reduction of pre-sowing wild radish emergence by 95% and seasonal total emergence by 90% in 2015 season compared to 2014 season.
- A higher gross margin came from the 60 kg/ha seed rate than the 120 kg/ha in 2015 season mainly due to lower seed costs at 60 kg/ha.
- Wild radish has developed resistance to most of the available selective and non-selective herbicides including glyphosate in Western Australia (WA). It is important that the IWM approach including as many weed control options as possible should be adopted by growers to manage wild radish.

Aim

To conduct IWM trials demonstrating the effect of chemical and non-chemical weed control options to minimise the impact of herbicide resistance in wild radish to improve adoption of wild radish IWM.

Background

Demonstrations were implemented as an effective way to raise the awareness of IWM practices among the growers. Three IWM demonstrations on wild radish control were established in the Central region of WA in collaboration with the Liebe Group. Selective control options available at pre-sowing, sowing, pre-emergence, PO, and at harvest time were incorporated into IWM options.

Trial Details

Property	Harding Sawyer, Nugadong
Plot size & replication	20m x 3m x 4 replications
Soil type	Sandy loam
Soil pH ($CaCl_2$)	0-10cm: 5.3
EC (dS/m)	0-10cm: 0.15
Sowing date	12/05/2015
Seeding rate	60 kg/ha or 120 kg/ha Mace wheat
Paddock rotation	2011 wheat, 2012 canola, 2013 wheat, 2014 wheat
Fertiliser	12/05/2015: 80 kg/ha Macropro Plus 1/07/2015: 50 L/ha Flexi-N
Herbicides & IWM	07/05/2015: First knockdown, see treatments (Table 1) 07/05/2015: Cultivation, see treatments (Table 1) 12/05/2015: 2nd knockdown, see treatments (Table 1), 118 g/ha Sakura across all plots 15/06/2015: First post-emergents, see treatments (Table 1) 03/07/2015: Second post-emergents, see treatments (Table 1)
Growing season rainfall	291mm (April to November 2015)

Treatments

Two seed rates (60 kg/ha and 120 kg/ha) of wheat cv. Mace were sown with 6 chemical and/or non-chemical weed control treatments each. Treatments included DKD plus or minus selective PO herbicides

(Table 1). Unlike the 2014 season, weed seed removal at harvest and windrowing were not performed in 2015 season on the assumption that growers may not follow these practices in every season on the same paddock.

Results
Pre-knockdown counts of wild radish in the 2015 season showed that DKD followed by (fb) PO herbicides (Triathlon® at Z12 fb Velocity® at Z30 or Velocity® at Z12 fb Triathlon® at Z30) in the 2014 wheat crop reduced pre-knockdown wild radish emergence by 92% to 98% (average 95%) regardless of sowing rates (Table 1). In contrast, DKD with no PO herbicides in the 2014 season (Treatments 1 and 7) reduced pre-knockdown wild radish emergence by 79% to 86% in the 2015 season.

DKD including cultivation applied in the 2015 season controlled pre-sowing wild radish by 97% to 100%. Wild radish control by first PO application was 80% to 100% in the 2015 season but final control of wild radish (after both PO applications) was 92% to 100% (Table 1). Although wild radish emergence was very low after the first PO spray, a second PO herbicide is necessary to control the late emergence of wild radish.

Since PO herbicides were not applied in Treatment 1 and 7, in-crop wild radish control was only 40% to 42% in these two treatments. These results suggest that PO herbicide application is very important to control wild radish even though the in-crop density of wild radish is low. This will maintain the wild radish seed bank at low levels.

Wheat grain yield in 2015 was not influenced by seed rate of wheat or herbicide treatment applied in 2014 even though wheat head numbers were 24% higher at the higher seed rate. However, this increase in wheat heads did not influence wild radish density as well in 2015 season even though the density of wild radish was very low (0.062 to 0.84 plants/m^2 after knockdowns and 0 to 6 plants/m^2 in wheat crop including the late emergence). Radish plants that emerged after second PO application were not as competitive with the wheat crop. Despite seed set control in 2014, radish density in the buffer was 10.5 plants/m^2 in 2015. At maturity, radish seed heads were collected and removed in 2015 to minimise the seed bank build up in buffer areas.

Table 1: Effect of IWM practices (knockdowns, seed rate and post-emergent herbicides) on yield of wheat crop, and control of wild radish at Dalwallinu in 2015 season[1].

	Treatments	Pre-knockdown radish reduction (%)	Radish control by Knockdown (%)	Radish control by first PO spray (%)	Final wild radish control (%)	Wheat head (No./m^2)	Yield (t/ha)
1.	Roundup® fb Alliance® + 60 kg/ha + WRB	79[b]	97	69[d]	40[b]	168[c]	1.96
2.	Roundup® fb Alliance® + 60 kg/ha + Triathlon® Z12 fb Velocity® at Z30	96[a]	98	85[bc]	100[a]	182[bc]	1.98
3.	Roundup® fb Alliance® + 60 kg/ha + Velocity® at Z12 fb Triathlon® Z30	92[ab]	99	90[b]	100[a]	180[bc]	2.17
4.	Cultivation fb Para-Trooper® + 60 kg/ha + Velocity® at Z12 fb Triathlon® Z30	98[a]	100	76[cd]	100[a]	178[c]	2.23
5.	Roundup® fb Alliance® + 60 kg/ha + Velocity® Z12 fb Triathlon® Z30	98[a]	100	100[a]	100[a]	178[c]	1.94
6.	Roundup® fb Alliance® + 60 kg/ha + Velocity® at Z12 fb Triathlon® Z30 + WRB	93[ab]	99	84[bc]	100[a]	174[c]	2.20
7.	Roundup® fb Alliance® + 120 kg/ha + WRB	86[b]	99	91[b]	42[b]	238[ab]	2.00
8.	Roundup® fb Alliance® + 120 kg/ha + Triathlon® Z12 fb Velocity® at Z30	94[ab]	98	94[ab]	92[a]	250[a]	2.09
9.	Roundup® fb Alliance® + 120 kg/ha + Velocity® Z12 fb Triathlon® Z30	96[a]	99	85[bc]	100[a]	233[ab]	2.12
10.	Cultivation fb Para-trooper® + 120 kg/ha + Velocity® Z12 fb Triathlon® Z30	98[a]	98	80[c]	99[a]	223[ab]	1.99
11.	Roundup® fb Alliance® + 120 kg/ha Velocity ®Z12 fb Triathlon® Z30	94[ab]	100	93[ab]	100[a]	246[a]	2.23
12.	Roundup® fb Alliance® + 120 kg/ha + Velocity® Z12 fb Triathlon® Z30 + WRB	97[a]	99	99[a]	100[a]	209[b]	2.05
	P value	*0.001*	*0.13*	*<0.001*	*<0.001*	*0.019*	*0.501*
	LSD (5%)	*8.4*	*2.18*	*7.75*	*18.3*	*29.5*	*0.316*
	CV (%)	*6.2*	*1.4*	*11.0*	*14.8*	*5.6*	*10.6*

[1]fb = followed by; PO= post-emergence; Herbicide rates: 2.5 L/ha Alliance®, 1.6 L/ha Para-Trooper®, 2 L/ha Roundup®, 670 mL/ha Velocity®, 1 L/ha Triathlon®. WRB = Windrow burning was performed in treatments 1, 6, 7 and 12 in April of 2015 while harvest weed seed removal (HWSR) was performed in treatments 5 and 11 in 2014 season but not in 2015; Seasonal wild radish plant reduction and wild radish control is compared with the radish density present in the untreated buffers sown to wheat crop using standard agronomy; Shallow cultivation (autumn tickling) was performed n 2015 variable costs. NS = No significant difference due to a P-value > 0.05

Table 2: Economic analysis of wild radish control treatments based on wheat price at $267 per ton at the wild radish IWM trial site, Dalwallinu in 2015[1].

	Treatments	Gross return ($)	Variable cost ($)	Gross margin ($)	Benefit /Cost ratio
1	Roundup® fb Alliance® + 60 kg/ha + WRB	523	101	422	4.2
2	Roundup® fb Alliance® + 60 kg/ha + Triathlon® Z12 fb Velocity® Z30	529	135	394	2.9
3	Roundup® fb Alliance® + 60 kg/ha + Velocity® at Z12 fb Triathlon® Z30	579	135	445	3.3
4	Cultivation[2] fb Para-Trooper® + 60 kg/ha + Velocity® Z12 fb Triathlon® Z30	595	128	468	3.7
5	Roundup® fb Alliance® + 60 kg/ha + Velocity® Z12 fb Triathlon® Z30 + HWSR	518	135	383	2.9
6	Roundup® fb Alliance® + 60 kg/ha + Velocity® at Z12 fb Triathlon® Z30 + WBR	587	137	451	3.3
7	Roundup® fb Alliance® + 120 kg/ha + WBR.	534	161	373	2.3
8	Roundup® fb Alliance® + 120 kg/ha + Triathlon® Z12 fb Velocity® Z30	558	195	364	1.9
9	Roundup® fb Alliance® + 120 kg/ha + Velocity® Z12 fb Triathlon® Z30	566	195	372	1.9
10	Cultivation fb Para-trooper® + 120 kg/ha + Velocity® Z12 fb Triathlon® Z30	531	188	344	1.8
11	Roundup® fb Alliance® + 120 kg/ha Velocity ®Z12 fb Triathlon® Z30 + HWSR	595	195	401	2.1
12	Roundup® fb Alliance® + 120 kg/ha + Velocity® Z12 fb Triathlon® Z30 + WBR	547	197	351	1.8

[1]fb = followed by; WBR = windrow burning cost ($2.05/ha) was included in 2015 variable cost but not in 2014; cost of HWSR (Harvest weed seed removal)= $10 was included in 2014 variable costs but not in 2015; Price of herbicides ($/ha): Alliance® = $25, Roundup® = $14, Para-trooper® = $12, Velocity® = $20, Triathlon® = $15.50; B/C ratio = Benefit/cost ratio cost of wheat seed = $1/kg. Source of wheat grain price in December 2015: http://www.australiangrainexport.com.au/pdf/Bidsheet.pdf; [2]Cost of shallow cultivation (autumn tickling) ($20/ha) was included in 2015 variable costs. Note: Values in table are rounded to nearest dollar.

Economic Analysis

Variable costs included costs of herbicides, wheat seed and windrow burning in April 2015. Cost of weed seed collection was included in 2014 but not in the 2015 treatment costs. Since cultivation was performed as a knockdown weed control option in the 2015 season in treatments 4 and 10, cost of cultivation was included in the variable costs for 2015.

Regardless of treatments, gross margin obtained from 60kg/ha seed rate (average gross margin $427/ha) was $60 higher than 120 kg/ha (average gross margin $367/ha) mainly due to lower seed costs at 60 kg/ha and effective radish control.

Regardless of seed rate, the highest gross margin came from treatment 4 where DKD (cultivation fb Para-Trooper®) and PO herbicides (Velocity® at Z12 fb Triathlon® at Z30) was applied and the grain yield was the highest (Table 1). However, the highest benefit cost ratio (B/C ratio) of 4.2 was obtained from Treatment 1 (Roundup® fb Alliance® + 60 kg/ha + windrow burning). The cost in Treatment 1 was low because no post-emergent herbicide was applied, it was sown at 60 kg/ha and the low radish density did not have a competitive effect on wheat grain yield.

Comments

This is the second year of the three-year trial plan of this wild radish IWM trial at Dalwallinu. Based on the results of the 2015 and 2014 seasons, double knockdowns and application of post-emergent herbicides from diverse mode of action (for example, Triathlon® and Velocity®) provided 100% control of wild radish. Despite 24% higher seed heads of wheat, higher seed rate did not result in greater weed control or grain yield in the 2015 season. These results suggest that a higher seed rate is not cost effective when radish is effectively controlled by herbicides. Further success in 100% radish control in subsequent years should deplete the radish seed bank to a further low level. However, despite being a bit expensive, two post-emergence sprays appear to be necessary to achieve 100% control of seasonal wild radish.

The efficacy of windrow burning in reducing the radish seed bank is unclear probably due to the small quantity of straw fuel windrowed by a small plot harvester in this trial. Analysis of trashes collected as an attempt to collect wild radish seed at 2014 harvest time in treatments 5 and 11 recorded only few radish seeds (0-4 seeds per plot of $36m^2$) indicating that wild radish seed had already shattered on the ground prior to harvest in the 2014 season.

The initial wild radish density counted in April 2014 at this site was 70 plants/m^2 while the average pre-sowing emergence of wild radish in 2015 was reduced to 3 plants/m^2 (95% reduction), as a result of effective radish control in 2014.

Wild radish has developed resistance to most of the available selective and non-selective herbicides including glyphosate in WA. It is important that the wild radish seed bank is reduced using an IWM approach including as many weed control options as possible. It is also important that growers adopt IWM approaches for the control of wild radish and other major weeds to minimise the impact of herbicide resistance in wild radish and sustain grain productivity.

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Summer Caltrop Trial

Michael Macpherson, Imtrade Australia and Elly Wainwright, Liebe Group

Key Messages

- Bipyridyls provide 100% brownout of caltrop.
- The addition of Sharpen (saflufenacil) to Paraquat will provide quicker brownout than Paraquat alone but an equivalent kill rate.

Aim

To investigate the response of caltrop to single knock post-emergent sprays in the summer period.

Background

Caltrop (*Tribulus terrestris*) also known as bindii, goats head, yellow vine, cat's eye, cat head and puncture vine is a summer annual herb that has a sprawling flat habit and extensive tap root system. The seed that is produced by caltrop is formed continually in the summer months and one plant can produce upward of 20,000 seeds (Department of Primary Industries, 2010) that will remain viable in the soil for five years (Wilen, 2006). The seeds are easily picked up by shoes, paws, wools and vehicles helping it get dispersed over wide areas. It is a problem in agricultural areas as it extracts soil moisture and can thrive in very dry conditions making it hard to kill. In a 2006 report, wheat emergence was reduced by 22% in 2003 and subsequently reduced wheat grain yield by up to 40% in two out of three years when caltrop was the dominant summer weed species. This means caltrop may have a strong allelopathic effect on wheat emergence (Hashem *et al*., 2006).

Method

The Liebe Group and Imtrade Australia ran a trial at the Carter's property in east Wubin to test single knock post emergent sprays on well-established caltrop in a summer fallow situation. The chemistries used were bipyridyls (Paraquat 250, Spray.Seed, Para-Trooper) and group M (glyphosate) with and without group I or G additives as 'spikes' (see table).

Trial Details

Property	KL Carter and Co, east Wubin
Plot size & replication	8m x 2m x 3 replications
Soil type	Red loam
Spray timing	17/03/2015
Soil pH ($CaCl_2$)	0-10cm: 4.8
Paddock rotation	2012 pasture, 2013 canola, 2014 wheat
Summer rainfall (Jan-April)	188mm

Chemistries Used

Trade Name	Active Ingredient	Comparison Products	Chemical Group
Imtrade Eradicator 450	450 g/L Glyphosate	Various	M
Imtrade Paraquat 250	250 g/L Paraquat	Gramoxone	L
Spray.Seed	135 g/L Paraquat + 115 g/L Diquat	Various	L
Imtrade Para-Trooper	250 g/L Paraquat + 10 g/L Amitrole	None	L
Sharpen	700 g/kg Saflufenacil	None	G
Imtrade Oxen	240 g/L Oxyfluorfen	Goal	G
LV Ester 680	680 g/L 2,4-D Ester	Various	I
Imtrade Hurricane 600	600 g/L Triclopyr	Garlon	I

Results

Table 1: Effect of treatments on the brownout of caltrop (mean percentage days after treatment (DAT)).

Treatment	Application rate (mL or g/ha)	7 DAT 23/03/2015	11 DAT 27/03/2015	22 DAT 7/04/2015	31 DAT 16/04/2015
1. Untreated	--	0.0[c]	0.0[f]	0.0[c]	0.0[d]
2. Imtrade Eradicator 450	1500	18.3[bc]	26.7[ef]	21.7[bc]	23.3[cd]
3. Imtrade Paraquat 250	1200	86.7[a]	86.7[abc]	76.7[a]	96.7[a]
4. Spray.Seed	1200	93.3[a]	85.0[abc]	76.7[a]	100.0[a]
5. Imtrade Para-Trooper	1200	86.7[a]	91.7[ab]	71.7[a]	100.0[a]
6. Sharpen	20	36.7[b]	43.3[de]	16.7[bc]	30.0[c]
7. Paraquat 250 + Sharpen	1200 + 20	88.3[a]	95.3[a]	83.3[a]	96.7[a]
8. Eradicator 450 + Sharpen	1500 + 20	25.0[bc]	33.3[de]	6.7[c]	23.3[cd]
9. Eradicator 450 + Imtrade Oxen	1500 + 75	43.3[b]	56.7[cde]	35.0[b]	60.0[b]
10. Eradicator 450 + LV Ester 680	1500 + 300	43.3[b]	60.0[bcd]	73.3[a]	90.0[a]
11. Eradicator 450 + Hurricane 600	1500 + 120	30.0[b]	48.3[de]	35.0[b]	36.7[bc]
P value		*<0.001*	*<0.001*	*<0.001*	*<0.001*
LSD		*26.94*	*32.06*	*27.92*	*25.63*

Means with the same letter within a column are not significantly different (P<0.05).

Table 2: Comparison of treatment means. Mean number of caltrop plants per square meter.

Treatment	Application rate (mL or g/ha)	Plants per square meter
1. Untreated	-	14.4[d]
2. Imtrade Eradicator 450	1500	11.1[cd]
3. Imtrade Paraquat 250	1200	0.7[a]
4. Spray.Seed	1200	0.0[a]
5. Imtrade Para-Trooper	1200	0.0[a]
6. Sharpen	20	11.1[cd]
7. Paraquat 250 + Sharpen	1200 + 20	0.4[a]
8. Eradicator 450 + Sharpen	1500 + 20	9.3[bc]
9. Eradicator 450 + Imtrade Oxen	1500 + 75	5.2[b]
10. Eradicator 450 + LV Ester 680	1500 + 300	0.7[a]
11. Eradicator 450 + Hurricane 600	1500 + 120	6.3[b]
P value		*<0.001*
LSD		*4.09*

Means within the same cell with a letter in common are not significantly different (P<0.05).

Comments

The bipyridyl herbicides (treatments 3, 4, 5) provided complete control. The addition of Sharpen (saflufenacil) to Paraquat provided faster brownout, but equivalent control to Paraquat alone. Glyphosate 450 at 1.5 L/ha did not provide acceptable levels of control however, the addition of 2,4-D LV Ester provided equivalent control to that of the bipyridyl chemistries. Sharpen (Saflufenacil) as a standalone was not effective.

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Paper reviewed by: Abul Hashem, Principal Research Officer (Weed Science), DAFWA.

References

Department of Primary Industries (2010) Regionally Prohibited Weed Information Sheet - Caltrop.

Hashem, A., Pathan, S. and Osten, V. (2006). Summer weeds can reduce wheat grain yield and protein. Department of Agriculture and Food Western Australia, Perth. Proceedings of Crop Updates: weed updates 2006 ed, A. Douglas. pp 70-73.

Wilen, C., How to manage pests. Pests in gardens and landscapes: puncture vine. University of California. http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74128.html

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Uragan® for Long-Term Fenceline Weed Control

Bevan Addison, Market Development Manager, ADAMA Australia Pty Ltd

Key Message

Using a non triazine group C product such as Uragan (bromacil) will provide extended residual control of grasses, broadleaf weeds and some species of problematic woody weeds.

Aim

To showcase the residual control of Uragan across a range of weed species.

Background

Fenceline weed control is becoming an increasing issue on farms for several reasons:

1. Fenceline and firebreaks are often the first place for development of herbicide resistance due to repeated use of the same type of products with little rotation. It is vital to reduce the reliance on the same products such as glyphosate, diuron, atrazine and sulfonyl urea's which have been the mainstay of fenceline weed control. Surveys have shown up to 30% of resistance problems are now identified as fenceline driven issues.
2. Harbouring insect pests. Often uncontrolled fenceline weeds are a haven for a range of insects depending on the weed species present. They can act as corridors for insects such as red legged earth mite (RLEM) to move around the farm. With growing levels of synthetic pyrethroid resistance in RLEM populations across the state, an integrated approach of using herbicides to reduce the host for insects is becoming an important tool.
3. As well as a break for herbicide resistance management, fenceline weed control provides a great opportunity to protect your infrastructure investment when sprayed on bare ground under new fences to stop weeds and shrubs growing up and becoming a physical and fire hazard.

Method

The demonstration involved two replicates, sprayed along the length of the fenceline using a 2.5m handboom. Each treatment spans the distance between fence posts. No fertiliser or seeding treatments were at the site as it was non crop area.

The site was designed to compare commonly used fenceline sprays with Uragan mixes for both knockdown and residual control.

All treatments included Wipe-Out 450® (glyphosate 450) which provided a knockdown on the majority of weeds. The benefit of the added products will be seen over time providing residual control of the regrowth.

Trial Details

Property	Ardoch, east Ballidu
Plot size & replication	15m x 2.5m x 2 replications
Soil type	Sandplain soil
Herbicide treatments	1. 2.5 L/ha Wipe-0ut 450, 1.5 kg/ha Uragan®, 0.2% v/v Wetter 1000 2. 2.5 L/ha Wipe-Out 450, 2.5 kg/ha Uragan®, 0.2% v/v Wetter 1000 3. 2.5 L/ha Wipe-Out 450, 3.5 kg/ha Uragan®, 0.2% v/v Wetter 1000 4. 2.5 L/ha Wipe-Out 450, 3 kg/ha Atrazine 900 WG, 0.5% v/v Uptake 5. 2.5 L/ha Wipe-Out 450, 3 kg/ha Diuron 900 WG, 0.2% v/v Wetter 1000 6. 2.5 L/ha Wipe-Out 450, 4 L/ha Oxyfluorfen 240, 0.2% v/v Wetter 1000
Application Details	02/07/2015: 9-10am, 16.6 °C, 63% humidity, moist soil
Weeds Present	Annual grass weeds, capeweed, wild radish, old man saltbush, prickly saltwort

Observations
Due to the nature of a residual herbicide trial, difference is residual performance of products will only be observed in the longer-term (i.e. second year). All products were effective in their weed control, however there were slight visual differences when treatments were scrutinised.

At time of final evaluation on November 5th (18 weeks after application), the lower rates of Uragan at 1.5 and 2.5 kg/ha equivalent had not given full residual control of all weeds.

Diuron and atrazine treatments did not perform as well on some of the more perennial type grasses, such as windmill grass.

Uragan at 3.5 kg/ha equivalent was providing the best overall control, with total control across a range of weeds, including windmill grass (Figure 1). This is consistent with other trial and demonstration work where rates in the order of 3 kg/ha are the minimum application required for reliable broad spectrum residual weed control.

Oxyfluorfen, a group G herbicide which is used for residual control in a range of horticultural situations, was also tested but gave the poorest results. In this environment, it does not appear to offer robust control. Group G herbicides are mainly knockdown products but some actives do have residual benefits, however not as much as the other options.

Ballidu site prior to spraying | Wipeout 450 + Atrazine 3 kg/ha | Wipeout 450 + Uragan 3.5 kg/ha

Figure 1: Images above taken 5th November show the survival of windmill grass in atrazine treatment compared to total control of weeds in Uragan treated area.

Economic Analysis
Uragan is more expensive than the traditional products used for fenceline weed management. Based on a 3m wide swath width, the approximate costs are as follows:

Table 1: Approximate costs for treatments in the trial, based on a 3m wide swath-width (approximately width of firebreak).

Treatment	Approximate cost/km fenceline
2.5 L/ha Wipe-Out 450, 3.5 kg/ha Uragan®, 0.2% v/v Wetter 1000	$70
2.5 L/ha Wipe-Out 450, 2.5 kg/ha Uragan®, 0.2% v/v Wetter 1000	$53
2.5 L/ha Wipe-out 450, 1.5 kg/ha Uragan®, 0.2 v/v wetter 1000	$36
2.5 L/ha Wipe-Out 450, 3 kg/ha Atrazine 900 WG, 0.5% v/v Uptake	$17
2.5 L/ha Wipe-Out 450, 3 kg/ha Diuron 900 WG, 0.2% v/v Wetter 1000	$20
2.5 L/ha Wipe-Out 450, 4 L/ha Oxyfluorfen 240, 0.2% v/v Wetter 1000	$55

Comments

While the above price comparison shows Uragan to be an expensive option relative to the traditional products used for fenceline weed management (Table 1), trial and demonstration work has shown that at these rates you are regularly able to get two seasons of residual control and control of summer weeds.

At this site there was not an extensive second germination but in many sites have seen more commonly used options such as diuron and triazines fail to keep weeds at bay even in the season of application.

A similar demonstration conducted at Kondut has shown 3 and 5 kg/ha Uragan has controlled weeds along the fenceline since its application in June 2014. Similarly residual control of Uragan applied at 5 kg/ha in May 2014 at the 2014 Liebe trial site carried over through the 2015 season and was clearly visible as bare earth areas in the 2015 wheat crop

The site will be monitored over summer and next season to assess residual control.

A similar site has already been sprayed at 2016's Liebe main trial site, Nugadong, ready for viewing over summer or next season to assess residual control.

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Brome Grass (*Bromus diandrus*): The Influence of Time of Sowing, Knockdowns and Rainfall on Pre-Emergent Herbicide Control

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Key Messages

- All pre-emergent treatments used in this trial are registered for suppression of brome grass and it is not recommended to rely solely on their efficacy alone under high weed densities. Under high weed population scenarios pre-emergent herbicides should form part of a strategy with an effective post-emergent herbicide.
- Pre-emergent herbicides should be considered one component of a fully Integrated Weed Management program with effective knockdowns, post-emergent control and harvest weed seed practices strongly recommended to further reduce weed numbers and delay the onset of resistance.

Aims

1. Demonstrate the value of knockdown strategies on reducing weed pressure and increasing the performance of pre-emergent herbicides.
2. Demonstrate the influence of rainfall timing on Sakura uptake (root) vs. commercial (shoot uptake) standards i.e. trifluralin.

Background

- Time of Sowing (TOS) dates were selected to ensure that treatments were applied under different moisture profiles with the most pressure on timing B where sowing was ~5 days after a germination event (significant rainfall ~10mm) had occurred but prior to significant emergence of brome grass to be controlled by the knockdown.
- Sakura 850 WG like other root uptake herbicides i.e. propyzamide, works best when activated within a moist soil profile prior to or as weeds germinate.
- The value of an effective knockdown in taking the pressure off pre-emergent herbicides cannot be underestimated when trying to drive a seed bank down.

Trial Details

Property	Ardoch, east Ballidu
Plot size & replication	2.2m x 20m x 3 replications
Soil type	Yellow sandy loam
Soil pH ($CaCl_2$)	0-10cm: 5.5 10-20cm: 5.5 20-30cm: 4.8
EC (dS/m)	0-10cm: 0.203 10-20cm: 0.072 20-30cm: 0.060
Seeding date	(A) Dry 30/04/2015, (B) post-break 25/05/2015, (C) weeds up 31/05/2015
Seeding rate	60 kg/ha Mace wheat treated with EverGol® Prime 60mL/100kg
Paddock rotation	2012 pasture, 2013 wheat, 2014 canola
Fertiliser	At each respective TOS (A, B, C): 60 kg/ha urea, 60 kg/ha Gusto® Gold
Pre-emergent Herbicides	(A) - 30/04/2015: 1.8 L/ha Roundup® Ultra (B) - 30/04/2015: 1.8 L/ha Roundup Ultra 25/05/2015 2 L/ha Roundup Ultra (C) - 30/04/2015: 1.8 L/ha Roundup Ultra 25/05/2015 2 L/ha Roundup Ultra 31/05/2015: 2 L/ha Spray.Seed®
Application rate	96 L/ha total volume
Post-emergent Herbicides & Fungicides	17/06/2015 & 20/08/2015: 800 mL/ha Velocity® + 200 mL/ha Prosaro® + 0.5% v/v Uptake® across all treatments
Growing season rainfall	243mm

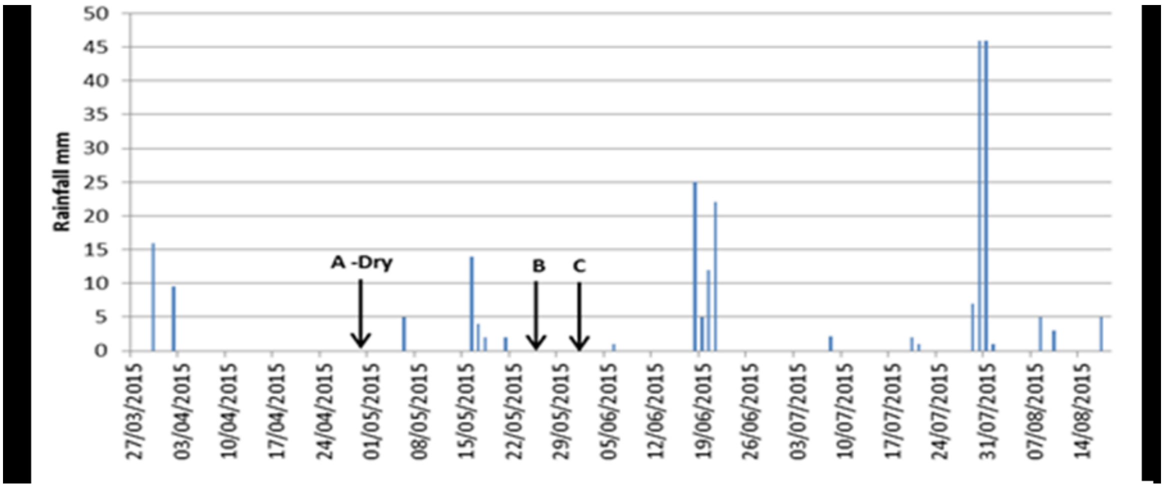

Figure 1: Daily rainfall (mm) recorded at east Ballidu with time of sowing indicated.

Influence of knockdown rainfall and weed emergence

At TOS A the knockdown applied was for summer weeds and some wild radish which had little impact on the brome grass population as very few plants had emerged at the time of application. This TOS was the equivalent of dry seeding.

The first flush of brome came up on 22mm of rainfall over several days from the 16/05/2015 on a rapidly drying soil moisture profile. As a result herbicides applied at TOS A were present for the germination event.

At TOS B, the knockdown only partly successful; weeds were partly emerged and the soil moisture profile was rapidly drying. This scenario would be considered sub-optimal for root uptake herbicides.

At TOS C all weeds that had germinated from the 22mm rainfall event had emerged meaning there was an effective double knockdown reducing weed numbers, improving overall efficacy of all herbicides.

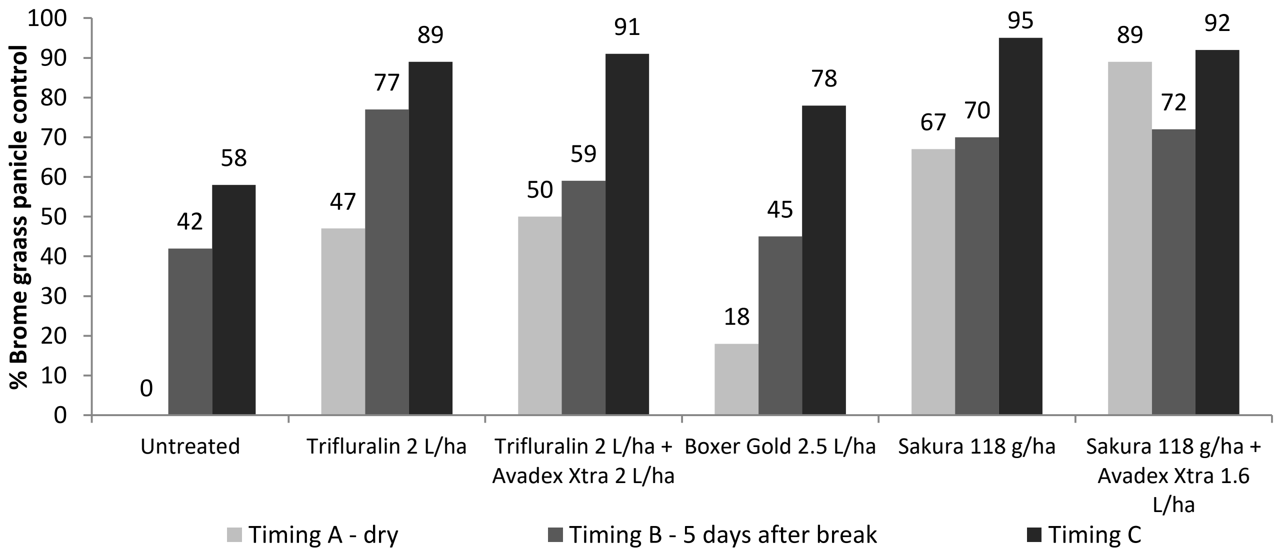

Figure 2: Final panicle counts (30/09/2015). % Brome grass control compared to untreated TOS A (286 panicles/m^2).

Results

Brome grass final panicle counts

The first flush of brome grass emerged under a rapidly drying moisture profile (22mm for week prior) with all TOS A herbicides activated but under higher pressure in terms of brome grass population. Sakura with its root uptake did not perform as well in TOS B (sown into the drying profile) with an observed increase of only 2% control from the addition of Avadex Xtra over Sakura alone, although earlier ratings were higher than this (14% see Table 1). An effective knockdown prior to TOS C recorded improved suppression of brome grass from all treatments with 58% control of panicles from the knockdown herbicides only (Table 1).

Table 1: Brome grass control rating compared to untreated within TOS, panicle counts and brome grass contamination.

Assessment date, days after TOS A or C (DAA/C):				14/07 44 DAC	18/08 79 DAC	30/09 153DAA/122 DAC			12/11 196 DAA/ 165 DAC	
No.	Treatment	Time of Sowing	Knockdowns applied	% Brome Control rating	% Brome Control rating	% Brome Control rating in TOS	Brome Panicles/m²	% Brome Control vs TOSA untreated (Trt 1)	% brome grass sample weight	Count seeds/ 1/2 L sample
1	Untreated	30-Apr	A: glyphosate 2 L/ha	0	0	0	286[a]	0	0.7	116
2	Trifluralin 2 L/ha			58	60	55	151[a]	47	0.4	91
3	Trifluralin 2 L/ha + Avadex Xtra 2 L/ha			50	63	60	143[a]	50	0.7	91
4	Boxer Gold 2.5 L/ha			45	47	40	236[a]	18	0.1	42
5	Sakura 118 g/ha			65	77	75	96[a]	67	0.1	34
6	Sakura 118 g/ha + Avadex Xtra 1.6 L/ha			85	92	91	30[a]	89	0.1	24
7	Sakura 118 g/ha + Trifluralin 1.5 L/ha			80	84	81	66[a]	77	0.1	31
8	Untreated	25-May	A: glyphosate 2 L/ha + B: glyphosate 2 L/ha	0	0	0	164[a]	42	0.8	***180***
9	Trifluralin 2 L/ha			58	67	58	64[a]	77	0.1	19
10	Trifluralin 2 L/ha + Avadex Xtra 2 L/ha			53	63	52	118[a]	59	0.5	124
11	Boxer Gold 2.5 L/ha			35	47	35	157[a]	45	1.4	***265***
12	Sakura 118 g/ha			58	70	70	86[a]	70	0.1	28
13	Sakura 118 g/ha + Avadex Xtra 1.6 L/ha			72	82	84	81[a]	72	0.2	54
15	Untreated	31-May	A: glyphosate 2 L/ha + B: glyphosate 2 L/ha + C: Spray.Seed 2 L/ha	0	0	0	119[a]	58	0.6	***188***
16	Trifluralin 2 L/ha			75	77	65	30[a]	89	0.4	107
17	Trifluralin 2 L/ha + Avadex Xtra 2 L/ha			82	83	81	27[a]	91	0.2	54
18	Boxer Gold 2.5 L/ha			65	63	58	63[a]	78	0.3	83
19	Sakura 118 g/ha			86	91	88	14[a]	95	0.1	19
20	Sakura 118 g/ha + Avadex Xtra 1.6 L/ha			86	94	90	22[a]	92	0.0	14
						LSD (P=0.05)	*195.8*			
						Standard Deviation	*118.7*			
						CV (%)	*118.5*			

Means followed by same letter do not significantly differ (P=0.05, Duncan's New MRT)

Values in bold and italics exceeded the receival standards for AGP1 of 150 seeds and resulted in a quality down grade to FED1.

Note: Brome grass panicles counted in the Sakura treatments were reduced in biomass and had smaller seed heads than other treatments due to the long residual activity of the herbicide.

Brome grass control ratings

In ratings at 14/07, 18/08 and 30/09 Sakura with the addition of Avadex Xtra recorded an increase of 12-20% control over Sakura alone at TOS A and B, with minimal increase (0-3%) at TOS C.
Sakura recorded increased control of brome grass compared to commercial standards at all timings (Table 1).

Brome grass seed contamination

Foreign seed contamination, while a reflection of weed control, is only the weed seed caught in the grain sample and may not reflect seed already shed before harvest.
In samples analysed from harvest on the 12/11/2015 Sakura treatments recorded the lowest percentage and seed count in TOS A and C, with 2 L/ha trifluralin in TOS B also recording a low result (Table 1).

Table 2: Annual ryegrass (ARG) control rating compared to untreated within TOS and panicle counts.

			Assessment date:	**30/09 – 153 days after TOSA/ 122 days after TOSC**		
No.	**Treatment**	**Time of Sowing**	**Knockdowns applied**	**ARG % Control rating in TOS**	**ARG Panicles/ m²**	**ARG % Control vs. TOSA**
1	Untreated	30-Apr	A: glyphosate 2 L/ha	0	230	0
2	Trifluralin 2 L/ha			85	47	80
3	Trifluralin 2 L/ha + Avadex Xtra 2 L/ha			85	70	70
4	Boxer Gold 2.5 L/ha			80	43	81
5	Sakura 118 g/ha			90	30	87
6	Sakura 118 g/ha + Avadex Xtra 1.6 L/ha			95	7	97
7	Sakura 118 g/ha + Trifluralin 1.5 L/ha			95	20	91
8	Untreated	25-May	A: glyphosate 2 L/ha + B: glyphosate 2 L/ha	0	183	20
9	Trifluralin 2 L/ha			80	40	83
10	Trifluralin 2 L/ha + Avadex Xtra 2 L/ha			80	47	80
11	Boxer Gold 2.5 L/ha			75	0	100
12	Sakura 118 g/ha			80	7	97
13	Sakura 118 g/ha + Avadex Xtra 1.6 L/ha			90	23	90
15	Untreated	31-May	A: glyphosate 2 L/ha + B: glyphosate 2 L/ha + C: Spray.Seed 2 L/ha	0	90	61
16	Trifluralin 2 L/ha			88	0	100
17	Trifluralin 2 L/ha + Avadex Xtra 2 L/ha			90	20	91
18	Boxer Gold 2.5 L/ha			90	7	97
19	Sakura 118 g/ha			95	0	100
20	Sakura 118 g/ha + Avadex Xtra 1.6 L/ha			95	0	100

Note: Statistical analysis was not possible for annual ryegrass as there was only two replicates with sufficient population to rate and count.

Annual ryegrass control ratings - 30/09

Ryegrass was only present across two replicates. The following trends are to be interpreted with caution. Ratings on the 30/09 recorded an increase in annual ryegrass control of 5% for Sakura with the addition of Avadex Xtra or trifluralin at TOS A over Sakura alone and 10% control at TOS B. There was no difference recorded at TOS C (Table 2).

Annual ryegrass control counts - 30/09

Ryegrass was only present across two replicates. The following trends are to be interpreted with caution. Sakura treatments with their longer residual activity recorded the highest control of ryegrass panicles at TOS A (≥ 81%). At TOS B Sakura treatments and Boxer Gold recorded excellent control of annual ryegrass (≥ 90%). At TOS C all pre-emergent herbicides recorded excellent control of annual ryegrass (≥ 91%) aided by an effective double knockdown (61% control) (Table 2).

Yield and quality

Most treatments met the receival standards for AGP1 although the untreated in TOS B and C with Boxer Gold in TOS B exceeded the allowable levels of type 7b foreign seeds resulting in a downgrade to FED1 (Table 3).

The highest gross margin in the trial was recorded from Sakura + Avadex Xtra at TOS A with $670.28 after costs of chemical and application. This was $40.01 ahead of 2 L/ha trifluralin at TOS A and $58.70 ahead of the untreated in TOS A (Table 3).

Table 3: Annual rye grass control rating compared to untreated within TOS and panicle counts.

Assessment date:					12/11/15 - 196 days after TOSA/165 days after TOSC									
Treatment	**Time of Sowing**	**Knockdown costs**	**Application Costs $/ha**	**Herbicide cost $/ha**	**Yield t/ha**	**% TOSA untreated**	**Moisture %**	**Protein %**	**Hectolitre weight (kg/hL)**	**Screenings (%)**	**Grade**	**Gross $/ha**	**Gross Margin $/ha**	**$/ha ROI TOS trifluralin**
Untreated	30-Apr	$11.88	$6.00	$0.00	2.34^{a}	100	9.5	9.0	80.3	6.6	AGP1	$629.46	$611.58	-$18.69
Trifluralin 2 L/ha				$10.90	2.45^{a}	105	9.6	8.8	81.5	6.6	AGP1	$659.05	$630.27	$0.00
Trifluralin 2 L/ha + Avadex Xtra 2 L/ha				$29.60	2.48^{a}	106	9.5	8.8	80.8	8.2	AGP1	$667.12	$619.64	-$10.63
Boxer Gold 2.5 L/ha				$36.60	2.35^{a}	100	9.5	8.7	81.5	8.4	AGP1	$632.15	$577.67	-$52.60
Sakura 118 g/ha				$39.32	2.62^{a}	112	9.5	9.1	81.5	6.9	AGP1	$704.78	$647.58	$17.31
Sakura 118 g/ha + Avadex Xtra 1.6 L/ha				$54.28	2.76^{a}	118	9.6	8.6	81.4	7.0	AGP1	$742.44	$670.28	$40.01
Sakura 118 g/ha + Trifluralin 1.5 L/ha				$47.95	2.71^{a}	116	9.4	8.7	81.6	7.6	AGP1	$728.99	$663.16	$32.89
Untreated	25-May	$25.08	$12.00	$0.00	2.19^{a}	94	9.5	8.8	80.3	8.3	FED1	$459.90	$422.82	-$139.83
Trifluralin 2 L/ha				$10.90	2.27^{a}	97	9.4	8.5	80.7	8.0	AGP1	$610.63	$562.65	$0.00
Trifluralin 2 L/ha + Avadex Xtra 2 L/ha				$29.60	2.07^{a}	89	9.5	9.0	79.3	5.9	AGP1	$556.83	$490.15	-$72.50
Boxer Gold 2.5 L/ha				$36.60	2.30^{a}	98	9.5	9.0	78.3	5.9	FED1	$483.00	$409.32	-$153.33
Sakura 118 g/ha				$39.32	2.30^{a}	98	9.5	9.0	80.6	8.6	AGP1	$618.70	$542.30	-$20.35
Sakura 118 g/ha + Avadex Xtra 1.6 L/ha				$54.28	2.39^{a}	102	9.5	8.9	80.4	5.9	AGP1	$642.91	$551.55	-$11.10
Untreated	31-May	$44.08	$18.00	$0.00	2.22^{a}	95	9.4	9.2	78.0	6.7	FED1	$466.20	$404.12	-$114.70
Trifluralin 2 L/ha				$10.90	2.20^{a}	94	9.4	8.9	78.7	6.1	AGP1	$591.80	$518.82	$0.00
Trifluralin 2 L/ha + Avadex Xtra 2 L/ha				$29.60	2.26^{a}	97	9.4	9.2	80.1	6.1	AGP1	$607.94	$516.26	-$2.56
Boxer Gold 2.5 L/ha				$36.60	2.17^{a}	93	9.4	9.0	79.0	7.9	AGP1	$583.73	$485.05	-$33.77
Sakura 118 g/ha				$39.32	2.20^{a}	94	9.5	9.0	79.8	5.8	AGP1	$591.80	$490.40	-$28.42
Sakura 118 g/ha + Avadex Xtra 1.6 L/ha				$54.28	2.26^{a}	97	9.5	9.3	79.5	6.4	AGP1	$607.94	$491.58	-$27.24
				LSD P=0.05	*0.81*									
				Std Dev.	*0.49*									
				CV (%)	*21.04*									

Means followed by same letter do not significantly differ (P=0.05, Duncan's New MRT)
Price AGP1 Kwinana 21/12/15 $269.00, Price FED1 Kwinana 21/12/15 $210.00

Final weed control comments

Previous TOS trials from 2014 for annual ryegrass highlighted the importance of knockdown herbicides in reducing crop competition and pressure on the pre-emergent herbicides, which is important in achieving maximum yield and delaying the onset of herbicide resistance.

In a brome population of this density, a follow up application of an effective post-emergent, such as Atlantis®, Monza® or Intervix® in a Clearfield® system, would be recommended to achieve acceptable control and reduce the seed bank. Harvest weed seed management would also be recommended.

Acknowledgements

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Physical and Chemical Control of Wild Radish in Lupins at Ballidu

Mohammad Amjad, Abul Hashem and Glen Riethmuller, DAFWA

Aim

To investigate the effect of on-row and inter-row physical and chemical weed control options on wild radish (weed population and crop damage) and performance of a lupin crop sown in wide rows at Ballidu.

Background

Wild radish has developed resistance to most of the herbicide groups (including glyphosate) that are used in Western Australia (WA). Integrated weed management (IWM) strategies employing both chemical and non-chemical weed control options need to be incorporated into lupin production systems to minimise the impact of herbicide resistance within the WA Wheatbelt. IWM tactics are aimed at effectively stopping weed seed set (as much as 100%) by applying double-knock techniques (non-selective chemical and physical weed control), cultural methods, rotation of crop species, rotation of herbicide modes of action, and physical weed control options. Recent work on physical and chemical weed control options in wide row lupins (Riethmuller *et al*., 2014; Hashem *et al*., 2010) concluded that inter-row cultivation or shielded spraying (if on-label) can be used in wide row crops in order to reduce weed growth between crop rows while causing minimal damage to the crop plants. The authors also suggested that shielded spraying may be worth further investigation as it did reduce weed seed numbers without a significant yield penalty in that research.

Trial Details

Property	Ardoch, east Ballidu		
Plot size & replication	4m x 20m x 4 replications		
Soil type:	Sandy soil		
Soil pH ($CaCl_2$)	0-10cm: 4.4	10-20cm: 4.3	20-30cm: 4.5
EC (dS/m)	0-10cm: 0.178	10-20cm: 0.088	20-30cm: 0.114
Seeding date	25/05/2015		
Seeding rate	110 kg/ha (90% germination) Barlock lupins		
Paddock rotation	2012 wheat, 2013 lupins, 2014 wheat		
Fertiliser	25/05/2015: 100 kg/ha Big Phos Manganese (deep banded)		
Herbicides, Insecticides & Fungicides	Double Knock before sowing and other herbicides as per treatments (Table 1) 11/05/2015: 2 L/ha Roundup, 25 mL/ha Hammer 25/05/2015: 2 L/ha Spray.Seed 250, 100 mL/ha Telstar 25/08/2015: 500 mL/ha Clethodim, 1% Hasten 26/08/2015: 0.3 kg/ha Pirimor+wetter Other herbicides as per treatments		
Growing season rainfall	243mm		

Trial Layout

The trial was laid out in a randomised complete block design in two banks with 12 combinations of treatments and four replications of lupin crop sown in 66cm row spacing. There were six rows sown in a plot (4m x 20m) using a cone seeder. On-row herbicide was applied using a knapsack sprayer immediately after the sowing. Sweep points (180mm) were used for inter-row cultivation. The shielded sprayer with Teejet^{TM} DG95015EVS (Riethmuller *et al*., 2014) was used for inter-row spray treatments. Some unregistered herbicide products and above the label rates (coded as X) were used in treatment combinations (listed in Table 1) for post sowing pre- and post-emergent applications.

Results

Lupin emergence in the 2015 season was good due to a good start of the season at Ballidu. There was no treatment effect on lupin plant establishment (Table 1). Post-emergent (PO) application of herbicides, Inter-row cultivations (IR) and slashing (mowing) were performed according to the treatment schedule.

The average initial density of wild radish was 19 plants/m^2 as counted on 1st July 2015.

Crop vigour (data not presented) of lupins in the treatments with application of product X1 (either applied on the rows or on the whole plot) was as good as simazine applied over the whole plot at post-sowing pre-emergent (PSPE). Wild radish control on the rows (OR) of lupin crop was good across all treatments where herbicides were applied on the OR.

Visual assessment made before the application of late inter-row (IR) cultivation or slashing (mowing), IR radish control was greater (92-99%) in the treatments where simazine was applied over the whole plot at PSPE followed by an application of metribuzin + Brodal® at post-emergent (PO) or Product X1 was applied over the whole plot at PSPE with no PO herbicides, than other treatments.

After applying all the post emergent treatments (including inter-row spraying, slashing (mowing) and cultivation), lupin and wild radish densities were assessed again on 23rd September 2015 (Table 2). There was no significant treatment effect on lupin plant density as was previously observed early in the season (Table 1); however, comparatively few more lupin plants were counted across treatments due to late germination. The post-seeding post-emergent chemical and non-chemical treatments significantly reduced the wild radish density (plant count) to 8 plants/m^2 when assessed on 23rd September 2015. Simazine, Outlook and Terbyne followed by Metribuzin + Brodal® killed all wild radish plants (Table 2). Other weeds such as annual ryegrass were also present in very low density across all the treatments.

The unusual dry conditions and tough finish of the 2015 season generally reduced the lupin crop growth and grain yield. There were a significant lupin yield differences between the treatments. The highest yielding treatment (Product 1204 herbicide at 1 L/ha) before seeding (PS) followed by 150 g/ha metribuzin + 100 mL/ha Brodal® at 3 leaf stage of wild radish produced 1.49 t/ha of lupin grain yield (Table 2). Yield (1.47 t/ha) in the treatment of Product X1 over whole plot at PSPE was very similar to Product 1204, followed by the treatment of 1.0 L/ha Outlook® PSPE and 150 g/ha metribuzin + 100 mL/ha Brodal® at 3 leaf stage of wild radish (1.35 t/ha). The cultivation treatments and inter-row shielded sprayers yielded similar (0.8 t/ha) but those yields were 45% lower than Product 1204. However, all the IR cultivation and IR shielded sprayers contributed to the reduction of wild radish density. Suppression of crop growth was observed in the treatment of 2 kg/ha simazine 900 throughout the season and resulted in the lowest yield (0.39 t/ha).

Table 1: Lupin and initial wild radish plant density after the pre-emergent treatments, averaged across four replications at Ballidu in 2015[a].

Treatment	Lupin plants/m^2 after emergence	Radish plants/m^2 after emergence	OR[b] radish control (%)	IR[c] radish control (%)
1. Product X1 over whole plot at PSPE	60	19	99	92
2. Product 1204 herbicide (1 L/ha) before seeding (PS) followed by metribuzin 150 g/ha + Brodal® 100 mL/ha @ 3 leaf stage of wild radish or 5 leaf stage of lupins	57	12	98	60
3. Simazine 900 2 kg/ha after sowing (PSPE) followed by metribuzin 150 g/ha + Brodal® 100 mL/ha @ 3 leaf stage of wild radish or 5 leaf stage of lupins	62	21	100	99
4. Outlook® 1.0 L/ha PSPE followed by metribuzin 150 g/ha + Brodal® 100 mL/ha @ 3 leaf stage of wild radish or 5 leaf stage of lupins	54	19	97	73
5. Terbyne® 1.0 L/ha PSPE followed by metribuzin 150 g/ha + Brodal® 100 mL/ha @ 3 leaf stage of wild radish or 5 leaf stage of lupins	60	12	97	75
6. Product X1 On-row at sowing and an early inter-row cultivation @ 3 leaf stage of wild radish or 5 leaf stage of lupins	58	33	90	61
7. On-row Product X1 at sowing and a late inter-row cultivation @ flowering of lupin	65	15	98	68
8. Product X1 On-row at sowing and an early and late inter-row cultivation @ 5 leaf stage and flowering of lupin	63	18	100	68
9. Product X1 On-row at sowing and inter-row spray-shield Product X2 @ budding stage of lupins	58	19	100	60
10. Product X1 On-row at sowing and inter-row spray-shield Product X3 @ budding stage of lupins	57	19	100	49
11. Product X1 On-row at sowing and inter-row spray-shield Product X4 @ budding stage of lupins	61	20	98	73
12. Silage making: On-row Product X1 at sowing and inter-row slashing (mowing) of wild radish at flowering of wild radish or at budding stage of lupins followed by inter-row spray-shield Product X2 @ budding stage of lupins	56	19	98	48
Mean	*59*	*19*	*97*	*68*
$LSD_{.05}$	*NS*	*NS*	*NS*	*42.2*

[a]Radish and lupin plant density were counted on 1st July 2015. Weed control assessment was made visually after first cultivation (done on 20 July 2015) but before application of second cultivation, slashing or inter-row sprayshield spray. [b]OR – on the row (furrow). [c]IR – interrow.

Table 2. Lupin and wild radish plant density after the post-emergent treatments (counted on 23rd Sep 2015) and lupin grain yield, averaged across four replications at Ballidu in 2015[a].

Treatment	Lupin plants/m² after emergence	Radish plants/m² after emergence	Lupin grain yield (t/ha)
1. Product X1 over whole plot at PSPE	68	10	1.47[a]
2. Product 1204 herbicide (1 L/ha) before seeding (PS) followed by metribuzin 150 g/ha + Brodal® 100 mL/ha @ 3 leaf stage of wild radish or 5 leaf stage of lupins	68	2	1.49[a]
3. Simazine 900 2 kg/ha after sowing (PSPE) followed by metribuzin 150 g/ha + Brodal® 100 mL/ha @ 3 leaf stage of wild radish or 5 leaf stage of lupins	56	0	0.39[e]
4. Outlook® 1.0 L/ha PSPE followed by metribuzin 150 g/ha + Brodal® 100 mL/ha @ 3 leaf stage of wild radish or 5 leaf stage of lupins	65	0	1.35[a]
5. Terbyne® 1.0 L/ha PSPE followed by metribuzin 150 g/ha + Brodal® 100 mL/ha @ 3 leaf stage of wild radish or 5 leaf stage of lupins	79	0	0.99[b]
6. Product X1 On-row at sowing and an early inter-row cultivation @ 3 leaf stage of wild radish or 5 leaf stage of lupins	59	18	0.89[bc]
7. On-row Product X1 at sowing and a late inter-row cultivation @ flowering of lupin	61	10	0.81[c]
8. Product X1 On-row at sowing and an early and late inter-row cultivation @ 5 leaf stage and flowering of lupin	61	7	0.72[cd]
9. Product X1 On-row at sowing and inter-row spray-shield Product X2 @ budding stage of lupins	70	9	0.81[c]
10. Product X1 On-row at sowing and inter-row spray-shield Product X3 @ budding stage of lupins	67	10	0.81[c]
11. Product X1 On-row at sowing and inter-row spray-shield Product X4 @ budding stage of lupins	68	21	0.82[c]
12. Silage making: On-row Product X1 at sowing and inter-row slashing (mowing) of wild radish at flowering of wild radish or at budding stage of lupins followed by inter-row spray-shield Product X2 @ budding stage of lupins	61	13	0.75[c]
Mean	*65*	*8*	*0.94*
LSD.05	*NS*	*13.0*	*0.158*

[a]Means with the same letters in a column are not significantly different (p<0.05)

Discussion

Both chemical and non-chemical treatment combinations were applied at post-seeding, pre and post-emergent to control and manage wild radish in wide row lupins. On-row herbicide application and inter-row cultivation and shielded sprayed combinations reduced wild radish numbers; however, some crop damage resulted in comparatively reduced lupin yield in 2015. These chemical and non-chemical strategies tested in 2015 are looking promising and need to be tested across seasons and environments to control wild radish to avoid yield losses and improve the efficiency of cropping systems while minimising the impact of herbicide resistance within WA Wheatbelt.

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References

Riethmuller, G., Borger, C. and Hashem, A., (2014). Physical and herbicide weed control in wide row lupins in Western Australia. Proceedings 19th Australian Weeds Conference, Hobart, Tasmania, Sep 1-4, 79-82.

Hashem, A, M Collins and D Bowran (2010). Efficacy of Inter-row Weed Control Techniques in Wide Row Narrow-leaf Lupin (Lupinus angustifolius) *Weed Technology* 25:135-140.

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Pre-Emergent Spray Targeting Ryegrass in Wheat

Michael Macpherson, Imtrade Australia and Elly Wainwright, Liebe Group

Key Messages

- There are multiple pre-emergent herbicides for ryegrass control.
- In-tank blends are becoming more common.

Aim

To demonstrate different pre-emergent herbicide options for control of ryegrass in wheat.

Background

Ryegrass is a serious problem in the north eastern Wheatbelt. Increasing issues with resistance make it important for growers to have herbicide strategies that give excellent kill rates as well as being cost effective. The modes of action also need to be taken into account as different seasons will contribute to the efficacy of different sprays. Imtrade Australia, in collaboration with the Liebe Group, implemented a pre-emergent spray trial to provide local information for growers.

The trial was conducted on the Hood Property in east Ballidu. Treatments were sprayed using a hand sprayer on the 20/05/2015. The site was sown the same day with the Hood's seeder bar using knife point tynes to a depth of approximately 2.5cm. The soil moisture at seeding was ideal due to a 16mm rain event four days prior. This was followed by 2mm the day after sowing, then a dry period of four weeks.

The chemical treatments are in Table 1. Note: treatments 3, 12 and 13 had to be discarded as two of the three replications were not suitable for monitoring due to a seeding error.

Conditions at planting were not ideal for pre-emergent herbicides due to the dry start and poor incorporation.

Trial Details

Property	Ardoch, east Ballidu
Plot size & replication	10m x 2.5m x 3 replications
Soil type	Light grey, 0-5% gravel
Soil pH ($CaCl_2$)	0-10cm: 6.2 10-20cm: 4.8 20-30cm: 5.1
EC (dS/m)	0-10cm: 0.17
Seeding date	20/05/2015
Seeding rate	60 kg/ha Mace wheat
Paddock rotation	2012 pasture, 2013 wheat, 2014 canola
Fertiliser	20/05/2015: 20 kg/ha Guano, 20 kg/ha MAP
Herbicides	See treatment list
Growing season rainfall	243mm

Results

Table 1: Average emergence of wheat per meter row, 28 DAT.

Treatment	Application rate (per ha)	Emergence (plants/m row)
1. Untreated	--	19.2
2. Boxer Gold	2.5L	18.7
3. Sakura	118g	NA
4. Jetti Duo	1.8L	23.3
5. Trifluralin	2L	24.5
6. Trifluralin + triallate 750	2L + 1.3L	24.8
7. Boxer Gold + trifluralin	2.5L + 2L	15.7
8. Boxer Gold + triallate 750	2.5L + 1.3L	11.7
9. Sakura + trifluralin	118g + 2L	18.2
10. Sakura + triallate 750	118g + 1.3L	24.5
11. Diablo Duo	3L	24.5
12. Bolta Duo	3L	NA
13. Dual Gold	1L	NA
P value		*0.508*
LSD		*NS*

Note: Shaded treatments were discarded.

Table 2: Comparison of treatment means. Average brome grass per square metre.

Treatment	Application rate (per ha)	28 DAT 16/06/2015 (plants/m^2)	64 DAT 22/07/2015 (plants/m^2)
1. Untreated	--	19.0	20.7
2. Boxer Gold	2.5L	22.0	16.8
3. Sakura	118g	NA	NA
4. Jetti Duo	1.8L	21.3	14.5
5. Trifluralin	2L	13.0	11.2
6. Trifluralin + triallate 750	2L + 1.3L	11.3	14.3
7. Boxer Gold + trifluralin	2.5L + 2L	8.7	17.5
8. Boxer Gold + triallate 750	2.5L + 1.3L	7.3	10.7
9. Sakura + trifluralin	118g + 2L	8.2	8.7
10. Sakura + triallate 750	118g + 1.3L	6.0	7.8
11. Diablo Duo	3L	11.3	17.5
12. Bolta Duo	3L	NA	NA
13. Dual Gold	1L	NA	NA
P value		*0.134*	*0.698*
LSD		*NS*	*NS*

Note: Shaded treatments were discarded.

Table 3: Comparison of treatment means. Average ryegrass per square meter.

Treatment	Application rate (per ha)	28 DAT 16/06/2015 (plants/m^2)	64 DAT 22/07/2015 (plants/m^2)
1. Untreated	--	2.2	1.7
2. Boxer Gold	2.5L	2.7	1.7
3. Sakura	118g	NA	NA
4. Jetti Duo	1.8L	0.8	0.25
5. Trifluralin	2L	2.8	1.2
6. Trifluralin + triallate 750	2L + 1.3L	1.7	0.8
7. Boxer Gold + trifluralin	2.5L + 2L	1.8	0.8
8. Boxer Gold + triallate 750	2.5L + 1.3L	1.7	0.3
9. Sakura + trifluralin	118g + 2L	1.0	2.0
10. Sakura + triallate 750	118g + 1.3L	2.5	0.8
11. Diablo Duo	3L	0.8	0.0
12. Bolta Duo	3L	NA	NA
13. Dual Gold	1L	NA	NA
P value		*0.466*	*0.191*
LSD		*NS*	*NS*

Note: Shaded treatments were discarded.

Comments

No statistical significance was noted between any treatments or between the treatments and the untreated control. Generally, it is demonstrated that under the conditions experienced at planting, pre-emergent herbicides were not effective in reducing grass weed numbers on their own. This suggests that there was enough soil moisture at depth to cause germination but not enough moisture at the soil surface for sufficient activity of herbicide treatments. By the time sufficient rainfall was received (30 days post sowing), the weed seedlings were beyond the physiological age where pre-emergents were able to be effective.

Acknowledgements

The Hood family for hosting and seeding the trial.

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Post-Emergent Control of Wild Radish in Wheat

Joe Delaney, Elders Scholz Rural

Key Messages

- Early spraying of wild radish is the best weed control practice.
- Using herbicides off-label can jeopardise your crop.
- The addition of an adjuvant will not increase weed control.

Aim

To compare and evaluate wild radish control in wheat using post-emergent herbicides.

Background

Wild radish, *Raphanus raphanistrum* L. is one of the most challenging crop weeds to manage in the West Australian Wheatbelt. Its perseverance as a costly weed to farmers is attributed to several factors, including:

1. its ability to germinate at any time throughout the year,
2. the prolonged viability of its seed in the soil's seedbank,
3. the large number of seeds that it can produce,
4. its adaptability to herbicide control, and
5. the rapid development of herbicide resistance in the region.

Trial Details

Property	Ardoch, east Ballidu		
Plot size & replication	3m x 7m x 3 replications		
Soil type	Sand		
Soil pH ($CaCl_2$)	0-10 cm: 4.4	10-20 cm: 4.3	20-30 cm: 4.5
EC (dS/m)	0-10 cm: 0.178	10-20 cm: 0.088	20-30 cm: 0.114
Seeding date	20/05/2015		
Seeding rate	60 kg/ha Calingiri wheat		
Paddock rotation	2012 wheat, 2013 lupins, 2014 wheat		
Fertiliser	20/05/2015: 25 kg/ha Guano, 25 kg/ha MAP		
Herbicides	13/07/2015: post-emergent as per protocol		
Growing season rainfall	243mm		

Table 1: Treatments.

Treatment	Rates (Per Hectare)
1	Jaguar 1 L
2	Jaguar 800 mL + MCPA LVE 570 300 mL
3	Jaguar 800 mL + MCPA LVE 570 300 mL + Uptake 0.5%
4	Jaguar 800 mL + MCPA LVE 570 300 mL + Hasten 1%
5	Jaguar 800 mL + Aptitude 200 g + MCPA Amine 750 330 mL
6	Triathlon 1 L
7	Paragon Xtra 720 mL
8	Velocity 670 mL + Hasten 1%
9	Velocity 670 mL + Tigrex 500 mL + Hasten 1%
10	Precept 750 mL + Metribuzin 100 g + AMS 1% + Wetter 0.25%
11	Aptitude 200 g + MCPA Amine 750 330 mL
12	Tigrex 750 mL + Diuron 200 g

Results

Table 1: Treatment control of wild radish at 10 and 32 days after application (DAA), east Ballidu 2015.

Treatment	10 DAA % Control	32 DAA % Control
1	92	97
2	90	99
3	90	97
4	83	97
5	91	97
6	90	97
7	91	99
8	93	98
9	94	98
10	89	98*
11	93	98
12	74	98

*Significant reduction in crop biomass

Comments

All treatments were giving very good control as of 32 DAA. The addition of an adjuvant to the Jaguar + MCPA LVE treatment did not give any increase in control; it also reduced the level of initial control (10 DAA) in one of the treatments. It was found that using metribuzin post-emergent led to a reduction in crop biomass and increase in plant death; as a result of this it is recommended that metribuzin should only be used as per label instructions.

Acknowledgements

Thank you to the Hood family for hosting the trial.

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Comparison of EverGol Prime 240 FS with Vibrance FS for the Control of Soil-Borne Flag Smut (*Urocystis agropyri)* in Wheat cv. Westonia

Zoe Bennett, Graduate Research Officer, Peracto WA

Key Messages

- There was no difference in emergence or final establishment between the untreated control and fungicide seed treatments.
- There was no difference in crop biomass between the untreated control and fungicide seed treatments.
- In the untreated control, there was a low infection, having 0.09% of plants infected with flag smut at early flowering.
- All fungicide seed treatments reduced flag smut to negligible levels.
- The untreated control yielded 1.81 t/ha with the fungicide treatments (not significantly different).
- There were no differences observed between treatments in crop colour, biomass or vigour and no signs of phytotoxicity or adverse crop effects from any treatment.

Aim

To compare EverGol Prime 240 FS at 40 mL/100kg seed with Vibrance 096.5 FS at 180 mL/100kg seed applied as seed treatments for the control of soil-borne flag smut (*Urocystis agropyri)* in wheat cv. Westonia.

Background

The trial was conducted at east Buntine, in the northern agricultural region of Western Australia in 2015 into a paddock with a history of soil-borne flag smut infection. Flag smut is a fungal disease which can significantly reduce yields by stunting growth and preventing the production of viable grain. The infection can be carried on seed or be present in the soil, where it can survive for up to seven years. Flag smut spores can be seen on an infected plant as long grey-black streaks, cause twisted and split wheat leaves or heads which fail to produce viable grain. When infection levels are high, the black flag smut spores can be seen as a black cloud behind the harvester, spreading the disease throughout the paddock. The fungus can typically be successfully managed through the application of effective seed treatments.

The trial was sown in late May following 13mm rainfall, which was followed by four weeks of dry conditions. The dry soil delayed germination and crop emergence. Above average rainfall fell in June, July and August, however, spring was very dry and well below average.

Trial Details

Property	Fitzsimons' property, east Buntine
Plot size & replication	10.30m x 1.76m x 6 replications
Soil type	Sandy loam
Sowing date	25/05/2015
Seeding rate	100 kg/ha Westonia
Paddock rotation	2012 pasture, 2013 wheat, 2014 pasture
Fertiliser	25/05/2015: 100 kg/ha Gusto Gold, 50 kg/ha urea
Herbicides	25/05/2015: Seed treatments (See Treatments) 25/05/2015: 2 L/ha Roundup, 3 L/ha Trifluralin
Growing season rainfall	201mm

Results

Eleven days after sowing (DAS), no plants had emerged due to inadequate rainfall. Plant establishment (per m^2) at 39 and 54 DAS were 147.2 and 126.0 respectively in the untreated control, with fungicide treatments not significantly different (Table 1). When assessed at 39 and 54 DAS there were no significant differences in crop biomass between any of the treatments (Table 2).

In the untreated control, 0.09% of plants were infected with flag smut when assessed at early flowering (112 DAS), with all fungicide seed treatments providing significant control of soil borne flag smut and reducing infection to negligible levels (Table 3). There were no significant differences between fungicide treatments.

At 170 DAS, the trial was harvested and the untreated control produced a mean yield of 1.81 t/ha with the fungicide treatments not significantly different (Table 4).

There were no differences observed between treatments in crop colour, biomass or vigour and no signs of phytotoxicity or adverse crop effects from any treatment.

Table 1: Average crop establishment (plants/m^2) in Buntine, 2015.

No.	Treatment	Rate (mL/100 kg seed)	Mean plants per/m^2		
			11 DAS	39 DAS	54 DAS
1	Untreated control	nil	0.0	147.2	126.0
2	EverGol Prime 240 FS	40	0.0	166.1	127.5
3	Vibrance FS	180	0.0	149.7	141.8
P value			-	*0.4814*	*0.2161*
CV (%)			*0.00*	*18.66*	*13.43*
LSD (P ≤ 0.05)			*NS*	*NS*	*NS*

NS = No significant difference due to a P-value > 0.05

Table 2: Crop biomass 39 DAS relative to best plot.

No.	Treatment	Rate (mL/100 kg seed)	Mean crop biomass (% relative to best plot in each replicate)
1	Untreated control	nil	100.0
2	EverGol Prime 240 FS	40	99.2
3	Vibrance FS	180	98.3
P value			*0.6892*
CV (%)			*3.60*
LSD (P ≤ 0.05)			*NS*

NS = No significant difference due to a P-value > 0.05

Table 3: Flag smut infection 112 DAS.

No.	Treatment	Rate (mL/100 kg seed)	Mean % of plants infected
1	Untreated control	nil	0.09[a]
2	EverGol Prime 240 FS	40	0.01[b]
3	Vibrance FS	180	0.00[b]
P value			*0.0035*
CV (%)			*142.72*
LSD (P ≤ 0.05)			*0.05*

Means followed by the same letter are not significantly different (P = 0.05, LSD)

Table 4: Harvest yield 170 DAS.

No.	Treatment	Rate (mL/100 kg seed)	Yield (kg/ha)	Mean yield Relative to untreated control (%)
1	Untreated control	nil	1812	100.0
2	EverGol Prime 240 FS	40	1857	107.2
3	Vibrance FS	180	1820	108.9
P value			*0.9701*	*0.8389*
CV (%)			*19.75*	*28.21*
LSD (P ≤ 0.05)			*NS*	*NS*

NS = No significant difference due to a P-value > 0.05

Comments

There were no significant differences in harvest yield between the untreated control and fungicide treatments.

Acknowledgements

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Comparison of Fungicide Treatments on Spot Form Net Blotch in Litmus Barley - Pithara

Elly Wainwright, R&D Coordinator, Liebe Group

Key Messages

- Environmental factors led to spot form net blotch being a significant problem in the 2015 season.
- There are various fungicides that will provide effective treatment.

Aim

To see the effects of old, new, generic and brand fungicides on spot form net blotch in Litmus barley.

Background

The green bridge caused by summer rains, significant wind lodging in 2014 and wet and cloudy conditions have caused spot form net blotch (*Pyrenophora teres f. maculate*) to be a problem this season (2015). Spot form net blotch most commonly occurs in the high to medium rainfall zones and survives over summer in stubble. The disease is present as oval, solid brown spots with yellow edges elongating to cause blotch symptoms as the disease progresses. When conditions are favourable secondary infections can occur within the season. Wet conditions favour disease initiation and progression of infection.

Spot form net blotch can have a severe effect on grain quality and yield. For every 10% increase in leaf area infected, a corresponding 0.4 t/ha yield loss may occur (2015, DAFWA).

Treatments were applied at GS 41 (commencement of booting, flag leaf fully emerged).

Trial Details

Property	OJ Butcher & Son, Pithara
Plot size & replication	2m x 10m x 3 replications
Soil type	Gravelly duplex
Sowing date	08/05/2015
Seeding rate	50 kg/ha Litmus barley
Paddock rotation	2012 pasture, 2013 wheat, 2014 wheat
Fertiliser	08/05/2015: 35 kg/ha Agstar 23/07/2015: 30 L/ha Flexi-N
Herbicides	05/05/2015: 150 g/ha Metribuzin750 WG, 1.8 L/ha Trifluralin 480, 1.5 L/ha Glyphosate 450 11/06/2015: 1 L/ha Jaguar, 300 mL/ha LVE MCPA 570
Growing season rainfall (April-August)	279mm

Results

Incidence = average presence of disease on nominated leaf as a percentage infected per plot.
Severity = average percentage of leaf area infected on nominated leaf per plot.

Table 1: Disease incidence and severity of spot form net-blotch on flag leaf, days after treatment (DAT).

Treatment	Application rate	19 DAT		33 DAT	
	(per/ha)	Incidence	Severity	Incidence	Severity
1. Untreated	--	46.7	0.53	80.0	2.93
2. Triadimefon	250g	30.0	0.47	93.3	3.47
3. Turbulence 800	156g	43.3	0.60	83.3	2.10
4. Tebuconazole 430SC	290mL	33.3	0.53	80.0	2.47
5. Octopus 800WG	78g	43.3	0.50	76.7	2.60
6. Cracker Jack 550	115mL	56.7	1.20	83.3	2.80
7. Cracker Jack 550	230mL	43.3	0.50	80.0	2.60
8. Radial	420mL	30.0	0.30	93.3	2.97
9. Amistar Xtra	600mL	40.0	0.50	80.0	2.17
10. Cogito	187mL	33.3	0.37	70.0	1.60
P value		*0.50*	*0.06*	*0.454*	*0.124*
LSD		*NS*	*NS*	*NS*	*NS*

NS - no statistical significance at P <0.05

Table 2: Disease incidence and severity of spot form net-blotch flag -1 leaf, days after treatment (DAT).

Treatment	Application rate	19 DAT		33 DAT	
	(per/ha)	Incidence	Severity	Incidence	Severity
1. Untreated	--	83.3	1.53	100.0	6.70
2. Triadimefon	250g	90.0	1.27	96.7	6.17
3. Turbulence 800	156g	86.7	1.40	93.3	3.87
4. Tebuconazole 430	290mL	80.0	1.87	96.7	4.33
5. Octopus 800	78g	76.7	1.00	96.7	4.23
6. Cracker Jack 550	115mL	76.7	1.87	100.0	4.07
7. Cracker Jack 550	230mL	86.7	1.20	96.7	3.97
8. Radial	420mL	83.3	1.83	100.0	5.50
9. Amistar Xtra	600mL	83.3	1.57	90.0	3.47
10. Cogito	187mL	86.7	1.70	96.7	3.53
P value		*0.99*	*0.69*	*0.248*	*0.205*
LSD		*NS*	*NS*	*NS*	*NS*

NS - no statistical significance at P <0.05

Table 3: Disease incidence and severity of spot form net blotch flag -2 leaf, days after treatment (DAT).

Treatment	Application rate (per/ha)	19 DAT		33 DAT	
		Incidence	Severity	Incidence	Severity
1. Untreated	--	100.0	3.17	100.0	6.70
2. Triadimefon	250g	100.0	2.97	100.0	6.17
3. Turbulence 800	156g	96.7	3.53	100.0	3.87
4. Tebuconazole 430	290mL	100.0	5.60	100.0	4.33
5. Octopus 800	78g	100.0	3.03	100.0	4.23
6. Cracker Jack 550	115mL	96.7	3.57	100.0	4.07
7. Cracker Jack 550	230mL	96.7	2.87	100.0	3.97
8. Radial	420mL	100.0	3.33	100.0	5.50
9. Amistar Xtra	600mL	100.0	3.37	100.0	3.47
10. Cogito	187mL	96.7	3.77	100.0	3.53
P value		*0.73*	*0.07*	*ANA*	*0.205*
LSD		*NS*	*NS*	*ANA*	*NS*

NS - no statistical significance at $P < 0.05$
ANA –analysis not applicable

Comments
The first assessment at 19 days after application did not demonstrate any significant differences between treatments and the untreated control. Following assessments at 33 days after sowing also showed no significant differences between treatments. Due to this it was decided to not to continue with further assessment.

It is not known why the applied fungicidal treatments were not efficacious in controlling spot form net blotch in the crop. It is noted that the application timing was potentially later than ideal for controlling spot form net blotch, with a two spray strategy preferred utilising a z33 timing for an initial application. The high level of underlying infection at the treatment timing (z41) may have contributed, being mindful that most fungicides are protectant in nature. The high level of in-crop inoculum may have over-ridden the ability of late applied fungicides to sufficiently prevent the spread of disease upwards in the plant.

Acknowledgements
Imtrade Australia for implementing and monitoring the trial and the Butcher family for hosting it.

References
Department of Agriculture and Food, Western Australia. 2015 [Online]**.** *Managing net type net blotch and spot type net blotch of barley in Western Australia***.** State Government of Western Australia. Available: https://www.agric.wa.gov.au/barley/managing-net-type-net-blotch-and-spot-type-net-blotch-barley-western-australia?page=0%2C1 August 2015.

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Fungicide Management of Powdery Mildew in Mace Wheat, West Buntine

Elly Wainwright, Liebe Group; Michael Macpherson, Imtrade Australia; Geoff Thomas, DAFWA.

Key Messages

- Environmental factors during 2015 led to powdery mildew being a significant disease in susceptible varieties.
- A range of fungicide products significantly reduced powdery mildew incidence and severity on treated leaves.
- Application prior to disease becoming too severe is important to protect uninfected leaves.
- Across all treatments, fungicide application resulted in an average yield response of 310 kg/ha (10.8%) above the untreated control (2.86 t/ha), ranging from 90-550 kg/ha across products.

Aim

To determine the effect of old, new, generic and brand fungicides on powdery mildew in Mace wheat.

Background

Significant wind lodging in 2014 and summer rains created a green bridge, dominance of susceptible varieties and favourable cloudy humid periods during the growing season which resulted in wheat powdery mildew becoming a problem in the 2015 season. Wheat powdery mildew is caused by *Blumeria graminis f. sp. tritici* and is a different disease from *Blumeria graminis f. sp. hordei* that causes barley powdery mildew. Powdery mildew survives between seasons on plant residues and volunteers; when conditions in autumn become cool and damp spores are produced infecting volunteer regrowth and new crops. Powdery mildew produces massive amounts of windborne spores that can spread rapidly over long distances. The disease is characterised by colonies that appear as white cottony patches on the surface of the plant. Most commonly these are present on the lower parts of the plant moving up as the growing season progresses. Powdery mildew can cause significant yield loss if it reaches the flag leaf.

Trial Details

Property	Wattlevale, west Buntine
Plot size & replication	2m x 10m x 3 replications
Soil type	Yellow sandplain
Soil pH ($CaCl_2$)	0-10cm: 5.4
Sowing date	15/05/2015
Seeding rate	80 kg/ha Mace wheat
Paddock rotation	2012 wheat, 2013 wheat, 2014 wheat
Amelioration	15/02/2015: 1 t/ha Lime sand
Fertiliser	15/05/2015: 85 kg/ha K-Till Extra 15/06/2015: 90 kg/ha urea 27/07/2015: 25 L/ha Flexi-N
Herbicides	15/05/2015: 1.5 L/ha Treflan, 1.5 L/ha Spray.Seed 15/06/2015: 540 mL/ha Flight
Growing season rainfall	290mm

Method

Fungicide treatments were applied at growth stage 41 (commencement of booting, flag leaf fully emerged) on the 29/08/2015. The treatments were applied at a water rate of 87 L/ha.

Treatment List

Product/Active	Label Rate
1. Untreated	Untreated
2. Triadimefon 500WG	250 g/ha
3. Turbulence 800WG (Tebuconazole)	156 g/ha
4. Tebuconazole 430SC	290 mL/ha
5. Octopus 800WG (Epoxiconazole)	78 g/ha
6. Cracker Jack 550EC (Propiconazole)	115 mL/ha
7. Cracker Jack 550EC (Propiconazole)	230 mL/ha
8. Radial (Azoxystrobin 75 g/L, Epoxiconazole 75 g/L)	420 mL/ha
9. Amistar Xtra (Azoxystrobin 200 g/L Cyproconazole 80 g/L)	600 mL/ha
10. Cogito (Tebuconazole 250 g/L, Propiconazole 250 g/L)	187 mL/ha

Incidence = average presence of disease on nominated leaf as a percentage infected per plot.
Severity = average percentage of leaf area infected on nominated leaf per plot.
DAT = days after treatment.

Results

At two weekly intervals after spraying, incidence and severity of powdery mildew infection was assessed. Mildew severity progressed over time on each leaf layer assessed. Maximum severity of infection was reached 6 weeks after spraying on Flag leaf, ~2% leaf area affected, and Flag-1, ~16% leaf area affected. All fungicides significantly reduced infection severity on these leaves (Figure 1).

On Flag-2, differences between fungicides were evident 28 days after spraying with Triadimefon, Turbulence 800, Radial and Amistar Xtra reducing incidence and severity of infection. Tebuconazole 430SC and Octopus were least effective (Table 2).

Response to fungicide was not significant on Flag-3, where significant infection was already present at time of spraying (Table 1).

All fungicide treatments resulted in a significant reduction in severity of head infection, reducing severity from ~10% in the untreated control to 2-3% in most fungicide treatments (Table 3).

Yield responses to fungicide products varied from 90-550 kg/ha. Combined fungicide response across all treatments was 310 kg/ha above the Untreated control. No differences in grain quality were evident (Table 4).

Table 1: Fungicide effect on incidence and severity of powdery mildew on top 4 leaves 14 days after treatment.

Treatment	Incidence (%)				Severity (%)			
	Flag	**Flag-1**	**Flag-2**	**Flag-3**	**Flag**	**Flag-1**	**Flag-2**	**Flag-3**
1. Untreated	16.7	76.7^{c}	83.3^{c}	60.0	0.2	3.5^{b}	2.3	4.2
2. Triadimefon 500WG (250g)	0.0	**3.3**^{a}	**26.7**^{a}	40.0	0.0	**0.3**^{a}	0.5	1.5
3. Turbulence 800WG (156g)	0.0	**30**^{b}	**46.7**^{ab}	53.3	0.0	**1.6**^{a}	2.2	3.6
4. Tebuconazole 430SC (290mL)	6.7	**40**^{b}	**50**^{ab}	66.7	0.1	1.9^{ab}	1.4	2.4
5. Octopus 800WG (78g)	0.0	**33.3**^{b}	63.3^{bc}	80.0	0.0	**1.1**^{a}	1.8	2.6
6. Cracker Jack 550EC (115mL)	3.3	**43.3**^{b}	53.3^{abc}	56.7	0.1	**1.7**^{a}	1.6	2.2
7. Cracker Jack 550EC (230mL)	10	53.3^{bc}	66.7^{bc}	70.0	0.4	**1.6**^{a}	1.6	3.2
8. Radial (420mL)	3.3	**20**^{ab}	**46.7**^{ab}	43.3	0.0	**0.5**^{a}	1.2	1.6
9. Amistar Xtra (600mL)	0.0	**16.7**^{ab}	**26.7**^{a}	56.7	0.0	**0.4**^{a}	0.5	2.5
10. Cogito (187mL)	0.0	**23.3**^{ab}	63.3^{bc}	66.7	0.0	**0.5**^{a}	1.5	2.0
P value	*0.337*	*0.001*	*0.039*	*0.225*	*0.314*	*0.013*	*0.429*	*0.441*
LSD	*NS*	***26.29***	***32.33***	*NS*	*NS*	***1.6***	*NS*	*NS*

NS - not statistically significant at P <0.05
Means in Bold, significantly different to Untreated control

Table 2: Fungicide effect on incidence and severity of powdery mildew on top 3 leaves 28 days after treatment.

Treatment	Incidence (%)			Severity (%)		
	Flag	**Flag-1**	**Flag-2**	**Flag**	**Flag-1**	**Flag-2**
1. Untreated	20^{b}	90^{d}	63.3^{c}	1.2^{b}	7.6^{c}	4.7^{c}
2. Triadimefon 500WG (250g)	**0**^{a}	**0**^{a}	**20**^{a}	**0**^{a}	**0**^{a}	**0.4**^{a}
3. Turbulence 800WG (156g)	**0**^{a}	**33.3**^{b}	**43.3**^{b}	**0**^{a}	**1.2**^{ab}	**1.7**^{ab}
4. Tebuconazole 430SC (290ml)	**0**^{a}	**56.7**^{bc}	66.7^{c}	**0**^{a}	**2.2**^{ab}	4.1^{bc}
5. Octopus 800WG (78g)	**3.3**^{a}	66.7^{cd}	70^{c}	**0**^{a}	**4.3**^{b}	4.5^{c}
6. Cracker Jack 550EC (115mL)	**0**^{a}	**40**^{bc}	53.3^{bc}	**0**^{a}	**3.6**^{b}	2.5^{abc}
7. Cracker Jack 550EC (230mL)	**0**^{a}	**46.7**^{bc}	56.7^{bc}	**0**^{a}	**1.9**^{ab}	**2.2**^{ab}
8. Radial (420mL)	16.7^{b}	**33.3**^{b}	**43.3**^{b}	**0.3**^{a}	**0.9**^{ab}	**2.1**^{ab}
9. Amistar Xtra (600mL)	**0**^{a}	**10**^{ab}	**30**^{ab}	**0**^{a}	**0**^{a}	**0.7**^{ab}
10. Cogito (187mL)	**0**^{a}	**30**^{b}	56.7^{bc}	**0**^{a}	**1.2**^{ab}	3^{bc}
P value	*<0.001*	*<0.001*	*<0.001*	*0.001*	*0.002*	*0.016*
LSD	***9.34***	***24.28***	***19.89***	***0.46***	***3.17***	***2.47***

Means in Bold, significantly different to Untreated control

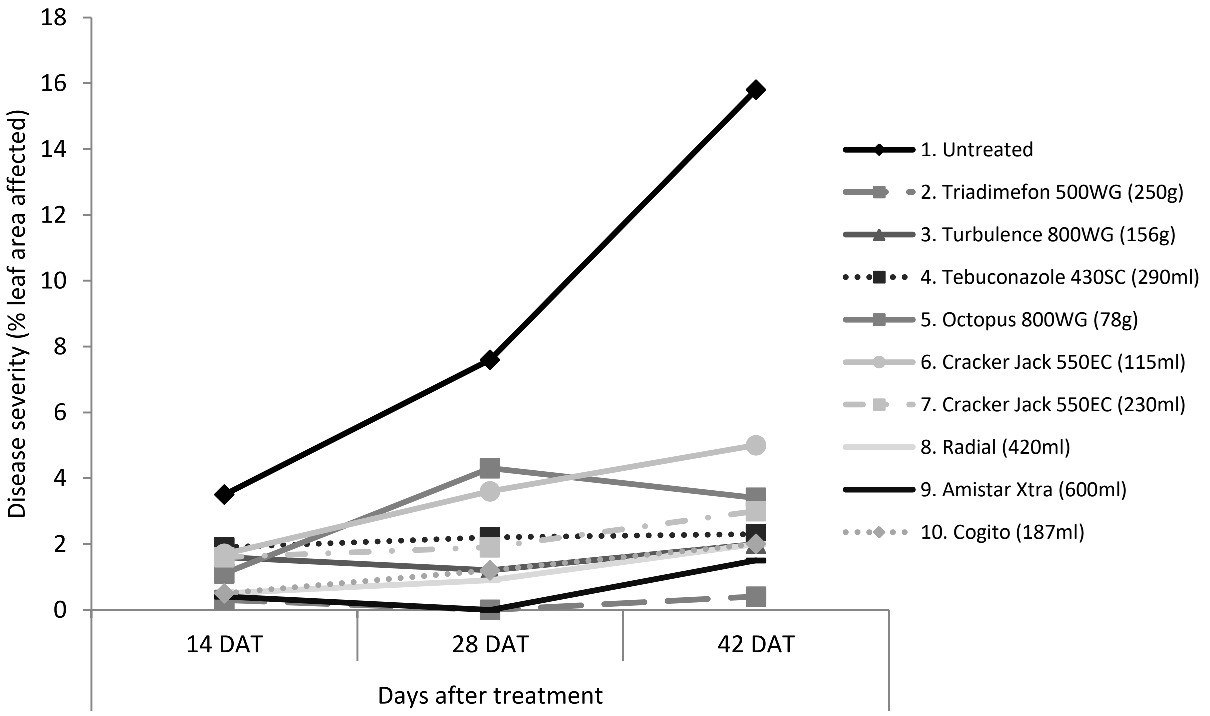

Figure 1: Fungicide effect on disease progress of powdery mildew on Flag-1.
** 14DAT (p value=0.013, LSD=1.6), 28DAT (p value=0.002, LSD=3.17), 42DAT (p value=<0.001, LSD=2.64)

Table 3: Fungicide effect on incidence and severity of powdery mildew on grain head.

Treatment	**Incidence (%)**	**Severity (%)**
1. Untreated	86.7	9.6[b]
2. Triadimefon 500WG (250g)	63.3	**2.6[a]**
3. Turbulence 800WG (156g)	73.3	**3.4[a]**
4. Tebuconazole 430SC (290mL)	76.7	**2.2[a]**
5. Octopus 800WG (78g)	73.3	**2.2[a]**
6. Cracker Jack 550EC (115mL)	56.7	**2.2[a]**
7. Cracker Jack 550EC (230mL)	70.0	**2.9[a]**
8. Radial (420mL)	63.3	**3.2[a]**
9. Amistar Xtra (600mL)	76.7	**2.9[a]**
10. Cogito (187mL)	66.7	**1.9[a]**
P value	*0.226*	*0.002*
LSD	*NS*	***3.06***

NS - not statistically significant at p <0.05
Means in Bold, significantly different to Untreated control

Table 4: Fungicide effect on yield and grain quality of powdery mildew affected Mace wheat, west Buntine 2015.

Treatment	**Yield**		**Protein**	**Hectolitre weight**	**1000 grain weight**	**Screenings**
	(t/ha)		**(%)**	**(kg/hL)**	**(g)**	**(%)**
1. Untreated	2.86	2.86^{b}	10.7	80.9	41	1.8
2. Triadimefon 500WG (250g)	**3.16**		10.5	80.5	39.4	2.2
3. Turbulence 800WG (156g)	**3.17**		10.8	81.0	40.9	1.8
4. Tebuconazole 430SC (290mL)	**3.20**		10.7	81.0	40.7	1.7
5. Octopus 800WG (78g)	**3.26**		10.5	81.0	41.2	1.8
6. Cracker Jack 550EC (115mL)[#]	-		-	-	-	-
7. Cracker Jack 550EC (230mL)	2.95		10.6	80.9	40.4	1.7
8. Radial (420mL)	3.12		10.7	80.9	41	1.6
9. Amistar Xtra (600mL)	**3.41**		10.8	80.4	40.6	2.2
10. Cogito (187mL)	**3.13**		10.4	81.1	39.7	2.1
Combined fungicide treatments		**3.17**^{a}				
P value	*0.071*	*0.012*	*0.057*	*0.159*	*0.536*	*0.598*
LSD (P <0.05)	*NS*	***0.238***	*NS*	*NS*	*NS*	*NS*
LSD (P <0.1%)	***0.261***					

NS - not statistically significant at p <0.05
Means in Bold, significantly different to Untreated control
[#] Due to harvest issues, this treatment was removed from yield analysis

Comments

Effective fungicidal treatments will prevent disease progressing up the tiller (reduced incidence scores compared to untreated on upper leaves) and reduce the severity of infection on infected leaves (lower severity rating compared to the untreated). Application of fungicide prior to disease becoming severe provides the greatest opportunity for the fungicide to effectively protect leaves from infection and delay the progress of infection up the canopy. This is clearly demonstrated in the results, with the application of all fungicide treatments providing a statistical difference in both the incidence and severity of powdery mildew infection on upper canopy leaves. Progression of the disease up the tiller post application is clearly demonstrated on the Flag-1 of the untreated control, with higher incidence and severity scores over time (Figure 1).

Significant fungicide responses were most evident on Flag-1 compared to the untreated, with Triadimefon, Radial and Amistar Xtra exhibiting the best response across all assessments. Flag-2 exhibited statistically significant reduction of infection severity at 28 days after treatment (DAT), with Triadimefon, Turbulence 800, Cracker Jack 550, Amistar Xtra and Radial all reducing the severity; similar trends were evident in disease incidence on this leaf. At the first assessment time there were no significant differences between treatments in the severity or incidence of disease on the Flag-3 leaves (high incidence and severity at application).

The data clearly demonstrates at least 4 weeks efficacy of fungicides. At the 42 DAT assessment there is decline in fungicide efficacy due to waning residual in the target leaves, however, the impact of fungicide treatments on leaf protection and inoculum reduction still exhibit significant differences from the untreated control.

There is a significant impact of fungicide on head infection, however, potentially damaging levels of disease are evident in all treatments, as demonstrated by the non-significant result for disease incidence on heads. This is expected from a fungicide application at booting (most heads still in flag sheath) as minimal systemic activity is experienced from most fungicides away from treated leaves (not translocated acropetally) so non-contacted parts of cereals are not protected by earlier applications and the benefit of treatment is related to reduced inoculum in the canopy rather than direct protection. Therefore if infection occurs earlier in the season or environmental conditions favour continued diseased development at later growth stages, repeated fungicide application (3-4 weeks after first application) may be needed to protect new growth.

Yield responses to fungicide treatment ranged from 90-550 kg/ha with Amistar Xtra giving the largest response (significant at $p < 0.1$). When the combined response to fungicide is compared to the untreated control there is a significant response ($p < 0.05$) of 310 kg/ha.

On susceptible varieties in seasons with favourable environment, application of fungicide early in the development of powdery mildew to protect leaves from infection can result in reduced incidence and severity of infection and return significant yield benefits.

Summary

- Fungicides were applied full Flag leaf emergence/booting growth stage, onto Mace wheat with powdery mildew present in the lower canopy.
- All products reduced development of mildew in the upper canopy compared to untreated controls. Control was evident up to 4-6 weeks post spraying, although period of efficacy of products did differ.
- Differences were evident between fungicide products; however, these were smaller than differences compared to the untreated control.
- Fungicide efficacy appeared best as a protectant on uninfected leaves or with trace infection at spraying (Flag and Flag-1) rather than those already infected at spraying (Flag-2 and Flag-3).
- Heads had not emerged at time of spraying and infection was evident on both sprayed and unsprayed treatments however, significant reduction in severity of infection on heads was evident in fungicide treated plots as a consequence of reduced disease pressure from foliar infection.
- Significant yield benefits can result from fungicide reduction of powdery mildew infection. Yield responses varied from 90-550 kg/ha. Combined fungicide response was ~300 kg/ha above the untreated control.

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Uniform® Demonstration for Rhizoctonia Control in Barley

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Aim

To demonstrate the efficacy of Uniform on rhizoctonia control in barley when applied in-furrow at sowing.

Background

Rhizoctonia solani is a fungal root pathogen. Infected seedlings can have rotting, brown discolouration, and stunted "spear tipped" roots. The root disease is most evident in young crops as bare patches, with symptoms more severe in dry years and under poor nutrition. Fast growing roots and good crop nutrition can help a seedling to 'get ahead' of the disease. Crop rotation, cultivation, seed treatments, and in-furrow fungicide applications are management tools against rhizoctonia.

Uniform® (322 g/L azoxystrobin + 124 g/L metalaxyl-M) is registered for the control of rhizoctonia, pythium, stripe rust and suppression of yellow leaf spot. To manage resistance risk, the first foliar fungicide following any Uniform use must be of a different chemical group (Uniform is Group 11 and Group 4).

The Barnes' first noticed bare patches symptomatic of rhizoctonia in a 2014 wheat paddock, which also yielded lower than expected for the season. To protect their upcoming 2015 barley (Baudin) crop against the rhizoctonia in the soil, they decided to treat the paddock with Uniform.

Uniform was applied in-furrow (with Flexi-N) at three rates: nil, 200 mL/ha and 300 mL/ha. No seed treatment was applied.

This demonstration was conducted using farmer equipment. Large-scale demonstrations are a valuable way to explore new varieties, products, or practices, complimenting results which are produced through more scientifically rigorous small plot trials.

Demonstration Details

Property	Oakley Farm, west Wubin
Plot size & replication	34m x 700m x single replication
Soil type	Heavy loam
Soil pH (CaCl2)	0-10cm: 5.2
Sowing date	09/05/2015
Seeding rate	60 kg/ha Baudin barley
Paddock rotation	2012 canola, 2013 wheat, 2014 wheat
Fertiliser	09/05/2015: 30 L/ha Flexi-N, 35 kg/ha Agstar Xtra 04/07/2015: 30 L/ha Flexi-N
Herbicides & Fungicides	03/03/2015: 1.5 L/ha Glyphosate, 100 mL/ha Garlon, 300 mL/ha Ester 680 05/04/2015: 2 L/ha Trifluralin, 1.4 L/ha Glyphosate 09/05/2015: 1.5 L/ha Paraquat, 1 L/ha Trifluralin, 180 g/ha Diuron 12/06/2015: 1 L/ha Jaguar, 300 mL/ha Tilt 04/07/2015: 300 mL/ha Tilt
Growing season rainfall	380mm

Results

This was an unreplicated farmer demonstration, thus interpretations of results are to be made with caution.

Root sampling showed that the nil plot had considerably more root spear tipping than the 200mL and 300mL Uniform treatments throughout the season (Figures 1, 2, 3). The samples were taken in the 'patchiest' parts of the plots (most affected by rhizoctonia). A vigour assessment was done to assess the whole plot. At 26 days after sowing (DAS), plant growth on the 300 mL/ha Uniform treatment was slightly less vigorous than the 200mL and nil treatments. By 51 DAS through to 81 DAS, the 300 mL/ha treatment was more vigorous (Table 2).

There was little difference between the yields for all treatments (Table 3). The 300mL Uniform treatment was the only treatment to make Malt 2 due to excess screenings in the other two treatments (Table 3).

Nil Uniform **200mL/ha Uniform** **300mL/ha Uniform**

Figure 1: Plants from areas visibly affected by rhizoctonia in each treatment strip taken 26 DAS.

Nil Uniform **200mL/ha Uniform** **300mL/ha Uniform**

Figure 2: Plants from areas visibly affected by rhizoctonia in each treatment strip taken 51 DAS.

Nil Uniform **200mL/ha Uniform** **300mL/ha Uniform**

Figure 3: Plants from areas visibly affected by rhizoctonia in each treatment strip taken 81 DAS.

Table 1: Plant establishment 26 DAS, total plants at each growth stage per 1m^2, west Wubin 2015.

Leaf Stages	Nil Uniform	200 mL/ha Uniform	300 mL/ha Uniform
1-2	2	15	12
3-4	18	21	2
early tillering	27	27	31

Table 2: Whole plot vigour assessment conducted in season, west Wubin 2015.

Treatment	Vigour assessment (%)		
	26 DAS	51 DAS	81 DAS
Nil Uniform	90	75	80
200 mL/ha Uniform	90	80	80
300 mL/ha Uniform	80	95	90

Table 3: Yield, quality and grade of Baudin barley sown, west Wubin 2015.

Treatment	Yield (t/ha)	Protein (%)	Screenings (%)	Hectolitre Weight (kg/hL)	Grade
Nil Uniform	3.98	9.3	44.04	64.93	BFED1
200 mL/ha Uniform	3.81	10.7	35.86	66.58	BFED1
300 mL/ha Uniform	3.99	9.3	28.24	64.56	MALT2

Comments

The variable nature of rhizoctonia patches within a paddock makes conducting trials with output of rigorous scientific data quite difficult. No formal assessment was made of incidence and severity of rhizoctonia patches across the demonstration, thus interpretation of yield results is made difficult.

Whilst unreplicated, the lack of significant yield difference between treatments may be a result of a generally favourable growing season reducing the severity of rhizoctonia in crop. Warmer soil temperatures and adequate moisture are less conducive to disease development. The dry finish to 2015 may explain the higher screenings in the untreated plot – less roots and a dry finish resulted in poorer grain-fill than the Uniform treatments.

Anecdotally the Barnes' did not see any noticeable differences in yield or during season that they would attribute to Uniform application.

Acknowledgements

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Soil Health Research Results

Liebe Group Soil Biology Trial

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Key Messages

- Tillage significantly increased hay yield in 2015 – effectively doubling yields compared to the minimum tillage system.
- While adding organic matter decreased yield in tilled soils by approximately 15% (this is likely due to contamination with seed contained in the chaff) it still out-yielded the minimum tillage treatment by 2.2 t/ha (60%).
- Nine years post last application adding organic matter to the organic matter rundown treatment there continues to be a small positive effect on nutrient availability (potassium, sulphur and phosphorous) compared to the tillage treatment though yield appeared constrained.

Aim

To investigate the potential for organic matter inputs to increase yield and improve soil health.

Background

This long term trial was established in 2003 to investigate how soil biology and carbon affect crop yield and soil health. The trial site was selected as it had no significant chemical or physical soil constraints, therefore capacity to increase grain production through improved moisture conservation and enhanced soil biota can be demonstrated.

The trial aims to understand how agronomic factors such as yield and grain quality are affected by organic matter (OM) breakdown and cycling. Although the application of 20 t/ha of organic matter is not practical in a commercial farming enterprise this treatment is designed to demonstrate the potential upper level of organic carbon for sandy soils in our environment. The plots have now received a total of 100 t/ha of organic matter across five separate applications (2003, 2006, 2010, 2012 and 2015) of chaff. Future modelling will determine whether the soil is nearing its upper soil organic carbon capacity. Recent modelling prior to the latest addition of chaff, suggested that the organic matter plots have reached approximately 80% of the attainable soil organic carbon storage capacity.

Trial Details

Property	Long Term Research Site, west Buntine		
Plot size & replication	10.5m x 80m x 3 replications		
Soil type	Deep yellow sand		
Soil pH ($CaCl_2$)	0-10cm: 6.2	10-20cm: 5.4	20-30cm: 5.2
EC (dS/m)	0-10cm: 0.075	10-20cm: 0.049	20-30cm: 0.043
Sowing date	29/05/2015		
Seeding rate	75 kg/ha		
Paddock rotation	2011 wheat, 2012 canola, 2013 barley, 2014 oats		
Fertiliser	29/05/2015: 30 kg/ha Agflow, 45 kg/ha MoP, 30 L/ha Flexi N, 5 L/ha Calsap 05/08/2015: 50 L/ha Flexi N, 30 L/ha Zinc and Magnesium		
Herbicides	26/04/2015: 2 L/ha Round Up, 0.25 L/ha Knuckle 21/05/2015: 1.6 L/ha Spray.Seed, 0.5 L/ha Dual Gold, 0.63 g/ha Terbyne Extreme 07/07/2015: 1.56 L/ha Precept, 140 g/ha Cadence, 0.4 L/ha Liberate		
Growing season rainfall	242mm		

2015 Treatment List

1. Minimum tillage (with knife points and full stubble retention).
2. Tilled soil (offset discs).
3. Organic matter (chaff is applied once every 3 years last applied 2015 at rate of 20 t/ha; tilled with offset discs).
4. Organic matter run down (plots with chaff previously applied in 2003 & 2006 but not since).
5. Burnt (stubble burnt annually in March; minimum till).
6. Brown manure.

Table 1: Trial History.

Year	Crop type	Yield range	Treatment notes
2003	Lupin	None recorded	Set up phase: 20 t/ha barley chaff applied, lupin crop brown manured.
2004	Wheat (cv. Wyalkatchem)	2.9 - 3.5 t/ha	Brown manuring and addition of 20 t/ha organic matter increased yield by 18-22%.
2005	Wheat (cv. Wyalkatchem)	2 - 2.8 t/ha	Burnt plots yielded 25% higher than control.
2006	Lupins	None recorded	Set up phase: 20 t/ha canola chaff applied, lupin crop brown manured.
2007	Wheat (cv. Wyalkatchem)	None recorded	Sprayed out due to high weed burden.
2008	Wheat (cv. Wyalkatchem)	2.4 - 3.4 t/ha	Addition of organic matter increased yield by 23% compared to control.
2009	Lupin	1.5 t/ha	Set up phase: lupin crop brown manured.
2010	Wheat (cv. Magenta)	2.5 - 1.9 t/ha	Set up phase: 20 t/ha oaten chaff applied. No significant yield difference between treatments.
2011	Wheat (cv. Wyalkatchem)	3 - 3.8 t/ha	No significant difference in yield.
2012	Canola (cv. Telfer)	0.7 - 0.9 t/ha	Set up phase: 20 t/ha oaten chaff applied, canola crop brown manured.
2013	Barley (cv. Hindmarsh)	2.3 - 3.6 t/ha	Addition of organic matter increased yield.
2014	Oats (cv. Brusher)	0.49 - 0.68 t/ha	No significant difference in yield.
2015	Oaten hay (cv. Yallara)	3.6 - 6.85 t/ha	Set up phase: 20 t/ha oaten chaff applied.

Results

Organic matter in the form of 20 t/ha oaten chaff was applied and incorporated using offset discs in April 2015, approximately five weeks prior to sowing the trial. This application of organic matter has brought the total application of chaff to 100 t/ha since 2003. Table 2 shows potassium levels in the treatment with added organic matter are three times higher than in the tilled treatment and 20% higher than the treatment which had organic matter last applied nine years ago (rundown). Treatments with additional organic matter inputs generally continue to have higher nutrient levels, especially phosphorus and potassium than either the minimum tillage or burnt treatments.

The application of oaten chaff increased soil organic carbon (< 2mm, 0-30cm) to 90t C/ha on the added organic matter treatment compared to the tilled treatment 60t C/ha and the minimum tillage treatment of 51t C/ha.

Table 2: Soil nutrients (0-10, 10-20, 20-30 cm) for soil collected at west Buntine in May 2015.

Treatment	Depth (cm)	NH_4 (mg/kg)	$N0_3$ (mg/kg)	Phosphorus Cowell (mg/kg)	Potassium Cowell (mg/kg)	Sulphur (mg/kg)
Minimum tillage	0-10	1	3	25	54	8
	10-20	1	2	28	32	11
	20-30	1	3	18	30	15
Tilled	0-10	3	8	26	89	6
	10-20	1	8	26	60	9
	20-30	1	7	16	46	18
Tilled + Organic Matter	0-10	2	16	47	267	17
	10-20	1	8	42	218	13
	20-30	2	7	27	198	16
Organic Matter Rundown	0-10	3	8	39	105	20
	10-20	1	6	37	102	15
	20-30	1	5	26	101	18
Brown Manured	0-10	1	3	24	83	25
	10-20	1	2	17	44	17
	20-30	2	3	7	35	21
Burnt	0-10	1	3	28	58	12
	10-20	1	2	25	36	16
	20-30	1	3	11	39	21

Figure 2: Organic carbon in topsoil (%, 0-10cm) for all treatments in selected years.
Note: Organic carbon percentage was not recorded for brown manure treatment in 2010 and 2011.

Table 3: Selected soil properties (0-10, 10-20, 20-30 cm) for soil collected at West Buntine in May 2015.

	0-10cm					**10-20cm**					**20-30cm**				
Treatment	**EC (dS/m)**	**pH (CaCl2)**	**Bulk Density**	**Organic Carbon (%)**	**Organic Carbon (t/ha)**	**EC (dS/m)**	**pH (CaCl2)**	**Bulk Density**	**Organic Carbon (%)**	**Organic Carbon (t/ha)**	**EC (dS/m)**	**pH (CaCl2)**	**Bulk Density**	**Organic Carbon (%)**	**Organic Carbon (t/ha)**
Minimum tillage	0.047^{cd}	6.4	1.42^{d}	0.92^{bc}	13.0^{ab}	0.027^{c}	5.1^{b}	1.69	0.56^{bc}	19.1^{b}	0.028^{b}	4.8^{b}	1.76	0.35^{bc}	18.6^{bcd}
Tilled	0.045^{cd}	6.1	1.21^{ab}	0.96^{bc}	11.7^{ab}	0.048^{bc}	5.8^{a}	1.60	0.75^{b}	24.0^{b}	0.045^{b}	5.3^{ab}	1.74	0.46^{bc}	24.3^{bc}
Tilled + Organic Matter	0.168^{a}	6.2	1.17^{a}	1.52^{a}	17.9^{c}	0.084^{a}	5.8^{a}	1.59	1.16^{a}	37.0^{a}	0.066^{a}	5.5^{a}	1.71	0.68^{a}	35.1^{a}
Organic Matter Rundown	0.075^{b}	6.2	1.28^{bc}	1.09^{b}	13.9^{b}	0.053^{b}	5.6^{a}	1.72	0.68^{bc}	23.4^{b}	0.048^{ab}	5.6^{a}	1.73	0.50^{ab}	26.2^{ab}
Brown Manured	0.072^{bc}	6.1	1.31^{c}	0.78^{c}	10.3^{a}	0.031^{bc}	5.1^{b}	1.67	0.44^{c}	14.6^{b}	0.033^{b}	4.9^{b}	1.62	0.28^{c}	13.5^{d}
Burnt	0.043^{d}	6.1	1.43^{d}	0.81^{c}	11.6^{ab}	0.051^{b}	5.0^{b}	1.74	0.49^{bc}	17.0^{b}	0.037^{b}	4.9^{b}	1.72	0.29^{c}	14.8^{cd}
LSD	*0.03*	*NS*	*0.07*	*0.25*	*3.2*	*0.02*	*0.31*	*NS*	*0.26*	*9.64*	*0.02*	*0.53*	*NS*	*0.18*	*9.61*
CV (%)	*20.6*	*3.5*	*3.0*	*13.6*	*13.5*	*25.6*	*3.1*	*3.6*	*21.3*	*23.5*	*26.5*	*5.7*	*2.7*	*24.1*	*23.9*
P value	*<0.001*	*0.531*	*<0.001*	*<0.001*	*0.005*	*0.003*	*<0.001*	*0.056*	*<0.001*	*0.005*	*0.024*	*0.027*	*0.53*	*0.005*	*0.004*

Results followed by the same letter do not significantly differ from each other (P= 0.05).
NS=Not significant.

In 2015, the addition of organic matter incorporated via tillage decreased yield by 15% compared to the comparative tilled treatment (Table 4) but both yielded significantly more than the minimum tillage treatment. The tilled treatment increased yield by 3.21 t/ha over the minimum tillage control – effectively doubling yield (Table 4). Increasing yields did not negatively influence hay quality, with no differences determined between treatments (Table 5).

Table 4: Yield results comparing different tillage and stubble retention treatments in west Buntine from 2010 to 2015.

Treatment	**Oats - Hay 2015 (t/ha)**	**Oats 2014 (t/ha)**	**Barley 2013 (t/ha)**	**Canola 2012 (t/ha)**	**Wheat 2011 (t/ha)**	**Wheat 2010 (t/ha)**
Brown manure	4.83^{c}	0.49	2.74^{bc}	Brown manured	-	-
Minimum tillage	3.64^{d}	0.68	2.62^{cd}	0.71	3.31	2.5
Tilled	6.85^{a}	0.54	2.88^{bc}	0.78	3.41	2.4
Tilled + OM	5.85^{b}	0.60	3.69^{a}	0.97	4.23	1.9
OM rundown	4.89^{c}	0.52	3.03^{b}	0.87	4.00	2.5
Burnt	4.43^{c}	0.63	2.35^{d}	0.78	3.78	2.4
LSD	*0.74*	*NS*	*0.37*	*NS*	*NS*	*NS*
CV (%)	*11.3*	*15.6*	*7.1*	*16.1*	*19.0*	*17.4*
P value	*<0.001*	*0.193*	*<0.001*	*0.236*	*0.513*	*0.439*

Results followed by the same letter do not significantly differ from each other (P= 0.05).
NS=Not significant.

Table 5: Quality parameters for oaten hay comparing different organic matter, tillage and stubble retention treatments in west Buntine 2015.

Treatment	**ADF (%)**	**DEMD (%)**	**ME (%)**	**NDF (%)**	**WSC (%)**	**Grade**
Brown manure	31.9	65.0	9.6	55.0	19.8	OH1QV
Burnt	31.7	65.4	9.6	54.7	20.9	OH1QV
Minimum tillage	31.5	65.7	9.7	54.6	20.5	OH1QV
OM rundown	31.3	65.7	9.7	54.1	20.3	OH1QV
Tilled	33.3	62.7	9.2	56.6	17.8	OH1QV
Tilled + OM	31.7	65.0	9.6	55.0	16.0	OH1QV
LSD	*NS*	*NS*	*NS*	*NS*	*NS*	
CV (%)	*4.4*	*2.8*	*3.4*	*2.3*	*8.6*	
P value	*0.4*	*0.21*	*0.23*	*0.29*	*0.22*	

NS=Not significant.
Acid Detergent Fibre (ADF) - least digestible plant components, including cellulose and lignin (low is better).
Dry Energy Matter Digestibility (DEMD) - proportion of forage that is digestible (high is better).
Metabolise Energy (ME) - net energy available to the animal (high is better).
Neutral Detergent Fibre (NDF) - structural component of the plant, it provides bulk or fill (low is better).
Water Soluble Carbohydrate (WSC) – sugar content such as sucrose, glucose and fructose (high is better).

Comments

Applying 100 t/ha of chaff to the soil, though not practical in a broadacre system, has been shown to supply large amounts of nutrients to the soil and drive changes in soil health that have resulted in variable yield increases since the trial was established in 2003. During the 2015 season and likely associated with plant numbers double that of other treatments, it was evident that application of organic matter drove changes in soil nutrient supply, with visible differences in plant colour (yellow green as compared to plants in other treatments). Plants were smaller and more stressed in the organic matter + tillage than in the other treatments suggesting water and competition limitations associated with high plant numbers resulting from viable seed in the oaten chaff (actual seeding rate estimated at 150 kg/ha). The organic matter rundown treatment despite no additional chaff added since 2006 continues to have more nutrients available particularly potassium, sulphur and organic matter than the tillage treatment. This suggests that nine years since the last application the organic matter, this treatment is still having a positive effect on soil health. However consideration of the changes in soil nutrients, pH and compaction which are not sufficient to result in the massive yield response observed in the tillage treatments, we suggest that soil-borne pathogens may have constrained yield in the minimum tillage treatment in 2015.

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Appendix 1
Hay Receival Standards 2015.

Grade	DEMD	ADF	NDF	WSC	Green (%)	Brown (%)	Weather Damage	Chaff (%)	Aroma	Stem (mm)
OH1QQQV	>60	<30	<52	>23	>70	<10	Nil	<25	Bland	<6
OH1QQQ	>60	<30	<52	>23	>70	<10	V. Minor	<25	Bland	<6
OH1QQV	>60	<32	<54	>20	>50	<15	Nil	<25	Bland	<6
OH1QQ	>60	<32	<54	>20	>50	<15	Minor	<25	Bland	<6
OH1QV	>58	<33	<56	>18	>50	<20	Nil	<25	Bland	<6
OH1V	>56	<36	<59	>12	>50	<20	Nil	<25	Bland	<7
OH1	>56	<36	<59	>12	>30	<20	Moderate	<25	Bland	<7
OHMINV	>54	<39	<64	>6	>30	<20	Nil	<25	Bland	<7
OHMIN	>54	<39	<64	>6	>30	<25	Moderate	<25	Bland	<7

Can Subsoil Constraints be Combated Economically?

Lilly Martin, Research and Extension Agronomist, Liebe Group

Key Messages
- Cost of treatments repaid in the first year.
- Grizzly/Control returned the best net margin in the first year.

Aim
To determine which ameliorant practice is the most effective and economic in remediating subsoil acidity at depth.

Background
It is estimated that more than 14.25 million hectares in the Western Australian Wheatbelt is acidic or at risk to become acidic (Gazey et al, 2014) making acidity one of the major limiting production factors to modern day faming systems. In monetary terms this is estimated to cost the agricultural industry $498 million equating to 9% of WA's annual crop (Herbert, 2009).

Soil acidity is a natural process however; modern farming systems accelerate the process through production (Gazey, P, 2015). Two of the main contributing factors to soil acidification in broadacre cropping systems is the use of ammonium based fertilisers and the export of alkaline products in the form of crop (Gazey & Ryan, 2015).

Aluminium toxicity is one of the major subsoil constraints that are clearly linked to soil acidity. Elevated levels of aluminium in the soil lead to root pruning resulting in decreased crop growth and yield. Generally aluminium toxicity will be an issue if your soil pH is ≤ 4.3 (Gazey & Ryan, Oct 2015). As a consequence, lime has been one of the major inputs in broadacre farming over the last 20 years, with 100% of Liebe members liming in 2012 (Hollamby, 2012).

This trial was designed by a project committee of Liebe members in an effort to determine the most effective liming strategy to undertake to maximise the return on investment in the Liebe region. The trial is located west of Wubin on a poor performing paddock that has the potential to improve once subsoil constraints have been addressed. The trial site was chosen for its uniform soil type and its obvious soil acidity issues. A target pH of 5.5 to a depth of 300mm was identified and entered into the Liebe Group's Lime Calculator along with the baseline soil pH results. The lime calculator generated a recommendation for lime rates required to achieve the given target pH of 5.5. Dolomite has a lower neutralising value than limesand therefore; more product is required to reach the target pH of 5.5, see trial details.

Incorporation techniques under investigation are spading and deep offset discs. Rotary spaders are the most effective type of cultivation for incorporating lime (Davies et al, 2015). Spaders mix and invert the soil to a depth of 25-30cm ensuring good incorporation of liming products through the profile (Davies, 2010). This mixing action is not even throughout the profile however, it does increase contact between the lime and the acidic soil giving a rapid response rate (Gazey et al, 2014).

Large offset discs (Tiny Grizzly discs) are an effective cultivation method that mixes well to a working depth of 30-35cm however, some layering occurs due to the angle of the discs (Davies et al, 2015). This can result in the lime becoming concentrated in the soil throw between the furrows (Parker, 2015).

An automated weather station and moisture probes have been installed at the site to monitor the impacts of spading against the control treatments, giving further insight into cultivation methods and their effect on water use efficiency (WUE).

Trial Details

Property	AJ & JA Barnes, west Wubin
Plot size & replication	11.65m x 14m x 4 replications
Soil type	Yellow Tammin sand
Soil pH ($CaCl_2$)	0-5cm: 5.9 5-10cm: 4.6 10-20cm: 4.2 20-30cm: 4.4
EC (dS/m)	0-5cm: 0.104 5-10cm: 0.048 10-20cm: 0.029 20-30cm: 0.025
Sowing date	01/05/2015
Seeding rate	62 kg/ha Calingiri wheat
Incorporation	23/02/2015: Tiny Grizzly (36 inch discs) 05/03/2015: Spader
Lime History	2009: 1 t/ha lime 2014: 1.5 t/ha lime 2015: 3.2 t/ha Lime only plots, 3.4 t/ha Dolomite only plots, 1.65 t/ha each Lime & Dolomite plots
Paddock rotation	2012 wheat, 2013 wheat, 2014 fallow
Fertiliser	01/02/2015: 35kg/ha DAPSZC 16/07/2015: 40 kg/ha urea 15/08/2015: 20 L/ha UAN
Herbicides & Fungicides	01/05/2015: 2 L/ha Glyphosate 450, 2 L/ha Trifluralin 480, 0.3% SP 700 Surfactant, 200 mL/ha LV Ester 680, 200 mL/ha Chlorpyrifos 500EC 16/07/2015: 850 mL/ha Diflufenican & Bromoxynil, 400 mL/ha MCPA 570, 150 mL/ha Tebuconazole 430
Growing season rainfall	288mm

Results

Limesand was applied to the paddock on two occasions prior to the trial being implemented in 2009 (1 t/ha) and 2011 (1.5 t/ha). From the baseline soil results in Table 1 it can be observed that this lime has not moved through the profile and is still sitting in the 0-5cm layer of topsoil.

Table 1: Baseline results for selected soil properties (0-40cm) collected prior to treatments being imposed at the trial site February 2015.

Depth (cm)	EC (dS/m)	pH ($CaCl_2$)	Organic Carbon (%)	NH_4 (mg/kg)	$N0_3$ (mg/kg)	Phosphorus Cowell (mg/kg)	Potassium Cowell (mg/kg)	Sulphur (mg/kg)	Aluminium (meq/100g)
0-5	0.104	5.9	0.79	3	23	38	42	15.4	0.12
5-10	0.048	4.6	0.71	1	13	36	24	9.7	0.24
10-20	0.029	4.2	0.36	1	7	16	22	11.6	0.42
20-30	0.025	4.4	0.28	1	5	6	17	19.4	0.34
30-40	0.025	4.7	0.16	2	4	3	18	24.7	0.24

In the first year since the trial was implemented the lime treatments showed no significant results. Both Spader and Grizzly treatments had significantly higher hectolitre weight than the Control (no till) treatment.

Table 2: Effect of lime treatments on yield and quality at west Wubin in 2015.

Treatment Number	Lime Treatment	Yield (t/ha)	Protein (%)	Screenings (%)	Hectolitre (kg/hl)	Grade
1	Control	2.0	10.2	1.6	78.2	ANW1
4	Limesand	2.2	10.3	1.7	77.7	ANW1
7	Dolomite	2.0	10.4	1.6	78.7	ANW1
10	Lime & Dolomite	2.0	10.3	1.6	77.8	ANW1
LSD		*0.31*	*0.23*	*0.45*	*0.85*	
CV (%)		*18.3*	*2.7*	*34.6*	*1.3*	
P value		*0.43*	*0.34*	*0.61*	*0.11*	

Table 3: Effect of tillage treatments on yield and quality at west Wubin, 2015.

Treatment Number	Tillage Type	Yield (t/ha)	Protein (%)	Screenings (%)	Hectolitre (kg/hl)	Grade
1	No Till	2.0	10.1[a]	1.7	76.96[b]	ANW1
2	Spader	2.0	10.3[a]	1.6	78.73[a]	ANW1
3	Grizzly	2.2	10.6[b]	1.4	78.63[a]	ANW1
LSD		*0.27*	*0.20*	*0.39*	*0.73*	
CV (%)		*18.3*	*2.7*	*34.6*	*1.3*	
P value		*0.501*	*<0.001*	*0.18*	*<0.001*	

Table 4: Interaction of cultivation and lime on yield and quality results for Calingiri wheat at west Wubin, 2015.

	Lime Treatment	Tillage Type	Yield (t/ha)	Protein (%)	Screenings (%)	Hectolitre (kg/hl)	Grade
1	Control	No Till	1.8	10.0	2.1	77.0	ANW1
2	Control	Spader	1.8	10.2	1.6	79.2	ANW1
3	Control	Grizzly	2.4	10.5	1.3	78.3	ANW1
4	Limesand	No Till	2.2	10.1	1.5	76.8	ANW1
5	Limesand	Spader	2.2	10.2	1.3	78.5	ANW1
6	Limesand	Grizzly	2.2	10.4	1.4	77.9	ANW1
7	Dolomite	No Till	2.3	10.1	1.4	77.0	ANW1
8	Dolomite	Spader	1.9	10.4	2.2	79.5	ANW1
9	Dolomite	Grizzly	1.9	10.7	1.4	79.5	ANW1
10	Lime & Dolomite	No Till	1.8	10.1	2.0	77.0	ANW1
11	Lime & Dolomite	Spader	2.1	10.2	1.4	77.7	ANW1
12	Lime & Dolomite	Grizzly	2.1	10.7	1.5	78.7	ANW1
LSD			*0.55*	*0.40*	*0.78*	*1.47*	
CV (%)			*18.3*	*2.7*	*34.6*	*1.3*	
P value			*0.16*	*0.94*	*0.17*	*0.38*	

Table 5: Crop establishment at west Wubin, 2015.

Treatment	Crop establishment (plant/m^2)		
	Grizzly	No Till	Spader
Dolomite	7	26	8
Lime Sand	8	18	9
Lime/Dolomite	9	25	10
Control	8	22	8

Economic Analysis

The Control/Grizzly treatment has given the greatest gross return at $688/ha, returning a net margin of $468/ha. The lowest average net margin was from the dolomite/spader treatment returning $230/ha in the first year (Table 6).

The treatment with the highest rate of return was the dolomite/no till at 661% while the lowest was the control/no till treatment at 0% (Table 6).

Table 6: Economic analysis of different soil ameliorant treatments at west Wubin, 2015.

Treatment Number	Lime Treatment	Tillage Type	Average Gross Return ($/ha)	Average Variable Cost ($/ha)	Average Net Margin ($/ha)	Average Return on Treatment Investment (%)
7	Dolomite	No till	659	203	456	661
4	Lime Sand	No till	632	217	415	459
3	Control	Grizzly	688	220	468	451
10	Lime/Dolomite	No till	519	227	292	247
2	Control	Spader	529	255	274	129
6	Lime Sand	Grizzly	648	302	346	117
12	Lime/Dolomite	Grizzly	614	312	302	79
9	Dolomite	Grizzly	539	288	251	73
5	Lime Sand	Spader	645	337	308	59
11	Lime/Dolomite	Spader	613	347	266	31
8	Dolomite	Spader	553	323	230	28
1	Control	No till	511	135	377	0

Note: Grain prices based on AWB prices for the Kwinana Zone on the 19th November 2015, ANW1 $288.
Costs taken into account; fertiliser, chemical, cultivation, lime ($7/t), dolomite ($26/t) and cartage. Cultivation cost based on an average contractor rate of $85/ha (Grizzly) $120/ha (Spader). Cartage cost based on contractor rate of $10/t dolomite (Watheroo) and $21/t limesand (Greenhead). Spreading of lime treatments based on contractor rate of $8/ha. Cost of spraying, seeding and harvest not taken into account. Cost of lime applied prior to trial being implemented not taken into account. ROI % based on treatment 1 (control/no till) set at 0%.

Comments

Prior to treatments being imposed aluminium toxicity was visually identified as a constraint by digging up plants and examining the roots. It was evident from the roots sideways growth that root pruning was occurring, affecting plant growth by limiting access to nutrients and water. Compaction was thought not to be an issue as it was possible to push a 1cm rod to a depth of 140cm by hand.

When the Grizzly treatments were being implemented it was difficult to have an even depth throughout the plot due to plot size. The discs were only achieving maximum depth (30-35cm) in the centre of the plot however; the average depth achieved within the plot was 25-30cm.

At seeding it was difficult to establish an even seed bed which led to uneven germination in both the Spaded treatments and the Grizzly treatments. This resulted in these treatments having lower plant establishment numbers over the no till (Control).

Throughout the season it was visually evident that the incorporation treatments had major effects on crop growth and health. The Grizzly and spaded treatments had better vigour and larger head sizes when compared to the control treatments. This is likely due to the lower plant numbers, leading to less competition for water and nutrients in the cultivated plots. Although this didn't translate to significant yield increases in the first year, the second year of the trial is expected to show more as the seeding bed will have settled allowing for an even germination.

Figure 1: Wheat grown at west Wubin 2015, Grizzly treatment (Left side) and No till treatment (Right side).

References
Gazey, C., Davies, S., Master, D. (2014). Soil Acidity: A Guide for WA Farmers and Consultants (2nd Edition). Bulletin 4858.
Gazey, C., and Ryan, L. (2015) Causes of soil acidity. Retrieved November 5, 2015, from https://www.agric.wa.gov.au/soil-acidity/causes-soil-acidity
Gazey, C., and Ryan, L. (2015) Effects of soil acidity. Retrieved November 5, 2015, from https://www.agric.wa.gov.au/soil-acidity/effects-soil-acidity
Gazey, P. (2015) Factsheet Soil Acidity. Retrieved November 5, 2015, from http://www.soilquality.org.au/factsheets/soil-acidity
Davies, S. (2010). Use of rotary spaders to manage sandplain soil constraints. Liebe Group Newsletter, June 2010, Volume 12, Issue 4.
Davies, S., Gazey, C., Parker, W., Blackwell, P., Riethmuller, G., Wilkins, A., Negus, P., Hollins, T., Gartner, D., Lefroy, W. (2015) Lime incorporation into acidic subsoils – assessing cost, efficacy, value and novel approaches.
Herbert, A. (2009). Opportunity cost of land degradation hazard in the south-west agricultural region. Resource management technical report 349, Department of Agriculture and Food, Western Australia.
Hollamby, N., Petersen, E. (2012). Liebe Group Technical Audit Results Executive Summary.
Parker, W. (2015). Comparison of tillage methods for lime incorporation 2014 trial report. Retrieved November 5, 2015, from https://www.agric.wa.gov.au/soil-acidity/comparison-tillage-methods-lime-incorporation-2014-trial-report?page=0%2C3.

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Soil acidity management strategies throughout Western Australia are available for download from: http://www.liebegroup.org.au/working-together-to-deliever-multiple-benefit-messages-to-growers-through-a-whole-systems-approach-to-soil-management/

Free for download Liebe Lime Calculator: http://www.liebegroup.org.au/lime-profit-calculator/

Soil Management Strategies for Improving pH on Red Loam

Debbie Gillam and Laura Dorman, Mingenew-Irwin Group

Key Messages

- As in 2014, there was a significant difference in yield, in response to the cultivation treatments but not between the lime treatments.
- Screenings in 2015 were much higher in the mouldboard and spaded plots than any other treatments. The percentage of screenings in these treatments increased with the increasing rate of lime.

Aim

Investigate the impact of soil management techniques and the application of different rates of lime over a five year period on soil pH.

Background

The purpose of the trial is to assess the benefits associated with lime application and incorporation, and the impact of different tillage systems on soil health and crop yield, 2015 is year two of this trial.

This trial contains twenty four combinations of lime rates and tillage systems. Extensive soil sampling was conducted to establish the base soil characteristics at this site and identify any variability between plots.

Trial Details

Property	JH & VI Rowe & family, Wongoondy, Mullewa
Plot size & replication	30m x 40m x 4 replications
Soil type	Red loam
Soil pH ($CaCl_2$)	0-10cm: 4.410-20cm: 4.4 20-30cm: 4.6 30-40cm: 4.8 40-50cm: 5.0
Sowing date	21/05/2015
Seeding rate	50 kg/ha Corack wheat
Incorporation	See Table 1
Lime History	See Table 1
Paddock rotation	2010 lupin, 2011 wheat, 2012 wheat, 2013 lupin, 2014 wheat
Fertiliser	Pre seeding: 50 kg/ha Amsul 21/05/2015: 50 kg/ha DAPSCZ 17/06/2015: 40 kg/ha Urea
Herbicides & Insecticides	Knockdown: 1.5 L/ha RoundUp, 100 mL/ha Ecopar, 100 mL/ha Garlon, 0.25% wetter, 1% Amsul Pre-emergent: 2 L/ha RoundUp, 1.6 L/ha Treflan, 35 g/ha Logran, 6 g/ha Ally, 1% Amsul, 0.2% wetter Post emergent: 750 mL/ha Jaguar, 600 mL/ha MCPA LVE 100 mL/ha Lorsban
Growing season rainfall	172mm, total annual rainfall: 299mm

Results

Table 1: Yield and quality results at Wongoondy, 2015.

Lime Rates	Cultivation	Lime Yield (t/ha)	Cultivation Yield (t/ha)	Interaction Yield (t/ha)	Protein (%)	Hectolitre Weight (kg/hL)	Screenings (%)
0 t/ha	Nil	1.68	1.81[a]	1.74	11.4	74.9	7.97
	Offset Disc		1.54[b]	1.75	12.2	74.8	8.28
	Mouldboard		1.22[c]	1.31	13.6	68.4	18.6
	One way Plough		1.88[a]	1.81	10.5	77.9	5.09
	Spader		1.40[b]	1.53	11.9	73.6	11.5
	Deep Digger		1.96[a]	1.90	11.1	76.5	7.97
3 t/ha	Nil	1.57		1.74	13.2	73.9	10.0
	Offset Disc			1.42	13.9	71.0	15.5
	Mouldboard			1.00	16.1	64.2	28.0
	One way Plough			1.96	12.1	74.9	8.56
	Spader			1.34	13.9	70.8	22.9
	Deep Digger			1.97	11.8	75.6	7.66
6 t/ha	Nil	1.68		1.96	13.0	74.0	8.59
	Offset Disc			1.43	12.5	73.0	12.1
	Mouldboard			1.19	14.8	68.2	22.4
	One way Plough			2.17	11.7	77.3	5.11
	Spader			1.39	14.4	68.9	21.0
	Deep Digger			1.92	12.2	74.3	9.81
12 t/ha	Nil	1.68		1.86	11.9	74.3	9.83
	Offset Disc			1.53	11.8	73.9	9.67
	Mouldboard			1.47	12.9	72.3	12.6
	One way Plough			1.69	12.6	73.0	12.1
	Spader			1.42	14.3	68.5	25.2
	Deep Digger			2.13	12.1	76.5	6.84
	P value	*0.324*	*<0.001*	*0.433*			
	LSD (0.05)	*NS (0.15)*	*0.17*	*0.38*			
	CV (%)		*16.3*				

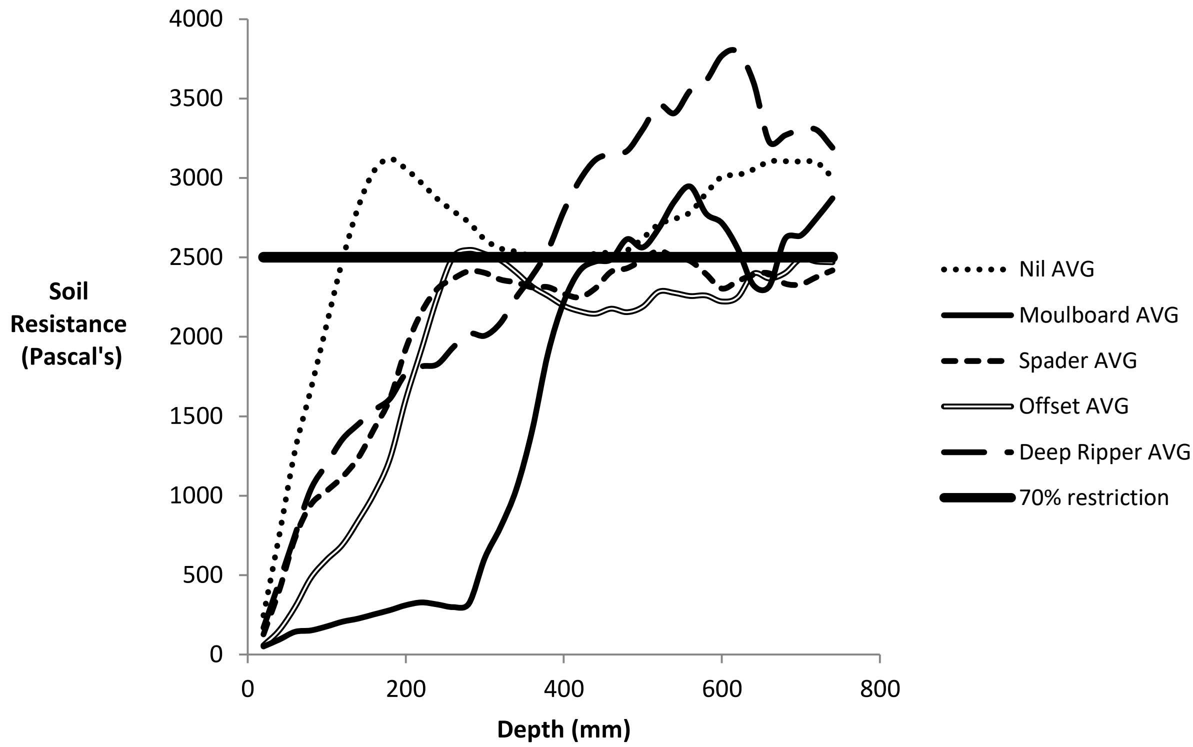

Figure 1: Compaction under Different Tillage Systems on Red Loam, June 2014.

Table 2: Treatment costs and returns $/ha for 2014 and 2015 at Wongoondy.

Lime Rates	Cultivation	Treatment Cost ($/ha)	2014 Grade	2014 Returns ($/ha)	2015 Grade	2015 Returns ($/ha)	Total Net Return ($/ha)
0 t/ha	Nil	0	AUW1	401	AGP1	474	875
	Offset Disc	45	AUW1	453	AGP1	477	885
	Mouldboard	120	AUW1	433	AUW1	327	640
	One way Plough	45	AUH2	498	APW1	541	994
	Spader	150	AUH2	452	AUW1	381	683
	Deep Digger	60	AUH2	480	AGP1	518	938
3 t/ha	Nil	63	AUW1	398	AUW1	432	767
	Offset Disc	108	AUW1	412	AUW1	355	659
	Mouldboard	183	AUW1	428	FED1	221	466
	One way Plough	108	AUH2	512	AGP1	533	937
	Spader	213	AUH2	495	AUW1	334	616
	Deep Digger	123	AUH2	509	AGP1	537	923
6 t/ha Lime	Nil	126	AUH2	471	AGP1	534	879
	Offset Disc	171	AUW1	431	AUW1	356	616
	Mouldboard	246	AUW1	404	AUW1	296	454
	One way Plough	171	AUH2	521	APW1	647	997
	Spader	276	AUH2	489	AUW1	346	559
	Deep Digger	186	AUH2	495	AGP1	521	830
12 t/ha Lime	Nil	252	AUW1	397	AGP1	507	652
	Offset Disc	297	AUW1	454	AGP1	415	572
	Mouldboard	372	AUW1	422	AUW1	365	415
	One way Plough	297	AUH2	504	AUW1	420	627
	Spader	402	AUH2	536	AUW1	353	487
	Deep Digger	312	AUH2	477	AGP1	579	744

Notes: All prices net delivered Geraldton and GST Exclusive.

Comments

Soil pH measurements were taken prior to treatment application on the site in 2014. The mouldboard plough treatments had the least compaction of all treatments to a depth of 30cm but below this depth the offset disc treatment measured the least soil resistance in 2014, Figure 1. The one way plough treatment with 6 t/ha lime applied, returned the highest $/ha to date due to low treatment cost and a high yield result in 2015. In 2015 the mouldboard plough and spaded treatments resulted in increased screenings. There was a trend towards increased screenings in both of these cultivation treatments with increased rates of lime.

Acknowledgements

Many thanks to Steve Rowe for the trial site and assistance. Many thanks to the following growers and industry for supply of the machinery, lime and dolomite used in this trial:
McIntosh & Son for supplying the Tiny 36 inch Grizzly offset disc and Deep Digger.
AFGRI for supply of the mouldboard plough.
The Mills family for supply of the one-way plough.
The Broad family for supply of the spader.
Chris Leigh-Fairbank for the donation and cartage of lime.

This trial is supported by GRDC funding through LIE00008: Working together to deliver multiple benefit messages to growers through a whole systems approach to soil management.

Further reading

Soil acidity management, Liebe Lime Calculator and the full report on *"Soil acidity management strategies throughout Western Australia"*
http://www.mig.org.au/lime-calculator/

Paper reviewed by: Lilly Martin, Liebe Group.

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Mouldboard Plough on Wodjil Soil Demonstration

Lilly Martin, Research and Extension Agronomist, Liebe Group

Aim

To evaluate the effects of mouldboard ploughing on yield on poor performing wodjil soil.

Background

Mouldboard ploughing involves a one-off inversion of the topsoil. The plough in this demonstration was able to invert the top 30cm of soil. Mouldboard ploughing can help in the control of weeds, burying water repellent topsoil, incorporating lime at depth as well as having a deep ripping effect. Cost of the operation is approximately $100-120/ha (Davies *et al*., 2012).

Wodjil soils are typically deep yellow sands which are inherently highly acidic, particularly in the subsoil. The low subsoil pH results in high aluminium concentrations that creates a hostile environment for root growth and therefore reduces crop yields.

This site received 1.5 t/ha of lime in 2006 in an effort to increase pH. However, research has shown that surface applied lime usually takes four to seven years to treat subsurface acidity (Gazey, 2009). Mechanical incorporation is one of the methods used to speed up this process. Examples include rotary spading and mouldboard ploughing, which invert the top layers of the soil, allowing the lime to be buried in the subsoil thus increasing the pH at depth.

The demonstration was ploughed on the 12th June 2012, using a 3 board Kverneland plough which had a working width of 1m. The site received 63mm of rain in the 7 days prior to ploughing allowing the soil profile to wet down to at least 30cm, required for effective inversion.

In 2015, 1.5 t/ha limesand and 0.5 t/ha dolomite was incorporated across all the plots using offset discs to a depth of 10cm.

Demonstration Details

Property	Colin & Ruth Cail, east Wubin
Plot size & replication	100m x 17m x 3 replications
Soil type	Yellow wodjil sand
Soil pH ($CaCl_2$)	0-10cm: 5.7 10-20cm: 4.7 20-30cm: 4.2 30-40cm: 4.1
EC (dS/m)	0-10cm: 0.116
Sowing date	12/05/2015
Seeding rate	55 kg/ha Mace
Soil amelioration	1999: 1 t/ha lime, 2006: 1.5 t/ha lime, 2015: 1.5 t/ha lime & 0.5 t/ha dolomite
Fertiliser	05/04/2015: 60 kg/ha Potash 12/05/2015: 60 kg/ha Agflow Extra, 25.7 kg/ha MoP, (70:30% Agflow: MoP blend) 12/05/2015: 35 L/ha Flexi N 23/06/2015: 30 L/ha Flexi N 22/07/2015: 20 L/ha Flexi N
Paddock rotation	2012 wheat , 2013 wheat, 2014 pasture
Herbicides & Fungicides	05/05/2015: 1 L/ha RoundUp Ultramax 12/05/2015: 118 g/ha Sakura, 800 mL/ha Gramoxone, 0.35 kg/ha Diuron 23/06/2015: 1 L/ha Jaguar, 250 mL/ha LVE MCPA, 50 mL/ha Zinc 22/07/2015: 100 mL/ha Tebcon 26/08/2015: 300 mL/ha Tebcon
Growing season rainfall	237mm

Results

Although replicated it is important to remember that this is a farmer demonstration and not a trial and all results should be viewed with caution. The site received 1.5 t/ha of limesand and 0.5 t/ha of dolomite in 2015 which was incorporated using offset discs, this is reflected in the soil pH results in Table 1.

Table 1: Comparison of selected soil properties as a result of incorporating lime and dolomite measured in November 2012 and November 2015.

Treatment	Depth (cm)	2015 EC (dS/m)	2012 EC (dS/m)	2015 pH ($CaCl_2$)	2012 pH ($CaCl_2$)	2015 Aluminium (mg/kg)
Mouldboard	0-10	0.0593	0.064	6.2	4.7	0.24
	10-20	0.0497	0.053	6.0	5.0	0.20
	20-30	0.0603	0.045	5.8	5.1	0.20
Control	0-10	0.0793	0.137	6.4	5.1	0.20
	10-20	0.0673	0.057	6.1	4.9	0.29
	20-30	0.0797	0.050	6.0	4.8	0.22

Note: Aluminium was not recorded in 2012.

Mouldboard plough treatments returned a yield increase of 7.7% over the control (Table 2).

Table 2: Yield and quality results of Mace wheat sown at east Wubin 2015.

Treatment	Yield (t/ha)	Protein (%)	Hectolitre (g/hL)	Screenings (%)	Grade
Mouldboard	1.4	10.8	77.5	4.3	APW1
Control	1.3	10.5	79.2	3.4	APW1

Table 3: Average gross margin for Mace wheat harvested at east Wubin, 2015.

Treatment	Yield (t/ha)	Average Gross Margin ($/ha)
Mouldboard	1.4	379
Control	1.3	345

Grain prices based on AWB prices for the Kwinana Zone on the 5th January 2016, APW1 $268/t.

Gross margins for 2015 show a $34/ha return on the mouldboard treatment over the control in 2015.

Comments

It has been four years since the demonstration was implemented and while the mouldboard treatment has yielded 0.1 t/ha more than the control, the treatment effects appear to be waning. The site pH has increased significantly with the application of 1.5 t/ha limesand and 0.5 t/ha dolomite in 2015.

Colin noticed through the season that weed control over the site was an issue and wheel tracks in the mouldboard plots affected the crop establishment significantly. When harvesting the site it was observed that the mouldboard plots were golden in colour when compared to the darker colour of the plants in the control plots.

Acknowledgements

Thanks to the Cail family for implementing and managing the demonstration.

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Paper reviewed by: Joe Delaney, Elders Scholz Rural.

References

Davies, S., Blackwell, P. And Newman, P 2012. 'The role of mouldboard ploughing in cropping systems', *Spring Field Day Booklet 2012,* Liebe Group.

Gazey, C and Davies, S. 2009. *Soil acidity – A guide for WA farmers and consultants*. Bulletin 4874, Department of Agriculture, Western Australia.

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Demonstration of Deep Offset Discs Over Three Soil Types at West Wubin

Lilly Martin, Research and Extension Agronomist, Liebe Group

Key Messages

- The deep offsets gave a substantial yield benefit in the three soil types in the first year.
- The return on investment for the deep offsets was paid back in the first year on all soil types.

Aim

To determine the effect of incorporating lime using deep offset discs on yield and quality.

Background

Soil acidity is a major constraint in WA agricultural areas, with an estimated 14.25 million hectares of Wheatbelt soils affected to the point of restricting production and agricultural sustainability. The Liebe Group along with West Midlands Group and Mingenew-Irwin Group surveyed over 130 farmers in the Northern Agricultural Region (NAR) on subsoil constraints and associated penalties. Of these, 68% rated soil acidity as their number one constraint. The grower group's survey represented 1.1 million hectares of agricultural land in the NAR. If each farmer is losing 5% wheat yield at $250/t, the region is missing out on $27.5 million every year.

The demonstration paddock has three very different soil types which lead to difficulties in management. The Barnes' identified the issues in the paddock as having the potential to be remediated through cultivation and liming. They top dressed lime on two occasions (see demonstration details), but there was no significant improvement in yield. These demonstrations tested the responsiveness of deep lime incorporation abilities by the cultivator (Tiny Grizzly, 36 inch discs) over three different soil types in the same paddock and rainfall zone at west Wubin.

Trial Details

Property	AJ & JA Barnes, west Wubin			
Plot size	6.8m x 200m x various replications*			
Soil type	Acid sand, yellow tammin sand, heavy red clay			
Soil pH ($CaCl_2$)	0-5cm: 5.9	5-10cm: 4.6	10-20cm: 4.2	20-30cm: 4.4**
EC (dS/m)	0-5cm: 0.104	5-10cm: 0.048	10-20cm: 0.029	20-30cm: 0.025**
Sowing date	02/05/2015			
Seeding rate	62 kg/ha Calingiri			
Incorporation	23/02/2015: Tiny Grizzly; 36 inch discs			
Lime history	2009: 1 t/ha lime, 2014: 1.5 t/ha lime			
Paddock rotation	2012 wheat, 2013 fallow, 2014 wheat			
Fertiliser	02/02/2015: 35 kg/ha DAPSZC 16/07/2015: 40 kg/ha urea 15/08/2015: 20 L/ha UAN			
Herbicides, Insecticides & Fungicides	01/05/2015: 2 L/ha Glyphosate 450, 2 L/ha Trifluralin 480, 0.3% SP 700 Surfactant, 200 mL/ha LV Ester 680, 200 mL/ha Chlorpyrifos 500EC 16/07/2015: 850 mL/ha Diflufenican & Bromoxynil, 400 mL/ha MCPA 570, 150 mL/ha Tebuconazole 430			
Growing season rainfall	288mm			

Note: *Acid sand and yellow tammin sand have two controls and three deep offset plots. Heavy red clay has two controls and two deep offset plots. **pH results are for yellow tammin sand demonstration only.

Results

This is a nearest neighbour farmer demonstration which is not fully replicated and the results should be treated with caution. In its first season the deep offsets have significantly increased crop yields across all three soil types (Table 1). It is inconclusive if this increase will be sustained over the coming seasons or if it is only a response to the initial cultivation and not the lime. Further monitoring is required to quantify the long term effects of incorporating the 2.5 t/ha of limesand with the deep offsets.

Table 1: Average yield and quality results for Calingiri wheat grown at west Wubin in 2015.

Soil Type	Treatment	Yield (t/ha)	Protein (%)	Hectolitre (g/hL)	Screenings (%)	Moisture (%)	Grade
Acid Sand	Grizzly	1.3	10.8	77.31	8.26	10.1	ANW2
	Control	0.5	11.1	77.50	4.65	10.1	ANW1
Red Clay	Grizzly	3.3	11.4	80.19	1.25	9.90	ANW1
	Control	2.9	11.4	79.42	1.63	9.80	ANW1
Yellow Tammin	Grizzly	1.8	10.6	78.43	4.25	10.2	ANW1
Sand	Control	1.3	10.5	76.67	4.92	10.2	ANW1

Note: All treatments were top dressed with 1 t/ha lime in 2009 and 1.5 t/ha in 2014.

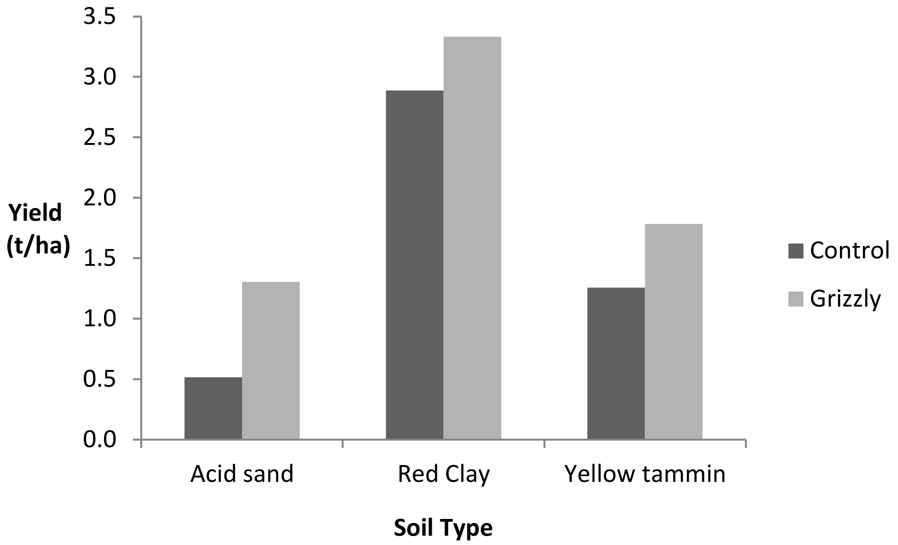

Figure 1: Yield results of Calingiri wheat grown at west Wubin in 2015.
Note: All treatments were top dressed with 1 t/ha lime in 2009 and 1.5 t/ha in 2014.

Economic Analysis

Table 2: Economic analysis for deep offsets over three different soil types at west Wubin, 2015.

Soil Type	Treatment	Average Gross Revenue ($/ha)	Average Variable Cost ($/ha)	Average Net Margin ($/ha)
Acid Sand	Grizzly	362	220	142
	Control	148	135	14
Red Clay	Grizzly	959	220	740
	Control	831	135	696
Yellow Tammin	Grizzly	514	220	294
Sand	Control	362	135	227

Grain prices based on AWB prices for the Kwinana Zone on the 19th November 2015, ANW1 $288, ANW2 $273.
Costs taken into account; fertiliser, chemical and cultivation. Cultivation cost based on an average contractor rate of $85/ha. Cost of spraying, seeding and harvest not taken into account.

The deep offset discs resulted in yield benefits that returned the cost of cultivation in the first year, with the most substantial return given over the acid sand.

Comments

As these demonstrations were implemented opportunistically there are no baseline soil pH results. However, pH indicator testing carried out prior to offsetting showed that limesand top dressed in 2009 and 2014 was still sitting in the 0-2cm layer of the topsoil (average pH 7-7.5 (H_2O) decreasing to 6-4 (H_2O) in the 3-10cm). This information highlights the importance of incorporating lime products. Alan commented at harvest that the acid soil is particularly low in organic matter which in his opinion is a major inhibitor of crop production.

Generally the huge mixing caused by these offsets does a couple of things to improve the soil, such as: breaking hard pans, increasing mineralisation of nitrogen, and shifting nutrients bound in the topsoil throughout the profile, all of which generally occur within the first year. Implementing the Tiny Grizzly over the top dressed limesand has shown significant yield returns in the first year of monitoring. The acid sand soil type showed the greatest response with a yield increase of 0.8 t/ha or 153% over the control, yellow tammin was 0.5 t/ha or 42% greater and the red clay was 0.4 t/ha or 15% greater than the control. In the first year of monitoring, and without pH analysis to depth, it is uncertain how much of this improvement can be attributed to either the cultivation or the incorporation of the lime.

Acknowledgements

Many thanks to the Barnes family for all their help and input in setting up and harvesting the demonstrations. Thanks to McIntosh and Son, Wongan Hills for the use of the Tiny Grizzly.

Paper reviewed by: Wayne Parker, DAFWA.

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Evaluation of Spading vs. Deep Ripping vs. Mouldboard Ploughing

Lilly Martin, Research and Extension Agronomist, Liebe Group

Key Messages

- Mouldboard ploughing has remediated the non-wetting soil at Marchagee.
- The effect of deep cultivation is decreasing across all the treatments.

Aim

To compare the effects of mouldboard ploughing, spading and deep ripping on yellow, non-wetting sand.

Background

Research has shown that mouldboard ploughing of some soil types can improve yields. This demonstration aims to compare spading, mouldboard ploughing and deep ripping. Inclusion of deep ripping will remove the effects of compaction on yield, compared to the topsoil burial of spading and mouldboard ploughing. If yield gains from mouldboarding and spading are not significantly different from deep ripping, it would be plausible that the yield improvement from mouldboard ploughing and spading is largely due to the removal of the compaction layer rather than other benefits.

The site chosen to conduct the demonstration was 1km long with soil varying from a yellow deep sandy earth (better sand) to pale deep white sand (poor sand). The demonstration was implemented in 2012. Monitoring of the demonstration was conducted in both soil types.

Demonstration Details

Property	Michael O'Callaghan, Marchagee
Plot size & replication	2.2km x 18m – various replications
Soil type	Yellow sand
Soil pH ($CaCl_2$)	0-10cm: 5.8 10-20cm: 5.2 20-30cm: 4.6
EC (dS/m)	0-10cm: 0.0985
Sowing date	09/05/2015
Seeding rate	80 kg/ha Mace
Soil amelioration	March 2012: 3 t/ha lime
Fertiliser	09/05/2015: 88 kg/ha Agras, 22 kg/ha MoP 01/07/2015: 25 L/ha Flexi N
Paddock rotation	2012 wheat, 2013 wheat, 2014 canola
Herbicides & Fungicides	09/05/2015: 1.2 L/ha Glyphosate, 1.8 L/ha Treflan 01/07/2015: 150 mL/ha Tebuconazole
Growing season rainfall	298mm

Results

This is a farmer demonstration, not a trial and as such the results should be viewed with caution.

The yield gains that were observed within treatments in 2012 have declined in 2015. The deep ripped treatment has fallen 0.2 t/ha below the control in 2015, when in 2012 it was 0.37 t/ha greater than the control. The spaded treatment was 0.47 t/ha great than the control in 2012, but this increase had dropped off to a 0.2 t/ha yield benefit in 2015. Similarly, the mouldboard treatment was 0.69 t/ha greater than the control in 2012 and in 2015 this has decreased to 0.5 t/ha benefit.

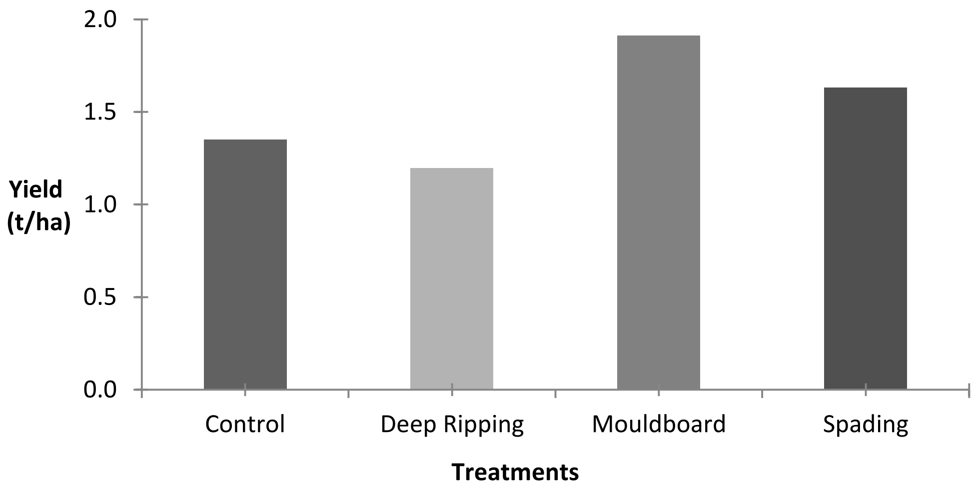

Figure 1: Yield results for Mace wheat grown at Marchagee, 2015.

In 2015 the yield was substantially better in the mouldboard treatments, which was 0.5 t/ha greater than the control. This would suggest that the mouldboard treatment has remediated the non-wetting soil.

Table 1: Average yield and quality results of Mace wheat sown in Marchagee, 2015.

Treatment	Yield (t/ha)	Protein (%)	Hectolitre (g/hL)	Screenings (%)	Grade
Control	1.4	12.4	68.7	9.9	AGP1
Deep ripping	1.2	12.9	74.8	8.2	AUH2
Mouldboard	1.9	12.6	71.6	9.4	AUH2
Spading	1.6	12.2	74.0	6.5	AUH2

Comments

This particular soil type has a very low water holding capacity (WHC) so Michael was conservative with his nitrogen application due to the lack of regular rainfall events. For crops to perform on this soil type, small, regular rain events are required. Large rainfall events like the one in July do not raise the yield potential as the bucket is too small to capture it. This was evident in the control and deep ripping treatments.

Michael observed that the deep ripping and control treatments lost a lot of yield due to a patchy germination. It was apparent that both the spading and mouldboard treatments had much better germinations. Four seasons after the treatments were implemented, the change in the germination zone due to burying the non-wetting soil is still evident. While the mouldboard treatment appears to have helped with the severe water repellence experienced on this soil type, the treatment still has issues with crusting. This is due to the clay which was brought to the surface from mouldboard ploughing. The clay affected the germination by crusting over however, due to the high seeding rate and dry finish, this did not affect the yield in 2015. The high clay content on the mouldboard treatment would have to be taken into consideration if planting canola. Michael suggests using gypsum and growing a high straw wheat variety to speed up the clay breakdown to reduce crusting.

Acknowledgements

Thanks to the O' Callaghan family for implementing and managing the demonstration.

Paper reviewed by: Tyrone Henning, Tek Ag.

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Wodjil Workout – Rise of the pH

Tyrone Henning, Director-Agronomist, Tek Ag

Key Message

Drought and compaction are limiting responses to lime incorporation treatments at present.

Aim

To test the long term effects of different methods of soil incorporation across different rates of lime on Wodjil soil in the Eastern Central Wheatbelt of WA.

Background

The trial was initially setup in 2014 to test different methods of lime incorporation and rate responses over the long term i.e. 20 years. The initial project, 'Wodjil Workout', was only funded for one year, and due to the tough season of 2014, there were minimal responses to applied lime. The site has very low pH of 3.4 - 4.1 ($CaCl_2$) and extremely high aluminium levels averaging 30-60ppm.

Mid-season 2015 the project was extended for another three years to monitor the change in pH and effect on the crops grown during this period. In saying this, at the time of seeding the trial was implemented by the farmer with the view that the trial would not be continued. There were some issues this year with a soft seeding bed as a consequence of cultivation in 2014. This resulted in a staggered germination due to the seeder dropping into the soil and sowing too deep in places.

The 2014 season was dry with a harsh finish (90mm post seeding). The 2015 season had long dry spells with a harsh finish. Rain fell mostly in two large falls, 19th of June (60mm) and 30th of July (110mm).

Trial Details

Property	Vancarla, north west Koorda		
Plot size & replication	27.5m x 27.5m, nearest neighbour control		
Soil type	Deep wodjil sandy loam		
Soil pH ($CaCl_2$)	0-10cm: 3.8-4.2	10-20cm: 3.7-4.1	20-30cm: 3.4-3.8
EC (dS/m)	0-10cm: 0.0493	10-20cm: 0.0353	
Sowing date	29/05/2015		
Seeding rate	60 kg/ha Speedy triticale		
Paddock rotation	2012 capeweed pasture, 2013 pasture, 2014 triticale		
Fertiliser	29/05/2015: 40 kg/ha DAP 05/07/2015: 30 L/ha Flexi-N		
Herbicides	29/05/2015: 1.2 L/ha Glyphosate 450, 1.2 L/ha Trifluralin 480, 0.2 kg/ha Diuron 06/08/2015: 750 mL/ha Jaguar, 350 mL/ha MCPA LVE 570, 100 g/ha Lontrel		
Growing season rainfall	180mm		

Results

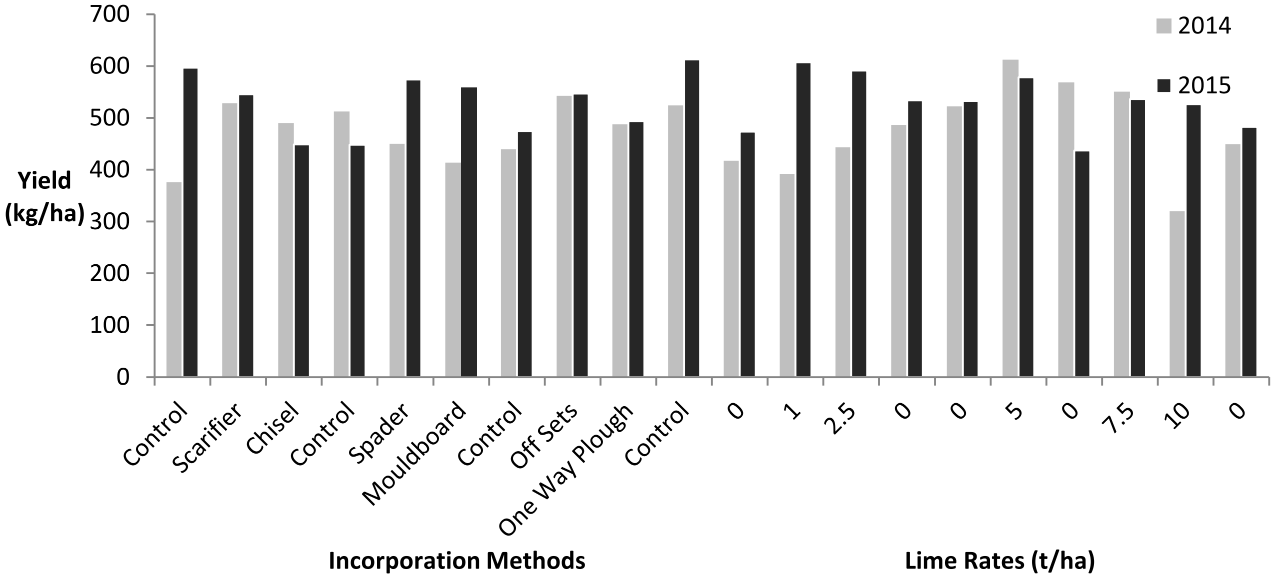

Figure 1: Yield data that has been averaged across treatments for the two years (2014 and 2015).
Note: Controls have not been averaged to indicate site variation.

Economic Analysis

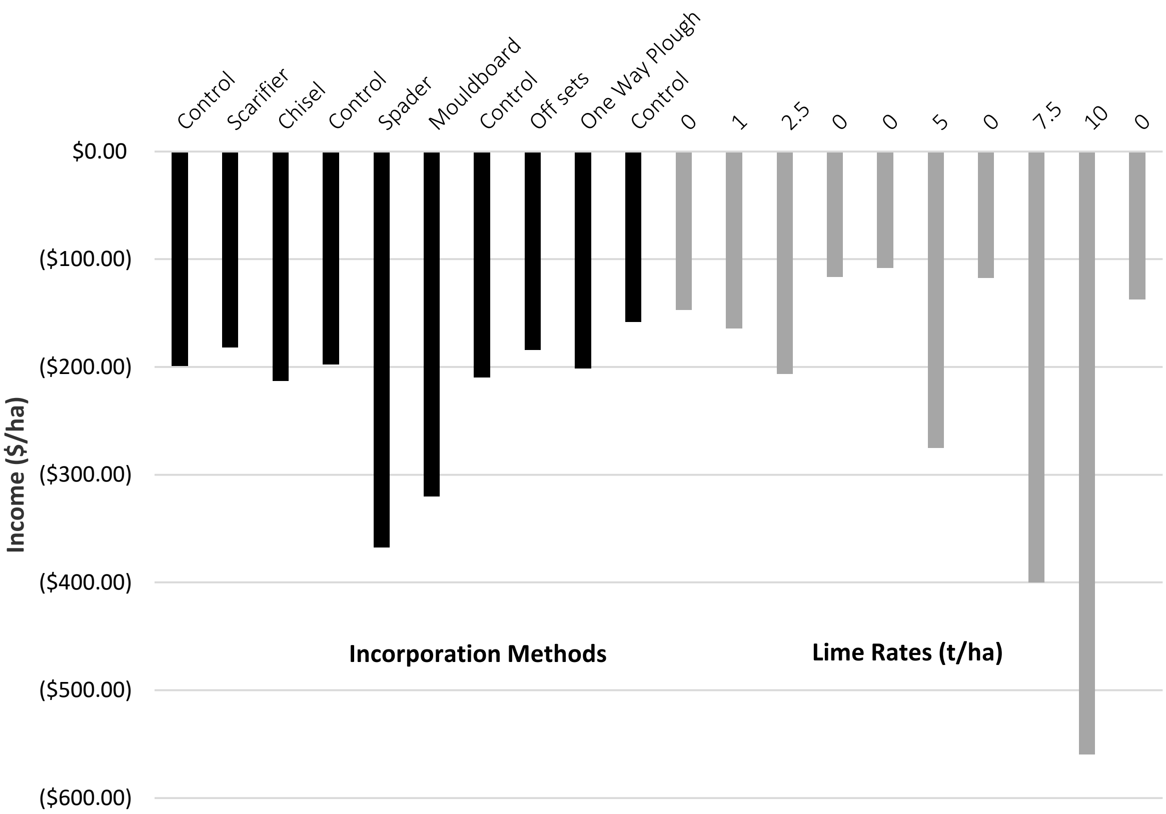

Figure 2: Profit and loss from 2014 carried over into 2015 to demonstrate long term economic results to date.
Note: Plots are combined to produce averages to help isolate treatment response across the trial.
Costs for production $150/ha, grain at $220/t.

Comments

Results from 2015 were disappointing to say the least, issues from germination to the finish all influenced the final results. Due to the lack of rain in 2014 after incorporation, there was little time for the lime to react with the acid in the soil profile, however, after substantial falls in June (60mm) and at the end of July (110mm), it was expected some neutralisation would have occurred.

One could assume that due to the hot, dry, windy finish the ameliorated treatments with a higher water holding capacity could not sustain the large canopy that was produced to grain fill.

The grain quality, soil test results and statistical analysis where not available at the time of publication.

Triticale was grown to maintain groundcover after cultivation, other crop rotations such as wheat, canola and possibly lupins will be utilised to express treatment differences going forward.

With another two years to go on the project, we are keen to see how the site develops over time. This site is located on the harshest of Wodjil soil types and in one of the driest parts of the Wheatbelt, as a consequence results from this trial will not be expressed immediately. The trial will require medium to long term monitoring in order to reflect the impacts of the applied treatments and the economic returns gained.

For more information on the previous project, visit http://www.giwa.org.au/pdfs/CR_2015/SORT/EOI7_Tyrone_Henning_Wodjil_Workout_Paper_CU15_EOI7_.pdf or scan the QR code (download QR code reader onto your smartphone to access).

Wodjil Workout photo's

Tek Ag YouTube

Acknowledgements

GRDC and RSCN as the major sponsor for the project.
The Fuchsbichler family for the use of their land, time and machinery.
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Faulkner Brother Holdings for use of machinery.
West Coast Soil Solutions and MDH Ag Contracting for bringing out the spader and mouldboard plough.
Digger's Agricultural Enterprises for carting the lime.
Bob French – DAFWA for looking at the statistical results of the trial.

Paper reviewed by: Lilly Martin, Liebe Group.

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Evaluation of Spading with Lime Incorporation in Low pH, Non-Wetting Sand

Lilly Martin, Research and Extension Agronomist, Liebe Group

Key Message

Using a spader to incorporate lime and dolomite into the subsoil has improved the pH of the soil and increased yield.

Aim

To examine whether deep cultivation by spading can be used to manage water repellence and subsoil acidity on sand plain soil.

Background

This demonstration was established in 2010 to assess the impact of one-off deep soil cultivation on water repellent soils and sub-surface acidity. A rotary spader was used to mix top soil and incorporate lime. The 'spade' on a rotary spader tyne can carry topsoil down into the subsoil and also bring subsoil up to the surface, mixing to a depth between 25 and 30cm. It is estimated that the rotary spader buries at least two-thirds of the topsoil with the remaining one-third left in the topsoil.

The demonstration was implemented in May 2010 with the spader and the deep ripper, each with a working to a depth of 30cm. In 2010, the spading was successful in diluting the water repellent soil but did not increase the yield of the lupin crop. This was due to poor establishment as a result of being sown too deep, exacerbated by furrow infill.

Water repellence in soils is caused by waxes from plant residues which coat the sand particles. These waxes are hydrophobic and can cause slow and uneven infiltration of water into the soil. The mixing action of a spader reduces water repellence in sandy soils by diluting the organic matter-rich repellent topsoil through the top 30cm of the soil profile and by lifting seams of subsoil to the surface that can act as preferred pathways for water movement. As a consequence of the mixing action some of the topsoil can remain slightly water repellent after spading. The fate of the buried water repellent topsoil is not yet clear, and there is a risk that cultivation of this type may ultimately increase the depth of non-wetting. Current findings are mixed with severity of water repellence in the buried topsoil declining by half after 3 years at one site but no measureable change at another site after five years (S. Davies pers. comm.). Research to assess this further is ongoing. In poor sands with low clay content the buried topsoil and associated organic matter can hold more soil moisture than the bulk soil so it can increase the amount of water held in the root zone, albeit by a relatively small amount.

Surface applied lime in a no till system can take in excess of seven years to move down the profile. To significantly increase the subsoil pH below 10cm the lime must be incorporated. Spaders can effectively incorporate surface applied lime into acid subsoils to depths of up to 30-35cm thereby significantly speeding up the amelioration of subsoil acidity.

Demonstration Details	
Property	Hunt partners, Marchagee
Plot size & replication	22.5m x 1000m x no replications
Soil type	Deep yellow sand
Soil pH ($CaCl_2$)	0-5cm: 6.0 5-10cm: 5.2 10-20cm: 5.1 20-30cm: 4.8
EC (dS/m)	0.022
Sowing date	09/04/2015
Sowing rate	2 kg/ha Hyola 401 and GT41 (50/50 blend)
Paddock rotation	2010 lupins, 2011 wheat, 2012 wheat, 2013 lupins, 2014 wheat
Soil Amelioration	2010: 1 t/ha lime and 1 t/ha dolomite 2010: Deep ripped and spaded 2011: 1 t/ha lime and 1 t/ha dolomite (topdressed)
Fertiliser	09/04/2015: 42 kg/ha AgFlow, 18 kg/ha MoP, 60 L/ha Flexi N 16/06/2015: 50 L/ha Flexi N 05/07/2015: 30 L/ha Flexi N
Herbicides & Insecticides	09/04/2015: 1.5 L/ha Propyzamide, 1.5 L/ha Spray.Seed, 500 mL/ha Lorsban 07/05/2015: 1.5 L/ha Weedmaster® DST® 04/06/2015: 1.5 L/ha Weedmaster® DST®
Growing season rainfall	298mm (May to September), 436mm total

Results

This is a large scale farmer demonstration which is not replicated. As such, the results should be viewed with caution.

Table 1: Comparison of selected soil properties as a result of incorporating lime and dolomite measured in July 2010 and November 2015.

Treatment	Depth (cm)	2015 EC (dS/m)	2010 EC (dS/m)	2015 pH ($CaCl_2$)	2010 pH ($CaCl_2$)	2015 Aluminium (mg/kg)	2010 Aluminium (mg/kg)
Spading/Lime/Dolomite	0-10	0.021	0.017	5.6	6.4	0.20	0.001
	10-20	0.018	0.024	5.2	6.4	0.81	0.001
	20-30	0.011	0.011	4.9	5.1	1.02	0.280
Spaded	0-10	0.022	0.017	5.8	5.7	0.20	0.001
	10-20	0.019	0.024	5.3	5.6	0.43	0.001
	20-30	0.017	0.031	4.9	5.5	1.04	0.120
Deep Ripped	0-10	0.030	0.026	5.9	6.3	0.21	0.001
	10-20	0.026	0.014	5.5	5.2	0.38	0.200
	20-30	0.021	0.013	5.4	4.6	0.94	0.320
Control	0-10	0.023	0.030	5.8	5.7	0.22	0.001
	10-20	0.019	0.024	5.4	4.9	0.35	0.240
	20-30	0.015	0.018	5.1	4.6	0.46	0.360

Note: Spading and deep ripping was implemented May 2010. All the treatments received a surface application of 1 t/ha lime and 1 t/ha dolomite in 2011.

The 2015 soil results show an overall decrease in pH ($CaCl_2$) for all treatments with the exception of the control (which increased) and the deep ripped treatment which decreased in the 0-10cm and increased in the 10-30cm layer, since the treatments were implemented in May 2010 (Table 1). This fall in pH could be attributed to crop production in the years following incorporation and the export of alkaline products from the paddock. The 2015 canola crop was drastically affected by hail damage, estimated at 73% by the insurance broker making it difficult to accurately compare it to previous years.

Crop yields were collected in 2010, 2011, 2012, 2014 and again in 2015 (see Table 3). In 2010, the year the spading was conducted, spading caused yields to decrease compared to the control. The lupins were sown too deep and sand-blasted due to the lack of soil cover, greatly reducing plant numbers. In 2011 and 2012 spading (no lime or dolomite) increased yield by 40% and 6% (0.2 t/ha) above the control, respectively; however, in 2014 the increase in yield was only 6% (0.1 t/ha). This is as a result of the incorporation effect wearing off. A similar trend is appearing in the deep ripped treatment which showed an increase the following year (2011) by 7.7% (0.1 t/ha) and 15% (0.2 t/ha) in 2012. However, the deep ripping showed no increase in yield when compared to the control in 2014.

Table 2: 2015 canola yield and quality at Marchagee.

Treatment	*Yield (t/ha)	Oil (%)	Screening (%)	Moisture (%)	Grade
Spade/lime/dol/2010	0.79	46.4	6.42	7.1	CAG1
Deep ripped	0.73	47.8	0.93	5.4	CAG1
Spaded	0.68	45.0	1.46	5.2	CAG1
Control	0.75	47.4	1.28	5.5	CAG1

*Note: 2015 canola crop severely affected by hail at the end of September. Yield is actual harvest recorded, insurance company quoted 73% damage.

In 2011 and 2012 an increase of 15% (0.2 t/ha) and 31% (0.4 t/ha) was observed between the control and the spaded and the spaded/lime/dolomite treatments respectively. 2014 spaded/lime/dolomite had an increase of 29% (0.5 t/ha) when compared to the spaded, as the effect from the cultivation is wearing off this can be attributed to the limesand and dolomite applications.

Table 3: Crop yields sown at Marchagee, incorporation of 1 t/ha lime and 1 t/ha dolomite using a rotary spader was carried out in 2010.

Treatment	2015 Canola Yield (t/ha)	2014 Wheat Yield (t/ha)	2012 Wheat Yield (t/ha)	2011 Wheat Yield (t/ha)	2010 Lupin Yield (t/ha)
Control (No tillage)	0.75	1.6	0.8	1.3	0.7
Deep Ripped	0.73	1.6	1.0	1.4	0.7
Spade	0.68	1.7	1.0	1.5	0.5
Spade + Lime + Dolomite	0.79	2.2	1.2	1.7	0.5

Note: All treatments were top dressed with 1 t/ha lime and 1 t/ha dolomite in 2011, bringing the total lime and dolomite on the spaded 2010 treatment to 2 t/ha lime and 2 t/ha dolomite. 2015 canola crop severely affected by hail at the end of September, insurance company quoted 73% damage. Yield not recorded in 2013.

The Hunt's have observed that the infiltration of rainfall has improved due to spading (measurements not recorded). Using the spader to incorporate lime through the soil has improved yield beyond the initial gain of spading alone. The addition of lime and dolomite increased yield by an additional 0.2 t/ha compared to spading in both 2011 and 2012 and increased yield by 0.48 t/ha in 2014, which is the greatest increase in yield to date.

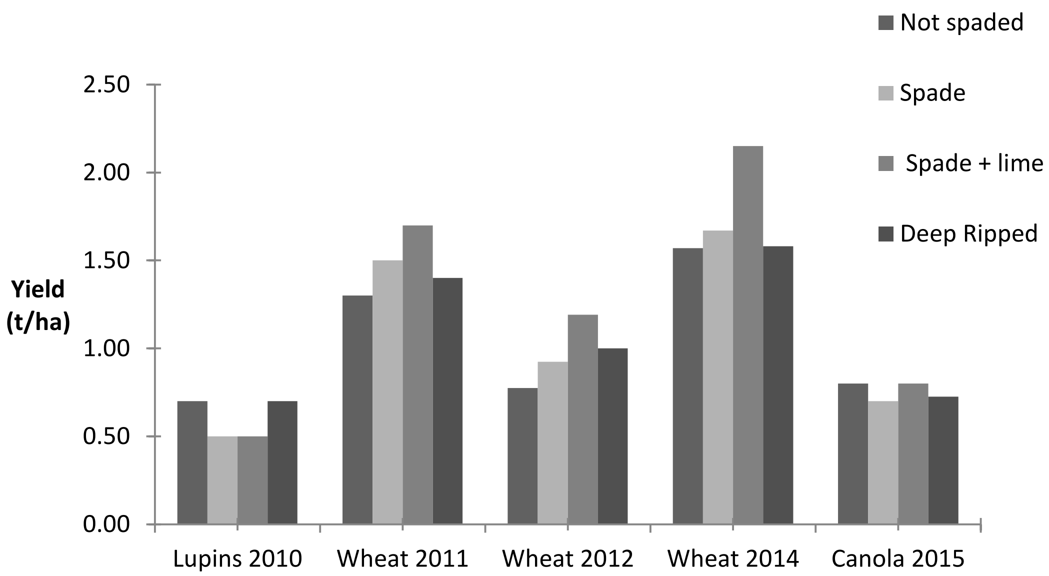

Figure 1: Comparison of yields produced since incorporation in 2010, Marchagee.
Note: 2015 yield affected by hail assessed at 73%. No yield data was recorded in 2013.

Comments

It is difficult to compare the 2015 season to the previous yields as a result of the hail damage that occurred at the end of September, Clint observed that while the damage has been assessed at 73% this percentage is not necessarily evenly represented over the treatments themselves. Canola germinated and ripened unevenly in the demonstration plots. Some plots were more mature and prone to shattering at the time of the hail and rain event (34mm).

Over the life of the demonstration the Hunt's have observed a difference over the treatments. The spading/lime/dolomite treatment attained the desired results, leading them to adopt the practice in 2011 when they implemented the treatment over the rest of the paddock. The Hunt's are still reaping the benefits of adopting this method of incorporation to deal with the two issues that the paddock was presenting.

The implementation of this practice has been proven to attain increased results in yield but it is not without its own issues as the Hunt's experienced in 2010 with wind erosion. It is a big risk with spading and led to a yield decrease in 2010, the year the spading occurred. Spading has the added benefit of reducing compaction in a similar method to deep ripping by physically breaking down any compacted layers in the top 30cm, although this benefit may only last a few years if a controlled traffic system is not implemented. In 2014 the demonstration showed no lasting impact of deep ripping or spading on crop yield, indicating that the cultivation benefit of these has disappeared, however the improved soil pH from incorporated lime and dolomite appears to be showing longer lasting benefits.

Acknowledgements

Thanks to Clint and Ian Hunt and Simon Meyer for implementing the trial.

References

Davies, S., Hall, D., Bakker. D. and Roper. M. (2014) Combatting non-wetting soils. A tour of on-farm research in Western Australia – 2014.

Paper reviewed by: Wayne Parker, Research Officer, DAFWA.

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Demonstration of Lime Placement by Direct Injection

Elly Wainwright and Lilly Martin, Liebe Group

Aim

To showcase the potential of a new grower-designed machine to combine two tasks, deep ripping and lime sand injection, to address yield limitation on sandplain soils in the WA Wheatbelt.

Background

Subsoil acidity is a major issue in broadacre farming in WA with a current estimate of 14.25 million hectares of soil in the wheatbelt affected or at risk of becoming affected (Gazey and Ryan, 2015). Due to the threat acidity poses to production growers are constantly considering strategies to place lime at depth. Without incorporation, limesand is slow to move down the profile to treat the subsurface acidity. Direct injection of limesand is a technique which places limesand in ribbons behind the deep ripper's tines.

Deep ripping is commonly used to break up layers of compaction. It involves the use of deep working tines, approximately 30cm-50cm, to alleviate compaction. This mechanism fractures the hardpan allowing the plant roots access to stored soil moisture and nutrients. These improvements in soil structure can last three to ten years depending on soil type and farming system (Blackwell *et al*., 2015).

Glen Freestone, a local Ballidu farmer, has modified his lime delivery system to allow the direct injection of lime sand behind his deep ripping tines (Figure 1). This system allows him to place lime at depth in one pass with the deep ripper. Subsoil acidity and hard pans are common in the Liebe area due to the prevalence of sandy soils that are prone to both subsoil constraints.

The focus of the demonstration was to look at what rates could be achieved. Both 1 t/ha and 3 t/ha of limesand were successfully applied. This gives Liebe confidence to design replicated trials involving rates, and with and without other mechanical mixing options to ensure more contact between lime injected and the acid subsoil.

Figure 1: Modified lime delivery system.

Demonstration Details

Property	Ardoch, east Ballidu
Plot size & replication	12.8m x 100m x single replication
Soil type	Sandy loam
Soil pH ($CaCl_2$)	0-10cm: 4.4 10-20cm: 4.3 20-30cm: 4.5
EC (dS/m)	0-10cm: 0.178 10-20cm: 0.088 20-30cm: 0.114
Seeding date	20/05/2015
Seeding rate	60 kg/ha Calingiri wheat
Paddock rotation	2012 wheat, 2013 lupins, 2014 wheat
Fertiliser	20/05/2015: 25 kg/ha Guano, 25 kg/ha MAP
Soil amelioration	As per treatments: 3 t/ha, 1 t/ha or 0 t/ha lime
Herbicides	20/05/2015: 2 L/ha Treflan 13/07/2015: 750 mL/ha Jaguar, 44 mL/ha LVE MCPA
Growing season rainfall	243mm

Results

This was an unreplicated farmer demonstration, thus interpretations of results are to be made with caution.

Table 1: Yield, quality and grade of wheat sown at east Ballidu, 2015.

Treatment	Yield (t/ha)	Screenings (%)	Protein (%)	Hectolitre Weight (g/hL)	Grade
No Deep Ripping or Lime (East)	2.0	2.86	9.7	79.00	ANW1
Deep Ripping + Lime 0 t/ha	2.4	2.78	9.5	77.36	ANW1
Deep Ripping + Lime 1 t/ha	2.1	1.96	9.2	79.16	ANW2
Deep Ripping + Lime 3 t/ha	2.0	2.12	9.4	78.00	ANW1
No Deep Ripping or Lime (West)	2.2	3.69	9.6	76.18	ANW1

Comments

Glen estimates that the limesand is incorporated to a depth of 300mm in a ribbon pattern, affecting an area approximately 5cm wide. Glen does not believe that his machine is a replacement for existing lime strategies but that is will add benefit to peoples existing regimes. He plans to continue demonstrations on his own property.

Yield in the demonstration ranged between 2-2.4 t/ha. Response to lime was unlikely in the time frame of the experiment, a longer term and replicated trial is needed to demonstrate a significant response. The Liebe Group plans to monitor the demonstration at the Hood's property in the 2016 season.

References

Blackwell, P., Bakker, D., Davies, S., Isbister, B. (2015) Deep ripping for soil compaction. Retrieved from https://www.agric.wa.gov.au/soil-compaction/deep-ripping-soil-compaction

Gazey, C and Ryan, Liam. (2015) Soil acidity in Western Australia. Retrieved from https://www.agric.wa.gov.au/soil-acidity/soil-acidity-western-australia?

Acknowledgements

Thanks to Glen Freestone for setting up the trial and the Hood family for hosting the Main Trial Site.

Reviewed by: Dr Stephen Carr, General Manager, Aglime of Australia.

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Humates to Increase Soil Health - Case Study

Elly Wainwright, R&D Coordinator, Liebe Group

Aim

To increase organic carbon levels on variable white sand to heavy red clay.

Background

The Hood's wanted to use humates to increase the organic matter in the paddock due to the paddocks low carbon levels. They used a Soil Management Systems liquid humate, Humate N. This humate is 43% w/v humic acid and 23% w/v nitrogen. Humates are a very stable form of soil carbon as it is the final product of decomposition. It provides chemical, physical and biological benefits, including: increasing water holding capacity, increasing soil cation exchange capacity, improving soil buffering capacity, accelerating decomposition of soil minerals in addition to improving soil microbial diversity. Humates can be applied in liquid or granular form at seeding, and are easily mixed with fertiliser. Sandier soils lacking soil structure are likely to benefit most from the addition of humates.

The paddock used for the farmer demonstration has been in production for approximately 40 years under a wheat, canola, lupins and barley rotation. One side of the paddock is deep white sand and the other heavy red clay. The Hood's have previously been happy with the results they have got with humates on salty paddock areas.

The 0 L/ha (control), 5 L/ha and 10 L/ha treatments ran across both soil types. The yields for the 0 L/ha (control) and 10 L/ha treatments were averaged.

Demonstration Details

Property	Ardoch, east Ballidu
Plot size & replication	11m x 200m x 2 replications (5L treatment single replicate only types)
Soil type	Variable white sand to heavy red clay
Sowing date	27/05/2015
Seeding rate	60 kg/ha Calingiri wheat
Paddock rotation	2012 canola, 2013 wheat, 2014 wheat
Fertiliser	27/05/2015: 25 kg/ha MAP, 25 kg/ha Guano, 50 L/ha Flexi-N 22/08/2015: 30 L/ha UAN
Herbicides	20/05/2015: 1 L/ha Glyphosate 27/05/2015: 2 L/ha Trifluralin 03/08/2015: 800 mL/ha Jaguar, 300 mL/ha MCPA
Growing season rainfall	243mm

Results

Table 1: Yield results of humate treatments applied at seeding, average of two replicates, east Ballidu 2015.

Humate (L/ha)	Yield (t/ha)
0	1.69
5	1.67*
10	1.68

*5 L/ha treatment single replicate only.

Comments

David did not notice any visual differences during the season between areas with different rates of humate. He did notice that the paddock appeared nitrogen deficient and applied 30 L/ha UAN in August.

Soil tests were not conducted so any benefits from humates on soil health cannot be confirmed. A yield response was not expected in the first year of applying humates, generally humates would need to be applied each year for many years before a yield response would obtained, as a result of improved soil health. If there were to be a first-year response to the humates, it would be expected to be found in improved soil health, rather than yield.

The long-term Liebe Soil Biology trial had humate treatments in its early years (2004-2008). The 5 kg/ha humate treatments did not differ in yield, nor had notable difference in soil health to the control plots in this four year period. The reports on the long-term Soil Biology trials is available on the Liebe website from 2008 onwards. For earlier reports, please contact the Liebe office.

Acknowledgements
The Hood family for sharing their experience.

Reviewed by: Stuart McAlpine, Grower.

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Liebe Group Projects

Working Together to Deliver Multiple Benefit Messages to Growers Through a Whole Systems Approach to Soil Management

Lilly Martin, Research and Extension Agronomist, Liebe Group

Aims

- Give growers in Western Australia the capacity to understand and better manage the economic and environmental impacts of acidic soils.
- Give growers the knowledge and awareness of tools and information available to manage soil acidity.
- Growers to become better equipped through development of new tools and information to make effective adoption decisions to manage soil acidity.
- Growers maintaining viable farming systems through optimum management of their systems.

Background

The Liebe Group is leading a grower driven initiative and has formed an alliance to work collaboratively with Mingenew-Irwin Group (MIG), West Midlands Group (WMG), Southern Dirt and Aglime Australia. Funding has been awarded from GRDC to begin research into the most appropriate liming strategy to maximise return on investment and increase knowledge around the economics of different soil pH management, products and techniques utilising the Lime Economic Calculator.

Farmers in the Northern Agricultural Region have experienced extreme climate volatility over the last 15 years including three severe droughts and a number of below average rainfall years. As a response to this farmers are looking to improve their farming systems through increasing water and nutrient use efficiencies and developing flexible farming systems. Managing soil acidity in this volatile environment is a key component in improving the system.

As part of Liebe Group's previous GRDC funded projects 'Growers critically analysing new technologies for improved farming systems' 2006-2009 and 'Improved stubble soil management practices for sustainable systems in the Liebe area' 2009-2012, surveys of 60 growers in the Liebe area were conducted. This included around 50 members and 10 non-members each time. These surveys asked questions around liming including 'Do you lime?' and 'How many years ago did you start liming?' In 2006, 94% farmers surveyed limed, with that number increasing to 100% in 2012, (Liebe Group Technical Audit Results 2012 Executive Summary). The average number of years since liming was first used is 16 years.

However, when asked what major issues are impacting their farming system, soil acidity is still one of the highest ranking issues. With the uptake of liming 100% but the issue continuing, there is research required to find out what is the best method to overcome soil acidity and barriers to full adoption.

The project team, in consultation with the Regional Cropping Solutions Network, local growers, key researchers and NRM agencies will determine an appropriate development and extension plan to improve soil pH. This will include field trials to provide validation of the economic model against different lime products and rates and will also utilise existing research trials where possible, including an extensive lime x incorporation trial established by the West Midlands Group through the GRDC agribusiness trial extension network and a lime x deep ripping trial established by the Mingenew-Irwin Group in March 2013. By utilising existing research trials, the project adds value to previous investments in this field by ensuring continuity of data and extension messages. Trials were implemented in 2015 by the Liebe Group and Southern Dirt. The Liebe Group implemented three methods of incorporation; minimum till, spading and deep offset discs and applied lime, dolomite and lime + dolomite on yellow tammin sand. Southern

Dirt's trial is evaluating four rates of lime (0, 2, 4 and 6 t/ha) and compare three methods of incorporation; minimum till, one way plough and offset discs on forest gravel soil.

To aid in the extension of liming messages, a Lime Economic Calculator will be used. The Lime Economic Calculator was a grower driven initiative developed after they had seen trials reporting improvements from liming but had trouble quantifying the return on investment. As a result of long term below average seasons, lime has often been the first input taken off the budget, further compounding both financial and environment problems in the longer term.

Environmental benefits will occur through increasing the soil pH, leading to improved soil health. The improved soil health will result in greater economic benefits compounding the improvements as growers are able to further invest in their soil health. A lack of adoption will result in soil pH continuing to decline.

Activities:

1) Develop and implement four new trials (Liebe Group, MIG, WMG and Southern Dirt) and revisit five old trials (Aglime Australia).
2) Conduct three workshops designed to increase knowledge around the economics of different soil pH management products and techniques utilising the Lime Economic Calculator.
3) Conduct six case studies throughout WA featuring growers who have adopted various soil acidity management practices (Liebe Group, MIG, WMG and Southern Dirt).
4) Deliver annual reports to communicate results.
5) Extend results on a state and national level.

Outputs

1) Six detailed case studies on improved soil acidity management practices will be produced and will include an economic analysis of the practice. Extension of information will be via each groups networks to ensure over 500 businesses throughout WA are exposed to the case studies.
2) Annual results and trial reports produced based on the assessment and economics of best management practices for soil acidity management. Nine trial reports, one each by WMG, Southern Dirt, MIG and Liebe Group and five by Aglime Australia, produced annually (2016 & 2017) and extended to farm businesses across WA.
3) A series of three workshops looking at addressing the issue of soil acidity and discussing economics of different ways to ameliorate acidic soils.

Further information

Soil acidity management strategies throughout Western Australia are available for download from:
http://www.liebegroup.org.au/working-together-to-delieverer-multiple-benefit-messages-to-growers-through-a-whole-systems-approach-to-soil-management/

Free for download Liebe Lime Calculator: http://www.liebegroup.org.au/lime-profit-calculator/

Please contact the Liebe Group, Mingenew-Irwin Group, Southern Dirt and Aglime of Australia for further information on trials in your area.

Acknowledgements

This project is funded by GRDC (LIE00008) in collaboration with Southern Dirt, West Midlands Group, Mingenew-Irwin Group and Aglime of Australia.

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Innovative Carbon Storage and Nitrogen Management Strategies in the WA Wheatbelt

Lilly Martin, Research and Extension Agronomist, Liebe Group

Aim

This project has two main objectives:

1) To demonstrate innovative on-farm practices that can reduce nitrous oxide emissions, through the rotational use of leguminous crops in order to reduce the use of nitrogenous (N) based fertilisers whilst maximising net primary production (biomass).

2) The project will trial and demonstrate innovative on-farm practices that can increase the sequestration of carbon (C) in soil, through the use of biochar, soil amendments, biological amendments and use of additional composting materials to develop economically viable farming practices that sustainably store and build soil carbon.

Background

C is an important part of maintaining soil health and the productivity of the soil. It provides an energy source for many functions considered important for soil biological health, including: the transformation of nutrients to plant available forms, increasing soil pH buffering capacity, increasing cation exchange capacity, stabilisation of soil structure and the degradation of soil pollutants.

Building soil C is a product of soil type, climate and management factors. The soil organic content that can be achieved depends not only on the potential of the soil to protect C but also on the productivity of the crop or pasture. Theoretically, there is a soil C upper and lower limit in all soils. Previous research conducted by the Liebe Group shows that in the low rainfall environment in the Northern Wheatbelt of Western Australia, over time the upper and lower limits of soil carbon will reach an equilibrium, that is where the microbial decomposition of organic C is lower (upper limit) or higher (lower limit) than the input of new C inputs.

The challenge for our farming system is to find ways that can push our current C storage equilibrium more towards the upper limit and thus improve the soils potential and keep it at that equilibrium.

Hoyle, Baldock & Murphy (2009), indicate that there are a number of management options for farmers to sequester soil C, centring on increasing inputs of soil C, improving soil structure and supplying adequate amounts of nutrients to the soil. This project aims to demonstrate practices that cover all three of these areas.

In the area of addition of soil C, growing more biomass such as perennial pastures, eliminating fallow or adding biochar to the soil, all present a viable way to add soil C. Improving soil structure, through improved stubble management and reducing wind erosion through cover cropping, decreases the loss of organic residues from the soil and thus the loss of soil C from the soil. Finally, by supplying nutrients through brown manuring crops, utilising the N fixing ability of leguminous crops and adding organic soil amendments, ensures that crop biomass and root growth is maximised, thus increasing C in the soil. As organic materials decompose, nutrients can be released (mineralised) or taken up (immobilised) by soil organisms.

This project is funded by the Australian Government Department of Agriculture Action on the Ground program. The project commenced in July 2012 and will be completed by January 2016.

Project Activities

1. Practice for Profit Trial - Mills Property, east Dalwallinu

The long term Practice for Profit trial compared high and low fertiliser use under the following crops; wheat, canola, volunteer pasture and field peas. Total C will be measured under different rotations. The trial will demonstrate the profitability of using legumes and low levels of N fertiliser in the farming system. To take seasonal variability and rotation effects into account the trial will run from 2014 to 2016 inclusive. The information provided from this research will allow growers to better manage the use of N fertiliser leading to improved gross margins.

2. Demonstration of Perennial Legume Tedera - Martin Property, north Watheroo

The project will demonstrate how using perennial legumes can increase carbon stored in the soil. To achieve this, tedera seeds and seedlings were planted in low fertility soils which the host grower has prioritised for C management. The demonstration ran from 2014 to 2015 inclusive.

3. Soil Amendment Trials - Buntine, north Miling and Wubin

A series of soil amendment trials were conducted to amend soil issues with the physical, chemical and biological status of the soil, in turn increasing productivity and C cycling on that soil. The demonstrations ran from 2014 to 2015 inclusive.

- Growing cereal rye - Pearse Property, west Wubin
- Removing soil compaction - Dodd Property, west Buntine
- Incorporating bentonite clay - Seymour Property, north Miling

4. Biochar Trial - Long Term Research Site, west Buntine

The project will investigate if biochar is a suitable option for storing C in WA's Wheatbelt and how it affects crop yield and C storage. The trial ran from 2014 to 2015 inclusive.

5. Crop Manuring Trial - Long Term Research Site, west Buntine

The Liebe Group's Soil Biology Trial will be utilised to assess how crop manuring can be used to increase the amount of C in the soil. Manuring refers to sacrificing a crop in order to put organic matter back into the soil to improve soil health, weed control and subsequent crop yield. Soil C levels, biomass and the economic and agronomic factors of how crop manuring fits into the farming system will be recorded. The trials ran from 2014 to 2015 inclusive, this trial will continue to be monitored as part of the Soil Biology Trial.

Collaboration with Other Projects

The Liebe Group has also collaborated with other organisations on projects funded through the Australian Government's Carbon Farming Futures program. These projects are summarised below.

"Economies of Managing Soil Organic Carbon" - Department of Agriculture and Food, WA

This project involved field-based and grower managed demonstration sites implementing innovative methods for improving both soil organic carbon (SOC) stores in conjunction with their production base; and monitoring of previously established soil quality sites to provide information to landholders on beneficial/perverse outcomes associated with changing SOC levels in grain production systems. This will enable landowners to determine the profitability and risk of managing C from a sequestration vs. production perspective. These trials began in 2013.

Does Increasing Soil Carbon in Sandy Soils Increase Soil Nitrous Oxide Emissions from Grain Production?" - University of Western Australia

This project investigated if varying soil organic matter content and quality alters the crop response to applied N fertiliser. The field sites included the Liebe Group's long term Soil Biology Trial where there is a gradient of soil organic matter. The crop and soil response to different N fertiliser rates was be measured to determine the influence of soil organic matter on N fertiliser response and estimate changes in nitrogen use efficiency. The project also measured nitrous oxide emissions in response to the changing soil organic matter and applied nitrogen regime.

Further Reading
Previous trial results available from;
http://www.liebegroup.org.au/innovative-carbon-storage-and-nitrogen-management-strategies-in-the-western-australian-wheatbelt/

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Investigating Different Approaches to Manage Soil Acidification in the WA Wheatbelt

Lilly Martin, Research and Extension Agronomist, Liebe Group

Aims

This project aims to show the mid-long term effects of deep cultivation for management of water repellence and subsoil acidity.

Background

The short term effects of different cultivation methods are well understood however, little is known about the mid-long term. The practice is relatively new for the Liebe Group region, with these demonstrations being one of the first implemented in the area. By utilising demonstrations previously established, it is possible to see the mid-long term impact of such a major soil renovation event. The project also aims to educate farmers on the mid-long term effects of amelioration techniques to incorporate liming products in order to reduce acidity caused by unused nitrogen in the system and highlight what the different techniques used in the area have on crop productivity. Over time growers have experienced decreasing margins and increased risk which makes it imperative that they can apply knowledge from this type of research. Specifically, spading and mouldboarding to incorporate lime and the affect this has on soil acidity and gross margins.

Liebe Group members have shown a continuing interest and investment in soil health, particularly soil acidity. Adoption of liming in the Liebe Group area is 100% (Liebe Group Technical Audit, 2012) however, soil acidity remains an ongoing problem. Growers want to determine how to gain the most economical and effective response to manage subsoil acidity. Understanding of the long term effect of liming is essential to show farmers that whilst lime does not always give an immediate return there are long term benefits to the gross margins.

Project Outcome

An improved understanding of the mid-long term impacts that different amelioration techniques have on soil health.

Acknowledgements

This project is supported by The Liebe Group and the Northern Agricultural Catchments Council, through funding from the Australian Government National Landcare Programme.

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Subsoil Constraints: Understanding and Management

David Hall, Senior Research Officer, DAFWA

Aims

- To improve the mapping and diagnostics of subsoil constraints (SSC) across the WA wheatbelt.
- To develop information through trials and tools that can help farmers in their management of constrained subsoils.

Background

Wheatbelt subsoils almost universally have one or more subsoil constraints. These constraints limit root growth and crop yields by restricting access to water and nutrients within the soil profile. The cost of these constraints conservatively exceeds $1 billion per annum.

The constraints are well known (toxicities, restricted water infiltration and storage, compaction) however; our ability to manage them effectively is not as well developed. The elements that we are unsure of include:

- Mapping spatial extent and severity of subsoil constraints at scales that land managers can use.
- Determining the effects on plant available water and yield responses to key constraints.
- Identifying management options (amelioration, mitigation) to alleviate these limitations.
- Knowing the costs, returns and risks of these interventions.

In response to this GRDC has funded a five year project to investigate the above issues. The project is a joint project between DAFWA and CSIRO with key collaborators Fitzgerald Biosphere Group, Liebe Group and Precision Agronomics Australia.

Activities specific to the Mingenew-Irwin Group, West Midlands Group and Liebe Group:

1. Current soil maps (1:250,000) are not at a scale that can be used and interpreted at a paddock scale by farmers and their consultants. Improved systems of soil mapping that integrate layers of spatial information (soil type, elevation, EM, Gamma) are being used generate information on a 90m grid. Testing of this information will be conducted in five areas where we have rich datasets. One of these areas is bounded by Moora, Beacon, Merredin and Northam.
2. Investigations are currently being conducted by Dr Phil Ward and Dr Yvette Oliver (CSIRO) into the effects of tillage and liming on water storage, crop water use, root growth rate and root depth at Dandaragan and the Liebe Research site. Further trials will be initiated in 2016 with the West Midlands Group and the Liebe Group. The trial will investigate ripping depth (30, 50 and 70cm) by nitrogen. Caroline Peek (DAFWA Merredin) in conjunction with Beacon growers will also be putting in a trial to investigate alternate strategies for managing acid sands. Caroline Peek will also work with the Liebe Group to implement a trial on sodic and magnesic gimlet/salmon soils. All trials will be on view at various field days.
3. Economics of subsoil constraints will be further developed within the Central Northern Wheatbelt. This will include likely impacts of subsoil constraints on yields in different seasons. A crop modelling approach will be used to determine yield responses where trial data is unavailable.

Outputs

1. Six reviews of subsoil constraints have been completed in the first eight months of the project. These reviews cover acidity, sodicity, transient salinity, nutrition, soils databases and economics. The reviews have concentrated on the extent of the problem, prior research, gaps in our knowledge and areas for future work. We plan to condense the information from the reviews and publish them on the web and incorporate them into extension activities.

2. Develop diagnostic systems and technologies that enable the nature and extent of subsoil constraints to be identified at regional, subregional and paddock scales. Having a better idea of what key constraints of soils are and their likely distribution will help growers better target soil improvement strategies.
3. Improve knowledge of the constraints, effects on crop production and their management. Economics will be an important part of this information. Much of this information will be derived from trials and extended through field days and workshops.

Soil Constraints - West
Soil Constraints - West is a major collaborative initiative to develop and deliver solutions for a range of soil constraints which limit productive grain cropping in Western Australia. The GRDC, Department of Agriculture and Food (DAFWA), CSIRO and Murdoch University are providing more than $33 million of new research investment to address these significant issues over the next five years. Through the soils constraint west suite of projects, this project is actively linking and collaborating with other GRDC projects: Minimising compaction (DAW00243), non-wetting soils project (DAW00244), soil acidity (DAW00236), and subsoil constraints (LIE01283).

Acknowledgements
This project is funded by GRDC (DAW00242) in collaboration with DAFWA and CSIRO.

Paper reviewed by: Yvette Oliver, Senior Experimental Scientist, CSIRO.

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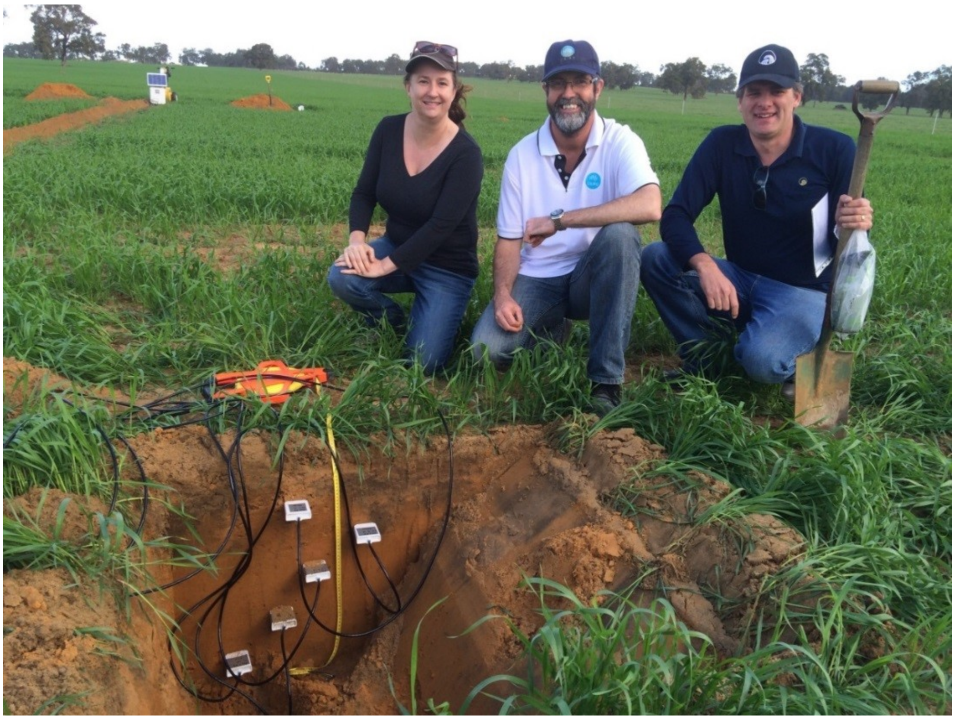

Figure 1: Yvette Oliver, Phil Ward and Steve Davies at the West Midlands site.

General Information

Planfarm Bankwest Benchmarks 2014 – 2015 Season

Both Planfarm and Bankwest – producers of the two dominant and most respected farm business benchmarking surveys in Western Australia, have joined forces to create the Planfarm Bankwest Benchmarks.

The Planfarm Bankwest Benchmarks are a comprehensive annual farm business analysis derived from the records of Planfarm, Bankwest, Bedbrook Johnston Williams, Business Ag and Ag Asset, and represents a large cross section of WA broadacre farm businesses.

The survey results need to be viewed in context of the individual situation. If the performance of a business is low in a certain area then the factors affecting this area will need to be analysed. If the lower performance can be justified by something which cannot be changed (e.g. the farm in question has a lower than average rainfall or poorer than average soils than the group) then there may be little need for concern. However, where there are factors affecting performance that are directly influenced by management, then an assessment should be made on what changes will improve performance and profitability.

Definition of terms

Effective Area (ha) – land area used directly for the purposes of producing crops or livestock. Does not include non-arable land such as salt lakes, rocks and bush.

Gross Farm Income ($Eff/ha) – all income produced from farm related activities with respect to the area farmed.

Fertiliser ($Eff/ha) – cost of fertiliser applied with respect to the area farmed.

Plant Investment ($/Crop ha) – measures the value of machinery with respect to the area cropped.

Operating Costs (OPEX) – relates to any payments made by the farm business for materials and services excluding capital, finance and personal expenditures.

Operating Costs ($Eff/ha) – relates to any payments made by the farm business for materials and services excluding capital, finance and personal expenditures with respect to the area farmed.

Operating Surplus ($Eff/ha) – farm income less operating costs. Measures the return on farming activity before account is taken of depreciation expense.

Pesticides/Herbicides ($/ha Crop) – cost of any pesticides or herbicides used with respect to the area cropped.

May – October Rainfall (mm) – growing season rainfall (May-Oct) of survey participants.

Total Sheep Shorn – total number of sheep shorn including lambs.

Wool Cut (Kg/WGha) – amount of wool cut with respect to winter grazed hectares.

Wool Price ($/kg) – value of wool sold with respect to the amount of wool cut.

Bottom 25% – the average of the low 25% of farms in the group surveyed ranked by operating surplus.

Top 25% – the average of the top 25% of farms in the group surveyed ranked by operating surplus.

These results have been extracted from the 'Planfarm Bankwest Benchmarks 2014/2015'.
For more information please contact the Bankwest Agribusiness Centre on (08) 9420 5112.

Figure 1: The regions used in the Planfarm Bankwest Benchmark survey.

Table 1: Farm Group Statistics - Medium Rainfall Zone, Region 2 from the 2014/2015 season.

Variables	Unit	Top 25%	Average	Bottom 25%
Effective Area	ha	4139	3845	3568
May – October Rainfall	mm	242	224	213
Permanent Labour	person	2.2	2.2	2.3
Casual Labour	wks	26.2	21.1	17.9
Effective Area/Perm Labour	ha	1628	1474	1215
Income/Perm Labour	$	1,199,553	823,107	447,557
Operating Surplus/Perm Labour	$	482,082	252,742	63,087
Gross Farm Income (GFI)	$/eff ha	773	563	395
Operating Costs (OPEX)	$/eff ha	466	396	343
Farm Operating Surplus	$ eff ha	307	167	51
Farm Oper. Surplus/mm GSR Rainfall*	$/eff ha	1.71	0.96	0.32
OPEX as % GFI	%	60	70	87
Return on Capital	%	7.0	2.4	-1.4
Total Crop Area	ha	3751	3117	2311
% Effective Area Crop	%	90	80	75
% Of Crop as Legumes	%	6	6	3
% Of Crop Oil Seed	%	10	13	12
% Effective Area Pasture	%	9	19	25
Wheat Yield	t/ha	2.70	2.17	1.69
Wheat Area	ha	2293	1908	1499
Wheat kg/mm Average	kg/mm	14.68	12.61	10.22
Lupin Yield	t/ha	1.58	1.45	1.20
Lupin Area	ha	278	331	360
Barley Yield	t/ha	2.69	2.31	2.05
Barley Area	ha	575	432	356
Canola Yield	t/ha	1.36	1.14	0.87
Canola Area	ha	596	674	410
N Use on Cereals	kg/ha	61.17	56.17	51.56
P Use on Whole Farm	kg/ha	11.23	10.17	10.20
Herbicide Costs	$/ha crop	73	67	57
Plant Investment	$/ha crop	404	456	411
Opening Sheep Number	hd	2420	2986	2931
Closing Sheep Number	hd	2088	2847	3287
Number of Ewes Mated	hd	1284	1377	1386
Lambs/WG ha	no.	3.3	1.9	1.8
Wool Price	$/kg net	5.90	5.97	5.72
Wool Cut/Grazed Area	kg/wgha	19.59	18.79	13.85
Stocking Rate	dse/wgha	4.42	4.54	4.33
Wool Production	kg greasy	11323	14246	13366
Average kg/Sheep Shorn	kg	4.07	4.15	4.46

*Top and bottom 25% groups are sorted by farm operating surplus/effective ha/mm growing season rainfall.

Table 2: Farm Group Statistics - Low Rainfall Zone, Region 2 from the 2014/2015 season.

Variables	Unit	Top 25%	Average	Bottom 25%
Effective Area	ha	7637	6908	6448
May – October Rainfall	mm	153	158	162
Permanent Labour	person	2.3	2.4	2.1
Casual Labour	weeks	30.2	19.9	16.4
Eff Area/Perm Labour	ha	2668	2544	2735
Income/Perm Labour	$	946,142	700,596	526,390
Op Surplus/Perm Labour	$	391,674	218,203	50,399
Gross Farm Income (GFI)	$/eff ha	364	290	196
Operating Costs (OPEX)	$/eff ha	219	203	182
Farm Operating Surplus	$/eff ha	146	87	14
Farm Oper. Surplus/mm GSR Rainfall*	$/eff ha	1.15	0.66	0.09
OPEX as % GFI	%	60	70	93
Return on Capital	%	7.9	3.5	-2.7
Total Crop area	ha	6213	5098	4128
% Effective area crop	%	81	75	68
% Of crop as legumes	%	0	2	2
% Of crop oil seed	%	10	8	7
% Effective area pasture	%	19	26	36
Wheat Yield	t/ha	1.41	1.25	1.01
Wheat Area	ha	5170	4165	3232
Wheat kg/mm ave	kg/mm	11.14	9.54	7.59
Lupin Yield	t/ha	-	0.74	0.71
Lupin Area	ha	-	222	158
Barley Yield	t/ha	1.62	1.31	1.01
Barley Area	ha	518	525	530
Canola Yield	t/ha	0.72	0.59	0.43
Canola Area	ha	680	437	592
N Use on Cereals	kg/ha	30.94	25.30	19.57
P Use on Whole Farm	kg/ha	6.03	5.36	4.28
Herbicide Costs	$/ha crop	$43	$46	49
Plant Investments	$/ha crop	270	300	322
Opening Sheep Numbers	hd	2503	2454	2668
Closing Sheep Numbers	hd	2133	2341	2639
No. of Ewes Mated	hd	1141	1228	1310
Lambs/WG Ha	no.	0.7	0.6	0.5
Wool price	$/kg net	5.58	5.77	5.82
Wool cut/grazed area	kg/wgha	6.79	6.81	6.60
Stocking rate	dse/wgha	1.19	1.43	1.62
Wool production	kg greasy	11562	11244	11635
Ave kg/sheep shorn	kg	5.38	4.77	4.55

*Top and bottom 25% groups are sorted by farm operating surplus/effective ha/mm growing season rainfall.

2015 Rainfall Report

	Dalwallinu	Kalannie	Coorow	Carnamah	Latham	Perenjori	Wongan Hills	Goodlands	MTS East Ballidu	LTRS West Buntine
Jan	11.2	2.0	19.0	5.0	23.2	-	1.4	12.8	0.0	15.0
Feb	27.6	20.8	45.8	63.4	31.0	44.5	32.5	20.2	20.0	28.6
Mar	44.6	71.2	43.3	32.3	64.0	60.7	27.8	93.8	42.0	71.0
Apr	56.4	34.0	56.6	53.4	40.0	20.7	27.2	29.8	9.5	46.0
May	13.8	24.0	17.7	20.2	11.8	15.4	19.2	16.2	22.0	13.5
June	55.4	60.4	56.1	42.7	59.4	-	35.5	43.8	65.0	57.9
July	85.2	106.0	75.2	83.6	64.6	-	113.5	72.8	104.0	107.7
Aug	50.6	51.4	46.0	33.1	44.4	66.3	54.0	57.4	38.0	30.6
Sep	4.4	3.4	5.5	0.0	7.0	2.8	8.4	6.0	4.0	5.0
Oct	5.4	0.0	5.3	2.6	1.2	0.0	6.4	0.0	0.0	3.0
Nov	30.0	35.8	17.4	16.5	26.4	12.0	28.6	37.2	33.0	-
Dec	0.5	-	1.0	3.1	1.8	-	4.2	-	0.0	-
GSR (Apr-Oct)	271.2	279.2	262.4	235.6	228.4	105.2	264.2	226.0	242.5	263.7
Total	385.1	409.0	388.9	355.9	374.8	222.4	358.7	390.0	337.5	378.3

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 on (08) 9263 2222, by fax on (08) 9263 2233 or by email at climate.wa@bom.gov.au

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

2015 Liebe Group R&D Survey Results

Conducted September 2015 at the Spring Field Day

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

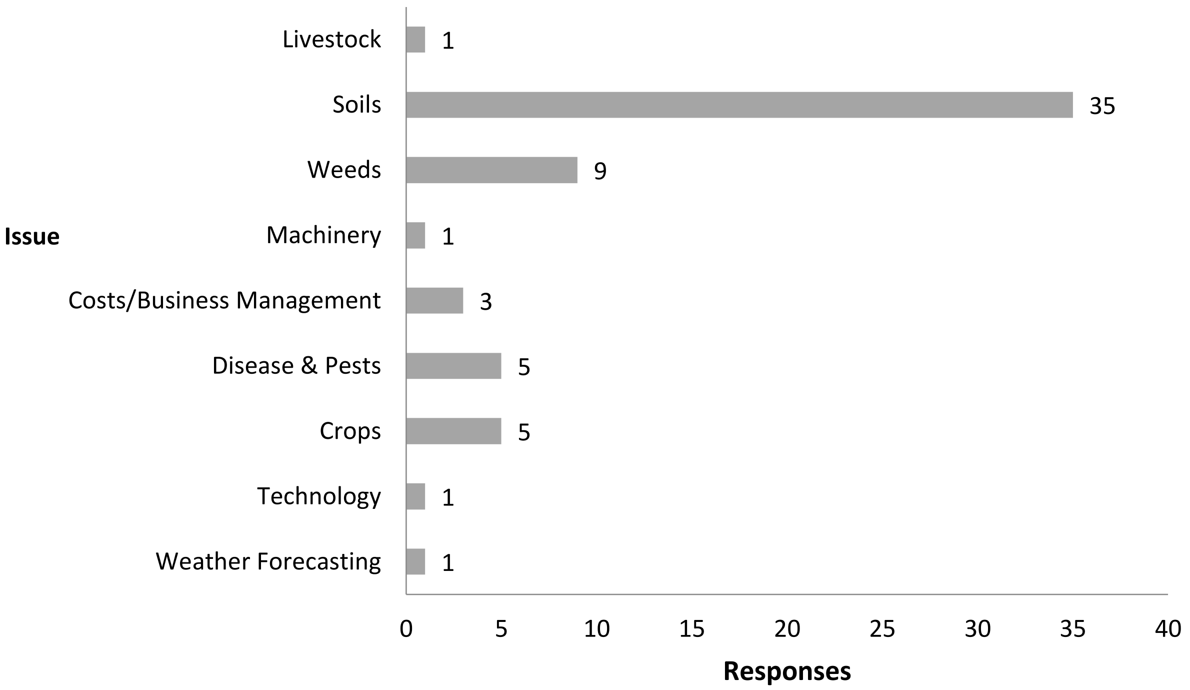

Figure 1: Farmers' responses when asked about key problems affecting their farm business, recorded at the Liebe Group Spring Field Day 2015.

What are the key areas of interest in relation to soils?

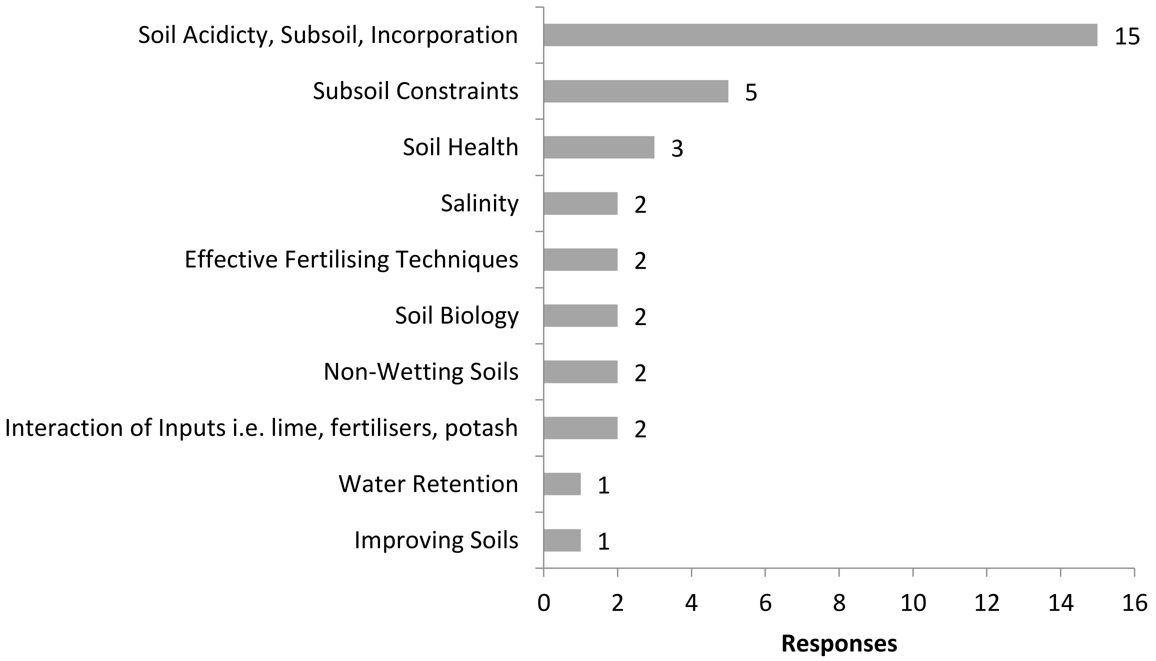

Figure 2: Areas of interest in soils recorded at the Liebe Spring Field Day 2015.

What are the key knowledge and skill issues that could be addressed through training, workshops or other communication activities organised through the Liebe Group?

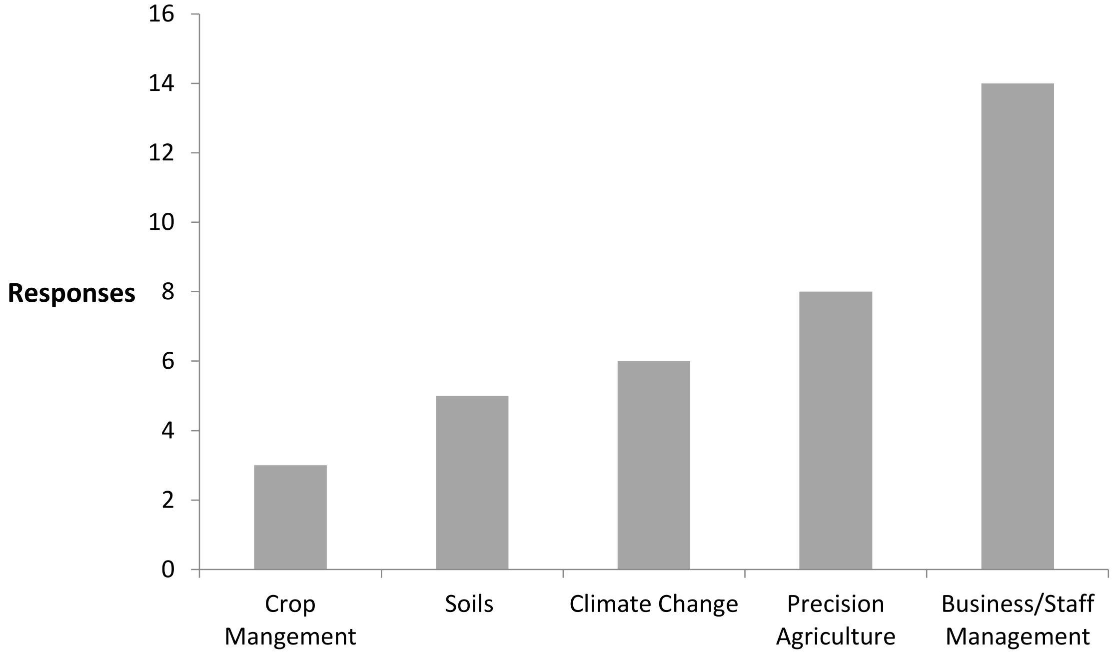

Figure 3: Farmers' responses when asked what key issues could be address in the training or workshops, measured at the Liebe Group Spring Field Day 2015.

Business/Staff Management interest areas based on grower responses at the Liebe Group Spring Field Day 2015 (See Figure 3):

- Marketing
- Farm Management Software
- Business Management
- Farm Safety and Compliance
- Diversification
- Technology Training
- Apps
- Communication Skills
- Auto Electrics
- "How to" Access Existing Information

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

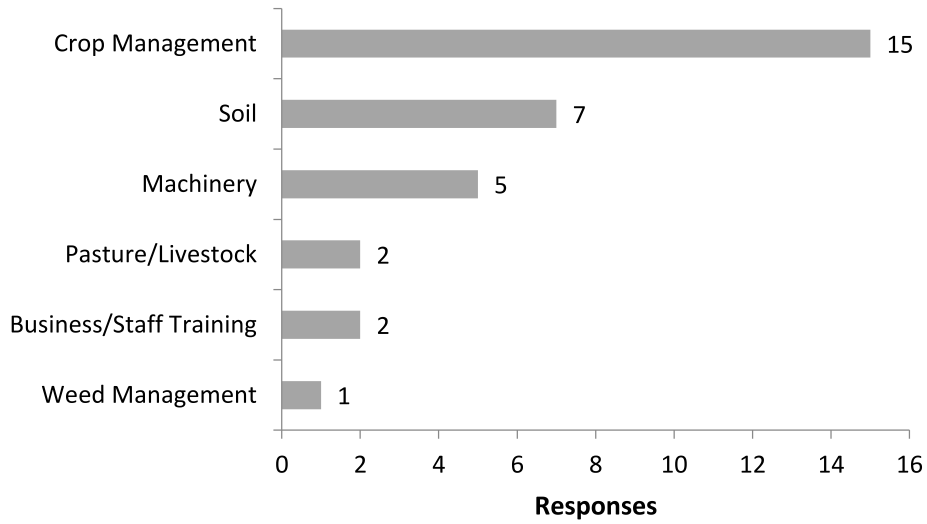

Figure 4: Farmers' responses when asked what concepts/products/practices they would like to see demonstrated, measured at the Liebe Group Spring Field Day 2015.

Machinery interest areas based on grower responses at the Liebe Group Spring Field Day 2015 (see Figure 4):

- Comparison of Different Seeder Bars
- Seed Placement
- Seeding Equipment
- Technology
- Conglomerate Pulveriser

The Liebe Group
Strategic Plan 2012 – 2017

Our Vision
Vibrance and Innovation for Rural Prosperity.

Our Mission
To be a progressive group, working together to improve rural profitability, lifestyle and natural resources.

Our Core Business
- Agricultural research, development, validation and implementation.
- Provide information, education, skills and training opportunities to members and wider community.
- Strengthen communication between growers, industry and whole community.

Our Values
The following are a set of evolving philosophies and values that the group maintains for members and employees. By accepting these values it enables us to build trust in order to make effective and efficient decisions and reach our potential.

Member Driven
Primarily the Group is here for its members, it must be to their cause and benefit. R&D, technology and capacity building is local and relevant and prioritised by the membership.

Innovation and Progression
The Group is innovative and progressive and this is encouraged and valued. An ethos of constant review is adhered to ensure we are on track and achieving best practice.

Inclusivity
The Group is inclusive which means we involve, encourage and support staff, members and the community to take part, have a voice and maintain their ideas and views as individuals.

Apolitical
The group is apolitical, which means collectively we won't represent the members without following a process to ensure we are representing all their ideas or opinions.

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

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

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

Working Together
Effective networking and links to beneficial partnerships is encouraged to add value and opportunities for the group. The Group works collaboratively within the agricultural industry to value add. The group maintains an ethos of team work and cooperativeness.

Respect
The Group always values and respects their members and their resources and experience. We expect people to be open and honest, and build processes that reflect transparency of the administration and processes used in the group.

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

Introduction

The 2012-2017 strategic plan was developed in September 2011 with the assistance of Nigel McGuckian from RM Consulting Group and builds on the existing strategic plan. Strategic planning has always been a focus for the Liebe Group since the group's inception in 1997 and has become part of the group's progression and success over the years. This is the fourth strategic planning exercise the group has conducted.

During this process members were asked to describe the current external agricultural environment they are working in and what it may look like in 10 years' time.

They described the future as having the following characteristics:

- Faster and more diverse modes of communication.
- Real-time accessibility to anything, anywhere.
- Food is highly valued and as a result, quality and accountability pressures are high.
- Rapid technology advancement in crops, soils and input efficiencies leading to significant productivity gains.
- Declining and more diverse rural populations.
- Information is readily available and comes in many different forms and from many different sources.
- Time pressures continue to increase.

Members were then asked to define what role a farmer group may play in the future.

They described a group having the following characteristics:

- Strong networks at a lot of different levels - locally, nationally and internationally.
- Impartial and independent information is highly valued in times of 'information overload'.
- Increased capability to capture, filter, catalogue and provide more targeted information.
- Ability to validate new technologies on-farm in a variety of different ways.
- Face-face interaction is valued more than ever and the group has good systems to support this.

The members acknowledged that the future and the environment we are currently operating in is continually changing and the role of the Liebe Group needs to continually change and adapt in order to stay relevant. During this time, there will be opportunities for the group to capitalise on and threats to manage.

OPPORTUNITIES

- Capturing and fostering the group philosophy and energy to engage more people with similar interests;
- Increase the use of new and varied tools for communication and extension;
- New systems to utilise and access knowledge from anywhere in the world instantly;
- Increase problem solving capacity – highly skilled staff and contractors;
- New methods of validating information and technology on-farm that is quicker and impartial;
- Strong processes to capture, catalogue, filter and extend information;
- Encouragement of new growth in rural towns through development of value adding projects;
- Develop methods to support and stimulate innovative thinking and new ideas;
- Creation of a more positive and attractive image of agriculture;
- Continual engagement and support of young people in agriculture.

THREATS

- Creation of a large gap between generations and those who don't relate to technology;
- Lack of new ideas and innovation;
- Loss of group vibrance through distance, population decline and burnout;
- Farmers becoming distracted from their core business and what they do well;
- Loss of capacity to operate at a continually growing level;
- Vision is too far ahead of the membership which risks losing member involvement;
- Declining profitability of farms;
- Decline in agricultural students coming through the system leading to a skills drought;
- Increasing call on resources increasing the risk of being too thinly spread to be effective;
- Uneven distribution of technology through membership e.g. variable mobile signal coverage;
- Loss of representation of members in the industry.

Strategy Area 1

High Priority Research and Development, Supported by Targeted Extension and Improved Validation Methods

Rationale

Conducting high priority research and development is important to foster growth in the agricultural sector. R&D improves the capacity of people to make effective decisions, and when supported by targeted extension activities and validation methods, growers will have an increased capacity to make effective adoption decisions.

Liebe Group members will have access to the latest research and development activities conducted in Liebe Group area. R&D activities will be targeted towards issues identified by the members and prioritised by Liebe Group management. The prioritisation will be supported by a research and development advisory committee. The group will assist growers with implementation through conducting appropriate extension activities and methods to improve on-farm validation.

2012-2017 Targets

- 100% of Liebe Group members have made an effective adoption decision concerning the adoption of new technology assist by the Liebe Group.
- 10% increase of attendees under the age of 25 at major events.
- A quality rating of 80% or greater by attendees of major events.

Activities

Attract and develop partnerships with agribusiness and research organisations

- Include key industry personnel on the Liebe Group mailing list.
- Maintain close relationship with Department of Agriculture and Food WA, Universities, CSIRO and other agribusiness.
- Keep abreast of GRDC research priorities and maintain close relationships Western Panel and grower group contact.
- Develop and maintain partnerships with other industry and research bodies when opportunities arise.
- Distribute Liebe R&D priorities and trial site details to major research organisations and agribusiness.

Develop trials and demonstration to address local priorities at the Main Trial Site, Long Term Research Site, satellite sites and on farm

- Determine research and development priorities from annual member survey and R&D planning meeting.
- Develop trial program for the satellite sites in conjunction with DAFWA and agribusiness.
- Organise and conduct on-farm demonstrations.
- Discuss strategic R&D priorities at general meetings.
- Ensure we seek R&D opportunities that encompass a whole systems approach.
- Maintain Soil Biology Trial at the Long Term Research Site.
- Raise profile of the Long Term Research Site and attract research bodies wishing to conduct trials of a long term nature to the site.
- Maintain trial program at the Long Term Research Site.
- Ensure R&D protocols are adhered to

Increasing adoption of new technologies

- Benchmark adoption levels of Liebe members every three years.
- Conduct farmer case studies and economic analysis on growers that have adopted new technology.

- Conduct on-farm demonstrations and economic modelling with growers that are considering technology adoption.

Extend Results of Research, Development and Validation
- Conduct a Spring Field Day at the Main Trial Site.
- Conduct field walks at satellite sites and the Long Term Research Site.
- Hold an annual Crop Updates to prepare growers for the coming season.
- Extend results in an annual R&D Book and review priority research at a Trials Review Day.
- Promote results to the wider community.
- Assist in attracting members to events by having a high profile guest speaker.
- Develop and maintain a website.

Performance Measures
- Research and Development advisory committee to meet at least three times a year to develop R&D priorities and discuss issues with industry partners.
- Conduct an annual membership survey to understand farming issues and priorities.
- Conduct a technical audit every three years to benchmark technology adoption.
- Conduct an evaluation of every event.
- Review website contents monthly.

Strategy Area 2

Members with High Business & Farming Aptitude

Rationale
Making good decisions is a product of understanding the issues and the opportunities and risks associated with these. By providing training in areas of skills gaps within the membership ensures members have the capacity to function effectively and efficiently to improve their businesses and reach their potential. This strategy will give Liebe members access to professional training conducted in areas of identified skills gaps as well as well-targeted, high quality, independent and factual information.

Activities
Workshops and study tours
- Use member survey and feedback to identify member requirements.
- Conduct high priority workshops annually (e.g. agronomic, management, financial, skills, communication).
- Conduct intra or interstate tours, visiting innovative, interesting and sustainable farming systems.

Communication
- Members informed of local, relevant and timely information in newsletters, e-news, Facebook and Twitter.
- Early notification of all dates and opportunities to provide members with plenty of time to schedule time off farm. Add dates to GGA calendar and check with local organisations to avoid clashes.
- Case studies of innovative farm practices produced.

Encourage all sectors of the community to attend Liebe Group events
- Conduct events that encourage young farmers and women to be involved.
- Encourage mentorship within the Liebe Group through encouraging interaction at events.
- Ensure we are being inclusive when catering for events.

Member Development
- Encourage greater input from non-involved members to come along to Liebe events. Bring a buddy philosophy.
- Promote external workshop or development opportunities to members via email and newsletter (Investigate sources of financial assistance for members to take up development opportunities or investigate possibility for Liebe Group to provide financial assistance).
- Review standard proposal for members to receive remuneration for voluntary time.
- Ensure members are being well serviced and areas for improvement are sought by phone interviews, farm visits and discussions at events.
- Ensure a sense of fun is incorporated at all Liebe events.

Efficient Information Management
- Cataloguing new and existing information.
- Improving searchability of new and existing information.
- Filtering information.
- More accessible information.

<u>Performance Measures</u>
- Conduct three major events annually
- Conduct three training workshops on prioritised subjects annually
- Produce nine monthly newsletters
- Produce six media releases per year
- Produce an annual calendar of events.

Strategy Area 3

A Collaborative and Connected Organisation

<u>Rationale</u>
The Liebe Group strives to connect its members to the industry and the media to ensure they are fairly represented and their successes are acknowledged. Collaborations with specific industry bodies allow for a participatory approach to research and a two-way feedback cycle to occur. Connections to other people whether locally, nationally or internationally allow members to share experiences with other like-minded people or groups. This approach fosters innovation and progress.

<u>2012-2017 Targets</u>
Recognised by stakeholders as a leading farmer group involved in rural profitability, lifestyle and natural resources.

<u>Activities</u>
Develop and maintain linkages with agribusiness, government agencies, tertiary institutions and political organisations
- Maintain ‘friends’ list for publications with all industry contacts made throughout the year and reviewed annually.
- The prospectus to be made available to the above bodies with an update occurring when necessary.
- Liebe Group website to be updated monthly and placed under high priority as our industry face.
- Encourage relevant industry to attend General Meetings.
- Attend an agricultural industry workshop developed by GGA and similar opportunities.
- Maintain industry profile, so that we are approached to facilitate contact if farmer’s individual opinions are required.

Promote agricultural successes in rural and non-rural media
- Maintain partnership with Farm Weekly to produce monthly Liebe updates for the paper.
- Invite media to main Liebe Group events and publish appropriate press releases.
- Develop contact and build rapport with the West Australian and Sunday Times to promote agriculture outside of the industry.
- Publish monthly updates in the local papers.

Celebrate Liebe and member successes
- Keep abreast of awards and nominate appropriate members.
- Hold an annual Liebe Dinner.
- Cater for post-event celebrations.
- Promote great achievements and member success in Liebe newsletter.
- Maintain and develop Liebe Group identity through staff uniform and badges to be worn at all events, promote sale of Liebe shirts and jumpers on membership flyer.
- Develop system to recognise members who have contributed significantly to the Liebe Group.

Network Building
- Utilise existing partnerships to build strong networks locally, nationally & internationally to foster innovation.
- Utilise new ways of interacting (e.g. social media, websites, electronic tablets etc.).
- Develop a 'sister' group with an overseas group.
- Ensure members are supported to be involved in networks.
- Get timely feedback from members.
- Build networks at a local level through mentoring, social interaction and fostering relations between various Liebe stakeholders.

<u>Performance Measures</u>
- Liebe Group to be represented at appropriate industry forums such as the Grower Group Alliance forum and Agribusiness Crop Updates.
- Contribute 6 media releases per year to the Farm Weekly.
- Hold an annual Liebe Dinner celebrating the success of the past year.

Strategy Area 4

Sustainable Group Finances

<u>Rationale</u>
Sound finances give the group the flexibility and control over its activities and progression. The Liebe Group seeks funding from different sources including membership, sponsorship and project funding.

<u>2012-2017 Targets</u>
To have one year's overhead costs in reserve.

<u>Activities</u>
Finance sub-committee to oversee Liebe Group financials and budget
- Review project funding timeline.
- Prepare budget and allocations for management.
- Approve finance for expensive purchase items.
- Review and account for the Liebe Group finances.
- Track progress of income and expenditure areas.

- Committee meets regularly and when necessary**.**
- Recommendation of fees and value of membership.

Seek Funding

- Maintain strong links with industry partners.
- Seek new sponsors and partners.
- Review sponsorship guidelines and return on investment for each.
- Identify and target high-return sources of funding (sponsors, programs, membership and subcontracting).

Develop membership contributions

Review stability of membership numbers and ensure members are being well serviced.

<u>Performance Measures</u>

- Finance subcommittee to meet at least quarterly and make recommendations to the management committee.
- Prepare a budget annually, to be signed off by the management committee.
- Membership fees to cover administration officer's position.

Strategy Area 5

High Performing Skilled Staff

<u>Rationale</u>

Maintaining and supporting appropriately skilled staff is a priority for the Liebe Group to ensure the group grows and roles are carried out effectively and efficiently. The staff is employed to manage the strategy and policies set by the Management Committee, by maintaining a philosophy of continual support and improvement in employees, the strategy can be implemented to its full potential.

<u>2012-2017 Targets</u>

- The Liebe Group will retain staff for an average of 2.5 years per staff member.
- Staff will consistently rate the Liebe Group as a 'highly desirable' workplace, as determined by an annual survey completed during the performance appraisal process.

<u>Activities</u>

Support and develop Liebe Group employees each year

- Review performance appraisal document.
- Review performance, salary, goals and objectives taking care to enhance employee's areas of interest.
- Conduct annual performance appraisal including SWOT.
- Review new employee induction program, guided by protocol and list of training requirements.
- Identify and provide staff with professional development.
- Conduct fortnightly team meetings.
- Ensure management maintain an ethos of supporting staff.
- Develop and review a mentoring policy for employees.

Maintain and increase employment base in order to meet group requirements

- Review list of all roles and responsibilities, delegating each responsibility to appropriate staff members.
- Identify gaps in roles and skills, and investigate employment options.
- Seek external contracting of specialist skills where necessary.
- Seek feedback from employees to develop and maintain a conducive working environment.

Performance Measures
- Hold an annual performance review for each staff member.
- Provide $1000/yr training budget for each staff member.
- Each staff member to meet with staff support officer at least 3 times a year, including training.
- Exiting staff to complete exit survey.
- Produce an annual social calendar.

Strategy Area 6
Highly Effective Governance

Rationale
Good corporate governance underpins the success of an organisation. The ability of the Management Committee, supporting committees and staff to make well informed and effective decisions is driven by effective process and well supported personnel. The Liebe Group is driven by the decision making capacity of its members and as such needs to adopt a process of constant review to ensure new committee members are continually up-skilled and aware of their roles and responsibilities on the committee. Good governance maintains integrity, accountability, transparency and quality in performance and reporting of our activities.

2012-2017 Targets
The Liebe Group will be a 'best-practice' community group, as measured by an external audit.

Activities
Management Committee, subcommittee and reporting structure
- Management Committee meet on a monthly basis at a general meeting and are responsible for governing the Liebe Group. This involves policy development.
- The Management Committee directs staff through the employment of an Executive Officer.
- A Finance subcommittee of the Management Committee provide recommendations to the Management Committee. This subcommittee consists of some personnel with specialist skills in financial management.
- An Ethics subcommittee of the Management Committee to provide recommendation to the Management Committee on issues of an ethical nature.
- A Research & Development advisory committee and Women's advisory committee, advise staff on operational activities. These committee's consists of some personnel with specialist skills and interests in these areas.
- An Employment advisory committee employs an Executive Officer and provides advice and support to the Executive Officer to employ other staff.
- The Executive Officer must sit on every Liebe Group committee.
- Review Management Committee, subcommittees and advisory committees' purpose and responsibilities annually at the Annual General Meeting.
- Analyse resources, skills and interests required for successful Liebe Group governance and management and individually approach members to be involved in various subcommittees.
- Distribute guidelines for effective committee meetings to all committee members annually.
- Follow succession strategy to increase member involvement on committees as per succession protocol.

Effective group process
- Develop 5 year strategic plan and review objectives annually as a working document.
- Committee members understand their roles and responsibilities.

- Communicate Liebe Group strategy to Liebe Group stakeholders.
- Ensure inclusive processes are always used.
- Maintain transparency in processes.
- Develop written protocols on Liebe Group process to aid in transition of staff and group positions.
- All committees and staff are to operate by the Liebe Group code of ethics.

Performance Measure

- Conduct and Annual General Meeting in February every year.
- Hold 9 General Meetings per year.
- Review strategic plan objectives and targets annually.
- Skills audit conducted annually.

Liebe Group Calendar of Events – 2016

EVENT	DATE	LOCATION	CONTACT
February General Meeting	8th February	Dalwallinu Discovery Centre Performing Arts Room	Clare Johnston
GRDC Farm Business Updates	11th February	Dalwallinu Recreation Centre	*register online
Trials Review Day	16th February	Dalwallinu Bowling Club	Jenni Clausen
Annual General Meeting	16th February	Dalwallinu Bowling Club	Clare Johnston
Crop Updates	2nd March	Dalwallinu Recreation Centre	Katrina Venticinque
March General Meeting	14th March	Dalwallinu Discovery Centre Performing Arts Room	Clare Johnston
April General Meeting	4th April	Dalwallinu Discovery Centre Performing Arts Room	Clare Johnston
June General Meeting	13th June	Dalwallinu Discovery Centre Performing Arts Room	Clare Johnston
Women's Field Day	21st June	Dalwallinu Recreation Centre	Katrina Venticinque
July General Meeting	18th July	Dalwallinu Discovery Centre Performing Arts Room	Clare Johnston
Post Seeding Field Walk & Beer 'n' Burger Night	21st July	Main Trial Site – Butcher's Property, Nugadong	Jenni Clausen
August General Meeting	15th August	Dalwallinu Discovery Centre Performing Arts Room	Clare Johnston
Liebe Group Annual Dinner	TBA	TBA	Katrina Venticinque
Spring Field Day	8th September	Main Trial Site – Butcher's Property, Nugadong	Jenni Clausen
September General Meeting	12th September	Dalwallinu Discovery Centre Performing Arts Room	Clare Johnston
October General Meeting	10th October	Dalwallinu Discovery Centre Performing Arts Room	Clare Johnston
December General Meeting	12th December	Dalwallinu Discovery Centre Performing Arts Room	Clare Johnston

Contact all Liebe Group staff on (08) 9661 0570
*www.grdc.com.au/Media-Centre/Events/2016/02/GRDC-Farm-Business-Update-Dalwallinu

AFGRI Equipment Australia

AFGRI Equipment is proud to be a sponsor of the Liebe Group and we are excited to be associated with the research and development they conduct. We look forward to a long and successful relationship with both the Liebe Group and the greater Dalwallinu community. Call in today to see the team and our extensive range of John Deere and other agricultural equipment.

AFGRI EQUIPMENT

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