2016 Trials Review

Tuesday 28th March 2017

Growing Agriculture Together

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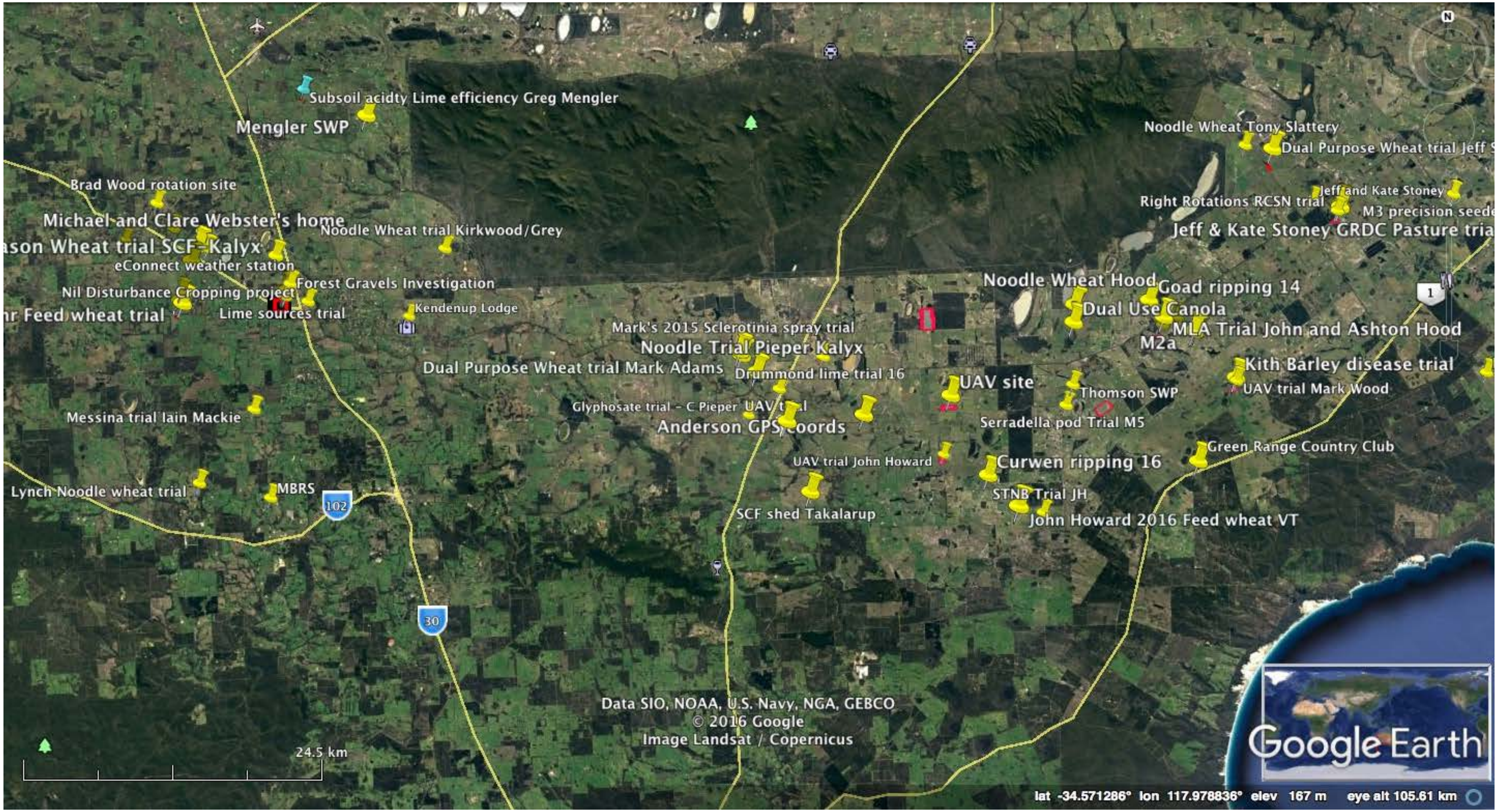
SCF 2016 Trial Location Map



Dual Purpose & Dual Use Long Season Wheat Trial Results

The SCF R&D project team - John Blake, Jake McGuire & Nathan Dovey.
Program overview by SCF CEO, Christine Kershaw.

Fit for Dual Purpose and Dual Use Long Season Wheat Project

CBH funds and Royalties for Regions GG R&D funds – "*SCF Fit for Dual Purpose Dual Purpose Wheat*" $325,000 (R4R) 3 years) +$30,000 (CBH 2 years).

Key Messages

- Yield premium for Long season wheat varieties April sown vs May sown was 920 Kg/Ha
- SCF dual purpose/dual use long season HRZ wheat production package is being upgraded with each year's research and case studies (2016-2019)
- Product testing for flour blend characteristics and feed qualities such as metabolisable energy in progress
- CBH trial offer for dual purpose/dual use long season wheat

Developing the SCF Long Season SCF dual purpose & dual use HRZ Wheat production package:

Of the standard dual-purpose winter wheat varieties Naparoo has achieved high head density and grain yields while Revenue and Manning were disappointing. The longer season spring wheat varieties in Sun-Lamb, Cobalt and Trojan also had high yields. A summary of harvest grain yields x quality results is below or attached. Lab. testing of all varieties for product characteristics is being undertaken with CBH at AGC and also the Agricultural Institute at Wagga Wagga. In 2017 we are adding DS Pascal (Sprout Resistant on order from David Clegg –Seed-Net) and Cobalt to varieties being tested in the broad-scale trials this 2017 season and dropping Revenue.

Results 2016 Trials

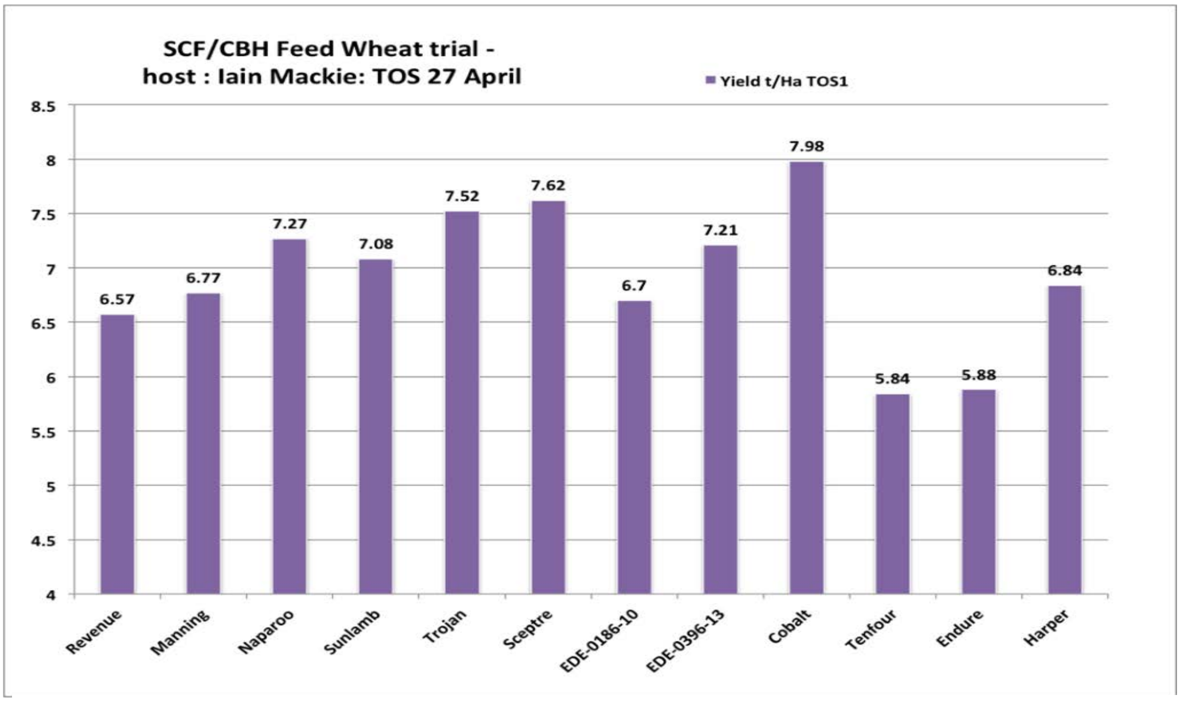


Figure 1: Intensive trial (small plots) Dual purpose Wheat– Host: Iain Mackie, Red Gum Farm, Kendenup (Kalyx contract).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More detailed analysis to be included on SCF website.

Note: Scaling up trial results – small plots need >15% yield discount over 200m plots

Image 1: Small plot trial at Iain Mackie's, Kendenup.

John Howard's Long Season Wheat trial 2016

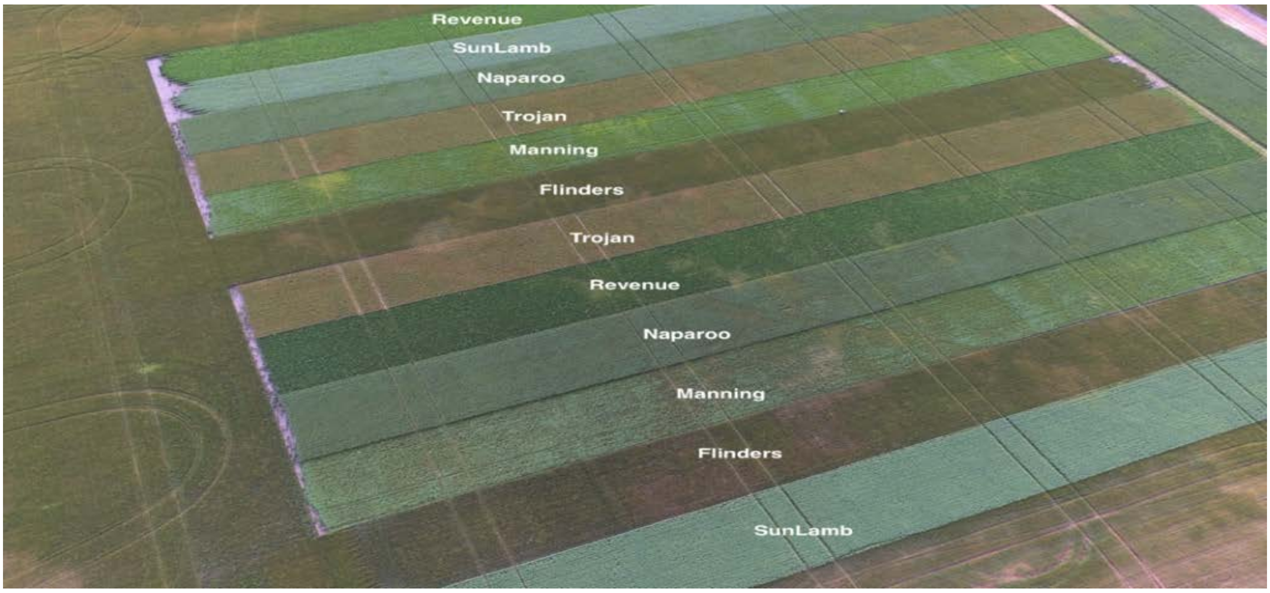


Image 2: John Howard's long Season Dual Use Wheat trial - October 2016; Trials were hosted by Mark Adams, John Howard, Andrew Slade, Jeff Stoney and Iain Mackie and include testing of the dual-purpose wheat varieties with grazing treatments on two trial.

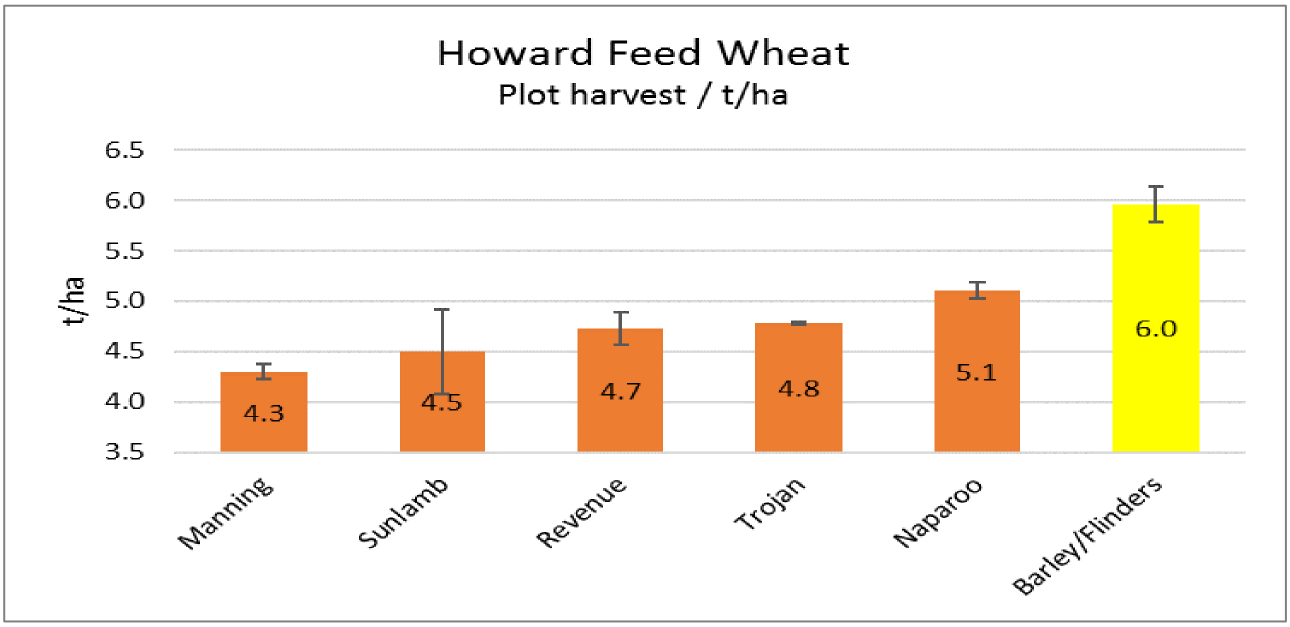


Figure 2: SCF Long season wheat trial – Host John Howard. The fit in cropping rotations maybe Canola/LS Wheat/Barley/Pasture in Southern areas and will require further testing.

Progress

The harvest and grain quality data from 4 broad-scale trials will be used to upgrade the Feed Wheat production package. Manning (showed physiological yellowing) and Revenue showing parent back type. This project is in association with SEPWA and Southern Dirt. CBH specialist market studies (with Rachid El Khayam) have been encouraging and the SCF market engagement tour is proposed for 2017. CBH will be updating SCF market information soon.

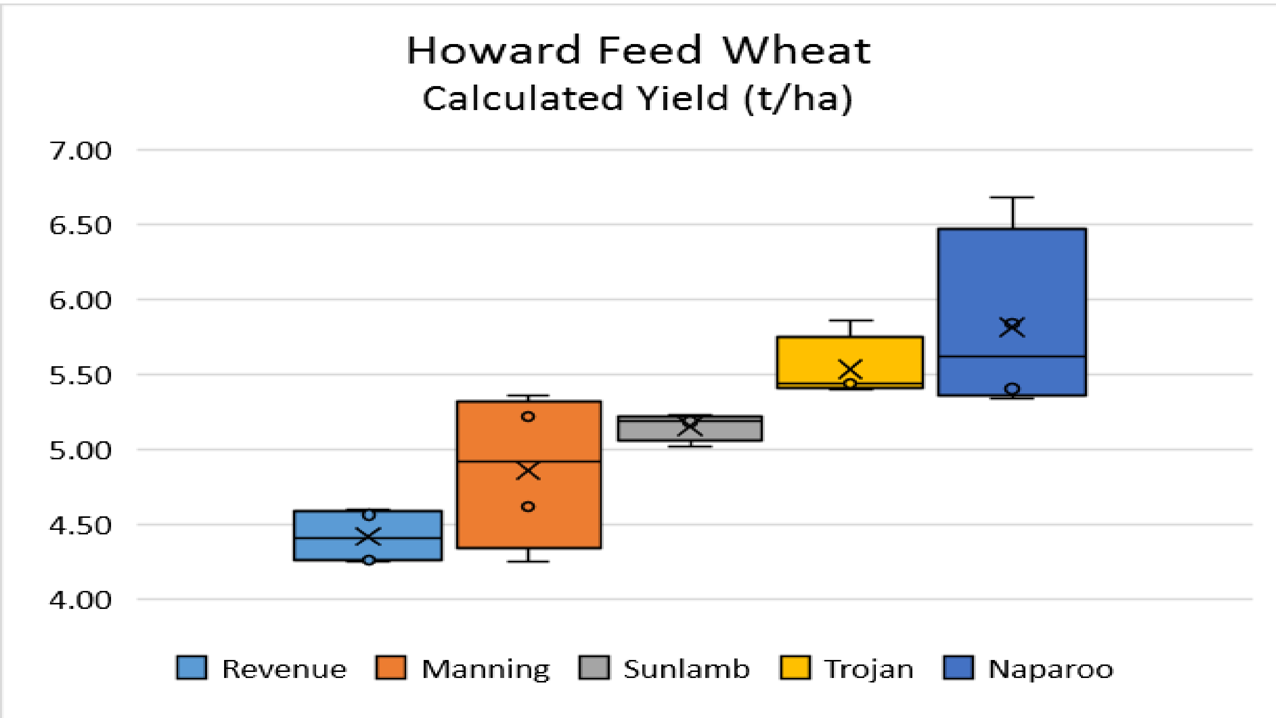


Figure 3: YIELD COMPONENT ANALYSIS: Yield calculation estimate based on head number per sq. m and measured head grain weight: SCF 2016 FW_ 3_ JH.

Image 3: As observed during the CBH trial visit in Nov 2016.

Image 4: Mark Adam's Feed Wheat Trial (photo courtesy of Kimberley Adams- September 2016).

Sown 14th April and had highest Yield potential – physiological yellowing in Manning still evident in September as shown in Image 4.

Summary of Key Results

Table 1: Grain yield (t/ha) from small plot trial and broad-scale feed wheat trials in 2016 with additional results courtesy of Southern DIRT and SEPWA.

	Small plots**	**Stirlings to Coast Farmers Broad-scale trials**			Southern Dirt sites			SEPWA *
Variety	**Mackie**	**Adams**	**Howard**	**Slade**	Broome -hill[1]	Muradup [1]	Mobrup [1]	Hope-toun
Manning	6.77	2.97	4.3	1.4/0.9[2]	2.40	3.00	2.02	4.23
Sun-lamb	7.08	4.12	4.5	1.7/1.5	3.25	3.98	2.19	4.36
Trojan	7.52	4.94	4.8	1.6/2.0	2.39	3.73	2.50	
Revenue	6.57		4.7	2.1/2.4				
Naparoo	7.27	4.32	5.1	2.5/2.1	3.33	4.3	2.82	
DS Pascal								5.4
Cobalt	7.98							
Harper	6.84							
Barley			6.0	3.5/2.1				
Comments		Some frost	Well drained	Water-logging				
	** Small plot yields need be discounted 20%			Variable yield response to grazing	Some frost	Some frost	Weedy site	

Note: The 2017 trials are underway. A grazing trial using Manning wheat has been sown this month and the first time of sowing of broad-scale trials last week.

Handout

- HRZ dual purpose wheat production package.
- Interim Conclusions from 2016 trials testing the SCF dual purpose HRZ feed wheat production package.

Noodle Wheat and Other Uses

John Blake, SCF

Key messages

- Growing Noodle wheat has been perceived as high risk by growers in the High Rainfall Zone (HRZ) due to the risk of not making ANW1 grade. There are, however, some specialist noodle wheat growers in the HRZ who consistently make better than Mace yields and achieve ANW1 for almost all grain produced. The reasons for this are guiding the HRZ Noodle wheat production package.
- A 30km distance from the south coast within the HRZ, proposed as the '*Chillinup Line,'* appears to be a critical agronomic cut off point for where the risk of downgrade (or failure to meet specification) is more manageable.
- The 2017 prototype *HRZ Noodle Wheat production package* is an upgrade on the 2016 version using the project's trial results and other research and experience by the SCF R&D team in consultation with key stakeholders.
- Intergrain and AEGIC are helping refine the HRZ Noodle Wheat production package to meet market specifications for Noodles and the other alternative products being tested by AEGIC.
- Grower groups recognise that differentiated products aid price stability in times of relative grain oversupply and higher competition. For example, grain for Udon Noodle wheat markets and other specialist new markets are less to be affected by downward price pressures than undifferentiated grade wheat prices.

Introduction

The Grain Industry Association of Western Australia (GIWA) with the Australian Export Grains Innovation Centre (AEGIC) conducted a review of the WA Noodle Industry on 'C*urrent Status and Future Challenges*' (2015). This review highlighted the possibilities for change. WA is the only external source of wheat grain for Udon Noodle manufacture for Japan and Korea. InterGrain has the only noodle wheat-breeding program in the world outside Japan.

Meanwhile in the HRZ, many growers have stopped producing noodle wheat because of higher risks of not making the grade in HRZ. Noodle wheat is one of very few differentiated grain products we market.

A key aim of this project is through three years of trials to deliver key elements of a demonstrated and communicated variety specific HRZ Noodle Wheat production package. This purpose of the HRZ package is to increase noodle wheat quantity and quality and reduce downgrade risk.

A second aim of the project is to provide greater diversity and options for crop rotations in the southern HRZ – the current dominant rotation of canola: barley is under threat with more disease and chemical resistance.

Methods

The prototype HRZ *Noodle Wheat production package* (2016) predicted the key elements of the required agronomy needed to meet market specifications.

- The prototype *HRZ Noodle Wheat production package (2016)* was tested using field trials, including one contracted intensive trial and four broad-scale trials in 2016 and CBH test results on grain quality of samples.

- The 2016 prototype *HRZ Noodle Wheat production package* is being refined using the project's trial results and other research and experience by the SCF R&D team in consultation with DAFWA, SCF growers, consultants, marketing agencies and Intergrain.
- Intergrain and AEGIC are undertaking end product testing of comprehensive samples (1kg, 5kg, and 20 kg samples from each treatment in each trial) from the trials to refine our HRZ production package to meet market specifications for Noodles and other alternative products being tested by AEGIC.
- The SCF Board and SCF R&D committee have reviewed the project and continue to be very supportive of the project objectives. Both groups recognize that in times of oversupply of grain and higher competition that differentiated products such as Udon Noodle wheat markets and other specialist new markets are less likely to be affected by downward pressures on undifferentiated grade wheat prices (niche marketing).

Image 1 below is an example of the broad-scale Noodle wheat trials on-farm. Growers gain from scaling up from small plot trials to test the "best bet" options

Image 1: Brad and Steve Lynch's Noodle wheat trial (West Mt Barker).

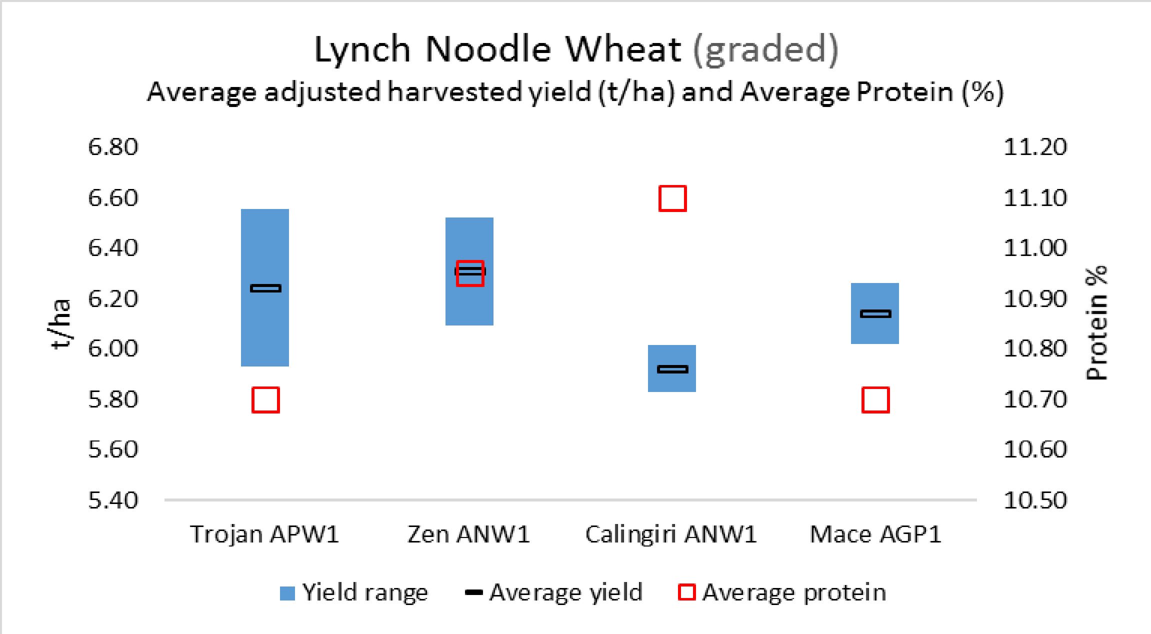


Figure 1: Lynch noodle wheat yields.

Results

Table 1: Summary of SCF Noodle wheat experiments 2016 – grain yields (t/ha) at intensive small plot trials and broad-scale trial sites.

Variety	**SCF Noodle wheat experiments 2016**			
Trial host	Craig Pieper Small plot trial	Steve and Brad Lynch's broad-scale trial	Tony Slattery's broad scale trial	Chris Kirkwood's broad-scale trial
LOCATION VARIETY	Kamballup- East Mt Barker	Forest Hill West Mt Barker	Gnowellen East of Stirlings	East Kendenup
Zen	6.01	6.31	6.25	3.03
Zen High Sow Rate	6.19			
Ninja	5.91			
Calingiri	5.93	5.92	6.04	2.53
Fortune	5.67			
Supreme	5.61		5.82	
Trojan	6.03	6.24	6.24	2.54
Mace		6.14		
Sceptre	6.28			
Soil Type Comments	Kalgan loam and well drained	Forest Gravel Well drained but trending to waterlog	Duplex but well-structured sub soil	Shallow Duplex extended waterlogging
	All quality Ok for noodle segregation	All quality Ok for noodle segregation	All quality Ok for noodle segregation	Proteins too low for segregation

Grain yields were mostly good for these sites, indicating that the varieties are well adapted to the region. Further investigation of management (N tactics, seed rates, soil types and rotations) is needed in 2017 to assess the impact on grain quality.

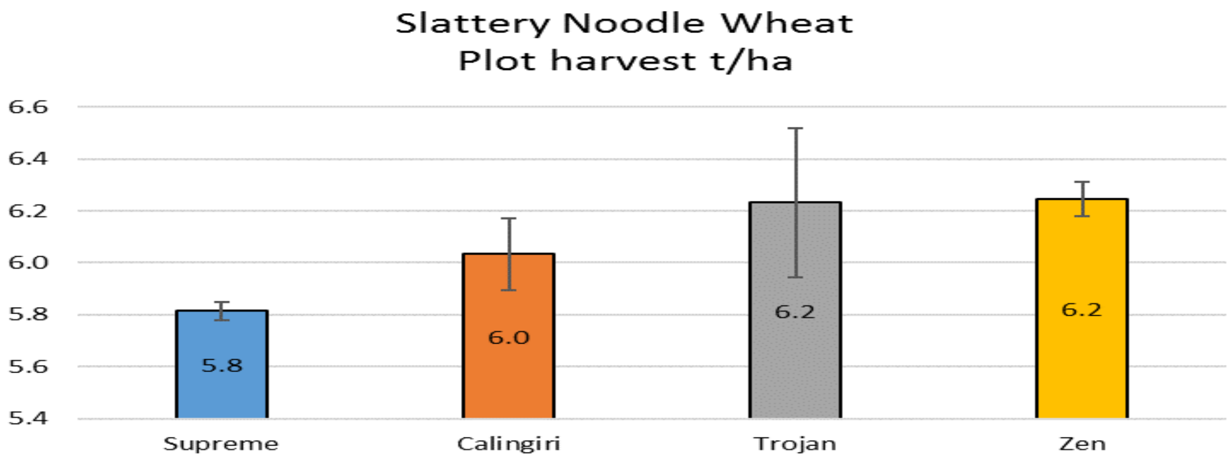


Figure 2: The Impact of Time of harvest on Yield and Quality for Noodle wheat.

A significant rainfall event (41.4 mm) occurred between the two times of harvest (TOH): First TOH 2 Dec 2016 and Second TOH 22 Dec 2016.

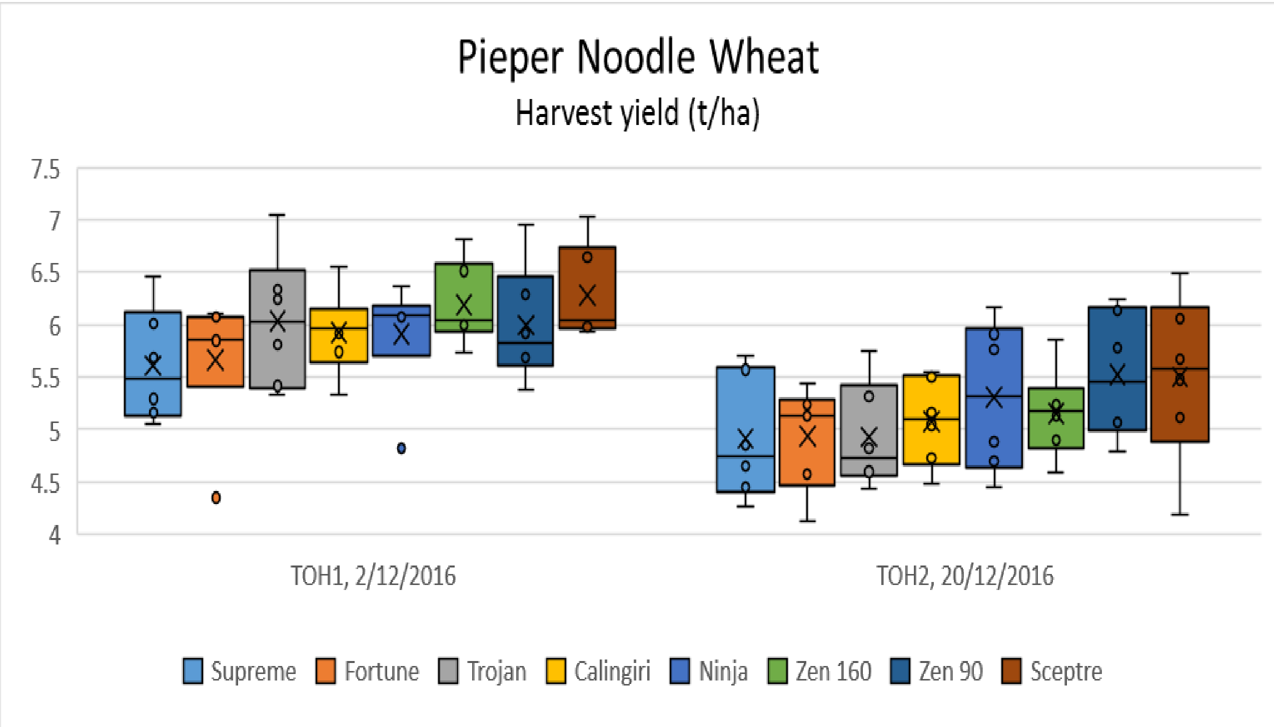


Figure 3: Ag. zones of the WA wheat belt and the regional focus.

The project area (and the focus area for the HRZ Noodle Wheat production package) is Southern part of AGZONE 3 and the Western part of AGZONE 6 above the 'Chillinup Line'.

Conclusions

- The 2016 prototype *HRZ Noodle Wheat production package* has been refined using the project's trial results and consultation with DAFWA, SCF growers, consultants, marketing agencies and Intergrain. The current version is available as handout for the 2017 season.

- Intergrain and AEGIC are undertaking end product testing of comprehensive samples (1kg, 5kg, and 20 kg samples from each treatment in each trial) from the trials to refine our HRZ production package to meet market specifications for Noodles and other alternative products being tested by AEGIC.
- Both groups recognize that in times of oversupply of grain and higher competition that differentiated products such as Udon Noodle wheat markets and other specialist product new markets are more likely to less affected by downward pressures on undifferentiated grade wheat prices (niche marketing).

Key words

Noodle Wheat, High Rain Fall Zone, agronomic production packages.

Acknowledgements

This project is one of two SCF wheat projects funded by the Royalties for Regions Grower Group Research and Development Grants Program (GGRD 2015-0050-AGSC Title: The 'Paddock to Plate' value chain for SCF Noodle Wheat: a case study for grower groups). Thank you to the growers for providing trial sites and management and SCF R&D team. Thank you to Kalyx for implementing the Intensive small plot trial.

Paper reviewed by: Professor Wal Anderson, SCF.

Disclaimer: These are preliminary results from within the first year of the project. Your feedback is very welcome.

2016 Southern Deep Ripping Trial Results

Jeremy Lemon, DAFWA Albany

Key messages

- Deep ripping produced barley yield responses of 0.5 to 1.5 t/ha on a responsive deep sand
- At a similar deep sand site, subsoil acidity restricted yield increase to about 0.3t/ha
- A response of about 0.4t/ha was evident on gravelly soils ripped to 35cm
- Deeper ripping on gravel soil at Muradup was no better than no cultivation

Introduction

Deeper deep ripping gives large yield responses in northern agricultural areas of WA. Sandy soils are prone to compaction from cropping machinery traffic. Clay and gravel soils are less prone to subsurface compaction. Larger and multiple tyres running at low pressure and tracks reduce surface compaction but do not reduce machinery loads and subsoil compaction. Heavy and frequent machinery passes compact susceptible soils between 30 and 60cm depth.

Results from deep ripping in other areas of WA need to be proven on local soil types. In 2016 two sites were established and one site had further planned treatments applied to quantify the benefits of deep ripping. The longevity of deep ripping will be assessed over several years at each site.

Method

Kojaneerup – this site started in 2014 with 16 alternate 700m runs of 35cm ripping and no ripping along the length of a paddock. The runs were 12m wide matching sowing and harvesting machinery. A four-treatment trial replicated four times has been overlaid on the original runs, leaving 2014 ripping and no ripping as control treatments. In Feb 2016, the grower ripped full plot widths to 120cm with dozer tines at 1.1m spacing. In late April, further plots were ripped to 75cm with a Heliripper, alternate tines at 0.5m spacing were 75 cm and 45cm deep. (i.e. 75cm tine depth spaced at 1.0m). The paddock was sown to barley and yields were extracted from a yield map and calibrated to paddock delivered yield.

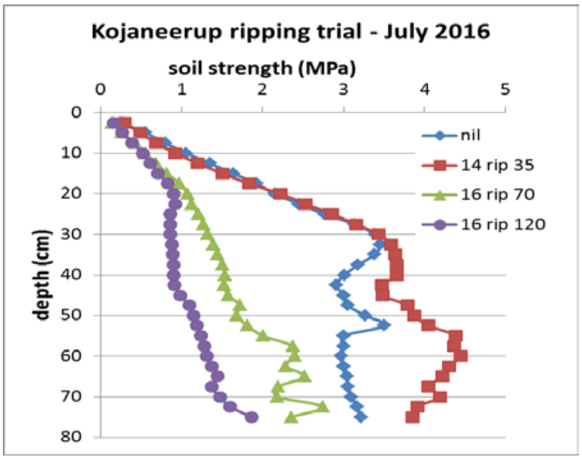
Bloxidge Road – soil type changes and machinery sizes constrained this site to an unreplicated demonstration. Two 24m wide Heliripper plots, one to 35cm and one to 75cm depth were placed between alternate unripped plots across both clayed deep sand and sandy gravel over laterite. A weigh trailer measured header barley grain yields from each soil type separately.

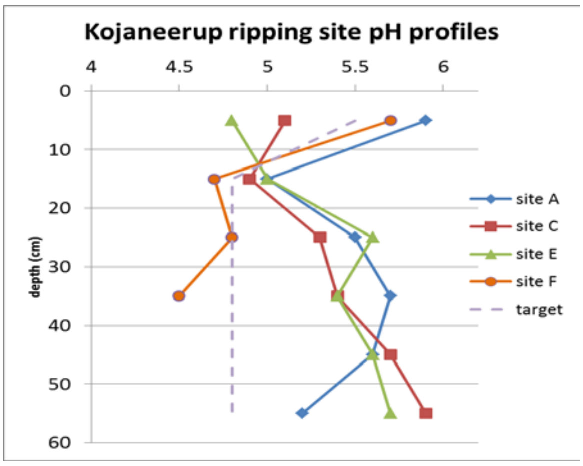
Muradup – a replicated trial of 4 treatments was established with the DAFWA experimental ripper working to 35 and 55cm. Plots were 400m long and 12m wide matching machinery passes in a Controlled Traffic system. Additional treatments of shallower cultivation and 60cm Heliripping were placed each side of the replicated experiment. The paddock was sown to barley with yields from a yield monitor calibrated with a weigh trailer.

Results and Discussion

Kojaneerup

The Kojaneerup site is clayed deep sand. 10-15cm of grey, clayed sand overlies fine white and pale yellow sand, below this soft iron nodules and gravel occur over clay at 50 to 120cm depth. The site is very compacted with average soil strength up to 3.5 MPa between 30 and 70cm depth. Soil pH is above target levels at most sites tested.





Figures 1a and 1b: Average soil strength profiles measured in July 2016 and pH profiles measured in April 2015.

Grain yield was increased with 2016 deep ripping to 75cm by 0.5 to 1.1t/ha, 0.7 t/ha over the full length of plots. Yields improved a further 0.2 to 0.7 t/ha with ripping to 120cm, 0.4 t/ha over the full length of plots. While there was a yield increase on all yield zones and over the whole paddock length, the largest increase was on the poorest zone associated with sand over 1.0m depth, increasing yield above no ripping in all zones. There was an insignificant residual yield benefit in 2016 from 2014 ripping to 35cm. In 2014 there was up to 0.3 t/ha barley yield increase from this shallow ripping.

Table 1: 2016 calibrated barley yields from yield zones and whole paddock plot length (650m).

three of four reps.	centre good zone	east medium zone	west poor zone	paddock length
nil	6.33	5.68	5.44	5.90
2014 rip 35cm	6.48	5.75	5.55	5.97
2016 rip 75 cm	7.06	6.19	6.58	6.61
2016 Dozer 1.2m	7.26	6.78	7.16	7.03
F prob	0.099	0.17	0.04	0.08
lsd 5%	0.831	0.927	1.176	0.857
lsd 10%	0.66	0.736	0.934	0.68

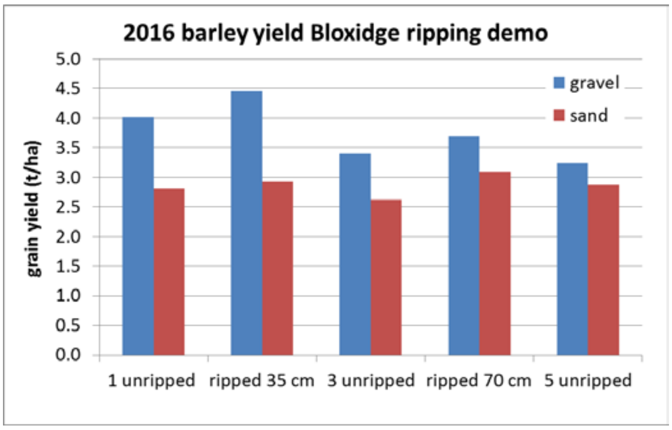
Bloxidge-Road

The site covers two soil types. At the east end, 10-15cm of grey clayed sand is over white sand with soft iron nodules and light gravel over clay at 80-100cm depth. The very soft soil from recent ripping caused wheel ruts and deep seed placement. Penetrometer measurements (Figure 2) clearly show softer soil to depth in the 70cm rip plots but no difference between 35cm ripping and no ripping. Crop growth was visibly better on the ripped plots, particularly the deeper ripped sand later in the season. A soil pit across deeper ripped and unripped sand plots in September showed root growth past 80cm in the 1m spaced deeper ripping tine lines. There was no root growth at this depth between the deep tines or in the unripped plot.

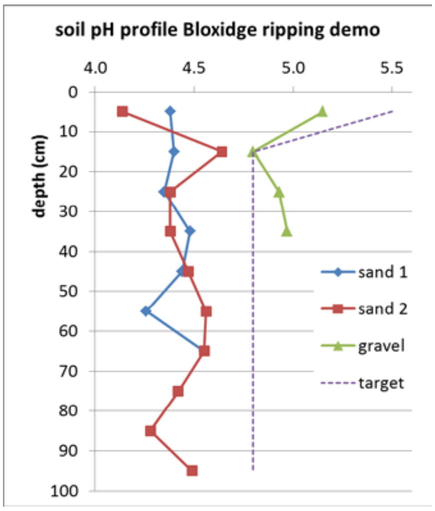
The largest yield increase was from 35cm ripping on the gravel area. This is an unexpected result and emphasises the need for replication to verify observations. While we have observed 0.2 to 0.3 t/ha yield increases from 35cm ripping, deeper ripping on such compacted sand sites often gives larger increases than the 0.34t/ha measured in this demonstration. Harvest results indicate a moderate response to both ripping depths on both soils.

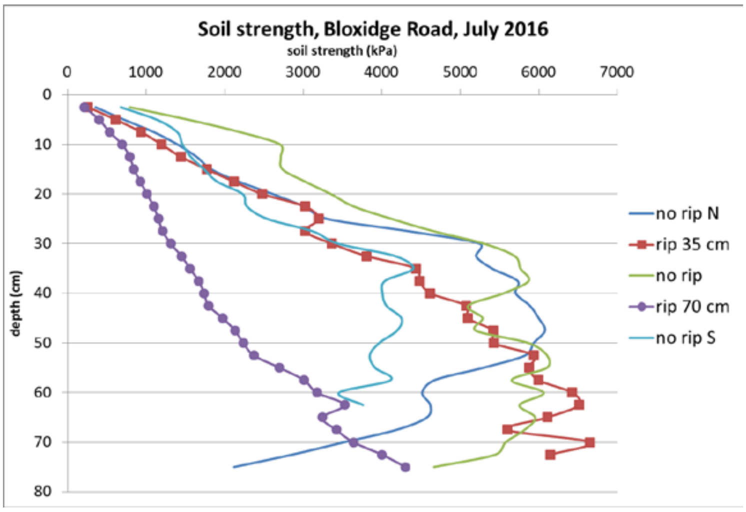
Table 2 and Figure 2: Barley grain yield from ripped and unripped plots on clayed deep sand and sandy gravel over laterite on Bloxidge Road, South Stirling.

treatment	yield t/ha	approx. benefit
gravel		
1 unripped	4.02	
ripped 35 cm	4.46	0.75
3 unripped	3.40	
ripped 70 cm	3.69	0.37
5 unripped	3.24	
sand		
1 unripped	2.80	
ripped 35 cm	2.93	0.22
3 unripped	2.63	
ripped 70 cm	3.09	0.34
5 unripped	2.87	



A likely reason for the moderate result on deep sand is that the acid soil profile to depth prevented effective root function. Ripping with the same machine at Kojaneerup (20 km NE) produced 0.5 to 1.1 t/ha grain yield responses in 2016. May to October rainfall of 350mm indicates a cereal yield potential of about 4.7t/ha, the highest plot yield approaches this with 4.46t/ha.





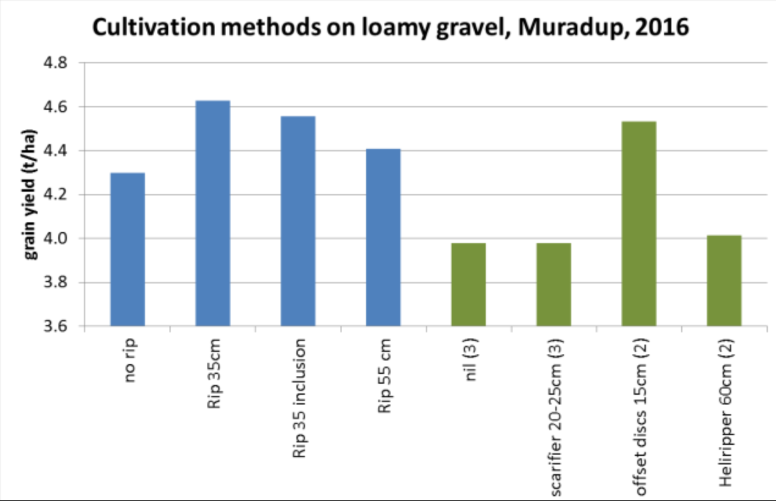
Figures 2a and 2b: Soil pH on two soils and penetrometer resistance profiles on the clayed deep sand section at South Stirling.

Muradup

The soil at this site is mainly a gravelly-loamy sand over clay at 35 cm. pH is not a limiting factor above 5.0 in the surface and 4.8 below 10cm. There was a yield gradient across the site with frost reducing yield on the extra downslope plots. The three replicates of central ripping plots were less influenced by the yield gradient giving greater confidence in the results. Ripping to 35cm increased yield about 0.26 t/ha. Soil inclusion with 35cm ripping had no additional effect on grain yield. Deeper ripping to 55cm did not increase yield significantly compared to no ripping.

Table 3 and Figure 3: Grain yield from cultivation and ripping treatments, Muradup loamy gravel, 2016.

Ripping trial	grain t/ha
no rip	4.30
Rip 35cm	**4.63**
Rip 35 inclusion	**4.56**
Rip 55 cm	4.41
F prob	0.028
lsd 5%	0.204
lsd 10%	0.162
cultivation treatments (no. of plots)	
nil (3)	3.98
scarifier 20-25cm (3)	3.98
offset discs 15cm (2)	4.53
Helipper 60cm (2)	4.01



Blue bars are replicated trial treatments, green bars are additional plots each side of the initial site (numbers indicate the number of plots averaged for each treatment).

The cultivation treatments added to the site indicated no benefit from 25cm scarifying or Helipper at 60cm. Offset discs at 15cm indicated a yield increase up to 0.5 t/ha however site variation reduces confidence of these results.

Conclusion

Ripping below a compacted layer effectively overcomes subsoil compaction on responsive soils. Other soil constraints may limit responses. In this set of three trials, subsoil acidity is likely to have limited response on one compacted deep sand site. Soils with high gravel content are unlikely to be compacted at depth. Longevity of ripping and seasonal variation of response are still being determined in southern areas but controlled traffic will ensure responses last as long as possible. Ripping costs vary by machine and soil type. Returns from ripping will depend on longevity of the response. A 0.5 t/ha cereal yield response with grain worth $200/t will cover costs in the first year.

Acknowledgments

Many thanks to the Curwen, Goad and Zacher families for conducting all operations for these investigations. Thanks to Paul Wells of Class Harvest Centre Katanning for the use of a Helipper at two sites.

GRDC Project Number

These trials were conducted as part of GRDC projects Subsoils Constraints DAW 242 and Building Regional Agronomy Capacity DAW 256 in partnership with DAFWA.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Pasture Trials Report

MLA Funded project: SCF – Optimal pasture phases for livestock in crop based rotations

John Blake, SCF

Key Messages

- The MLA trials demonstrated that early summer seeding (January) of Serradella pod was a viable option. The summer sowing of Serradella pod has outperformed the twin sowing methods in the two trials conducted by SCF growers
- The current district practice of dry seeding pasture seed in Autumn on sandplain soils has severe limitations compared to summer pod sowing or seeding when soil is moist after full seasonal break. This was confirmed in the 2014 season in the MLA trial where the second time of sowing (into moist soil) outperformed the first time of sowing in total legume biomass production and this advantage has carried right through to seed set in Year 3 (in M1 trial Santorini and Margurita plots).
- The performance of a precision seeder for sowing Serradella in a 2015 trial demonstrated that modifications of conventional seeding systems could improve plant establishment efficiency by more that 35%.
- The hard seeded Serradellas are performing well in specific treatments in the MLA trials even on the lower fertility, acidic and non-wetting sandplain soils. Mixed maturity Serradellas like cv Margurita lose significant pod set with spraytopping ryegrass compared to Cadiz or Santorini.

Trial Results for 3 year project:

Site 1: MLA Trial: Optimal Pasture phases for Crop based rotations:

Trial Site M1: John, Dorothy and Ashton Hood's property

This first trial site involved Pasture trial first year then Canola year 2 and Cereal year 3

2014: The purpose of Trial Site 1 (M1) was to evaluate species and pasture phase systems (including hard seeded annuals) for light sand-plain soils (with low pH and low available soil water) in crop-based rotations. M1 Trial results**:** Refer to previous reports. High producing Second time of sowing in 2014 carried throughto 2016.

2015 the net benefit of the 2014 legume phases (versus non-legume phases) to the Canola crop was monitored and measured with plot sampling of control plots and 2014 2nd TOS Serradella plots. A yield response of 0.23t/Ha was measured in the plots with highest legume biomass.

2016: A Pasture strip within the crop paddock has been used to monitor year 3 regeneration. In 2016 the regeneration of pasture from the 2014 seed set was assessed. Again the best regeneration was following the second Time Of Sowing Serradella with highest pod set in 2014. The unclayed section was used to assess pasture species tolerance to spray treatments and weed control in IWM.

Note: The contrast between 2013, 2015, 2016 and now 2017 (moist soils when April sowing) with 2014 (April dry sowing) has been very significant and demonstrates best methods will be seasonal dependent

	
Figure 1: YEAR 3: Spraytopping lowered seed set in Margurita but less in Santorini	*Ashton Hood: co-initiator of MLA project*

Site 2: MLA Trial: Optimal Pasture phases for Crop based rotations:

2014/ 2015 Trial Site M2: John, Dorothy and Ashton Hood's property

Will twin sowing in the previous crop year or summer sowing of pod in pasture year achieve a better early feed source, while still fitting within the management system?

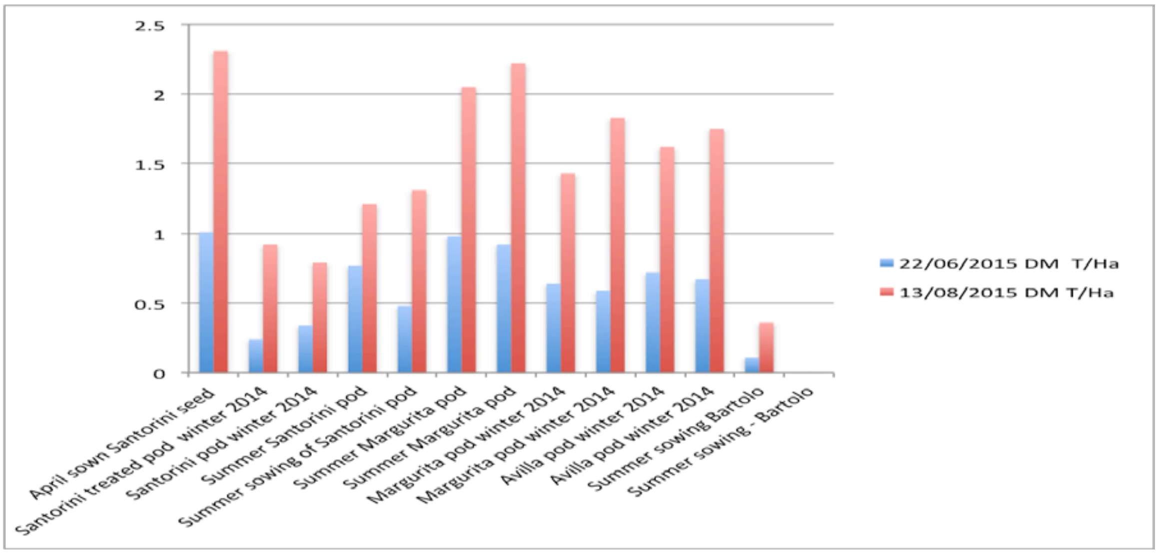
Figure 2:
John Hood at his M2 trial site 2015

1. Twin sowing (application by sowing or spreading of seed pod in previous crop) June 2014,
2. . Summer application of Serradella pods, January 2015 and

3. Sowing de-hulled seed in April 2015.

It appears there is varying hard-seed levels with Margurita Serradella and in the 2014 and 2015 trials M1, M2, M4 and M3 all having good regeneration of Margurita. *Note: during the exceptionally wet summer.*

Santorini and Avilla have had low levels of regeneration by comparison after the December and January rain events and did not regenerate well even after the March rainfall events.



M2a trial - John and Ashton Hood				
Treatment	Treatment #	Date applied	Plant counts 27 May 2015 (plt/m2)	Plant counts 29 Jan 2016 (plt/m2)
Control	0		0	0
April sowing of Serradella – Santorini seed	7	11 April 2015	76	11
Santorini treated pod broadcast in crop 2014	3	9 July 2014	20	5
Summer sowing of Santorini (treated) in pod	6	17 Jan 2015	38	8
Summer sowing of Margurita serradella pod	5	17 Jan 2015	86	41***
Margurita pod broadcast in crop winter 2014	1	9 July 2014	48	12
Avila pod broadcast in crop winter 2014	2	9 July 2014	51	5
Summer sowing of Bladder clover	4	17 Jan 2015	3	0

M3: SCF/MLA Trial: Optimal pasture phases for crop based rotations: 2015 preliminary test: precision planting of Serradella

Site 3: Peter and John Diprose – owners of precision planter and host for test site.

This preliminary test site has been implemented following SCF interest in the outstanding performance on sowing small seed (in 2014 – Canola) into non wetting soils in an adverse growing season start (2014 with < Decile 1 dry start) using a precision planter. SCF intends to contract a slot seeder and a conventional tyne seeder to sow alongside the precision seeder in a dry April start (not 2015 or 2016 season thankfully). The crop sequence was 2014 Saia Oats, 2015 Sown Serradella pasture, 2016 planned Canola but because of outstanding Serradella performance in year 2 it was retained as a pasture paddock.

Fig 3: Site M3 – ***Precision sowing of Serradella on non-wetting soils***
– sown 19 April 2015 and re-established in 2016 (normally a crop phase)

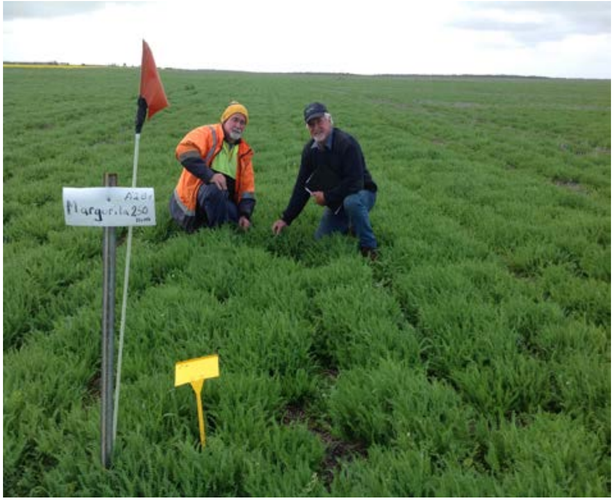


Figure 4: Site M3 – Precision planting of Serradella at 250mm row spacing (plot 1) on non-wetting soils – 11 August 2015 Peter Diprose & John Blake.

Figure 5: John Blake presenting to Bus 2 group at 2015 SCF Spring Field day 17 September 2015.

Soil Type: Stirlings Sandplain: Medium level water repellence.
Crop: Serradella (cv Margurita and Santorini)

1. Establishment rates of 70% were exceptional.
2. The 250mm row spacing is the maximum spacing of plant rows as at 500mmm row spacing, full canopy closure was not achieved until early September.
3. At commencement of podding the pasture dry weights in treatment 1 were 5.3 t/Ha however a very dry spring has caused severe moisture stress in the highest biomass plots in 2015
4. With 2016 wet summer and autumn the Margurita produced cohorts of Serradella plants with each rain event resulting in sufficient plant numbers for 2016 pasture phase.

Pasture trial - precision planting of Serradella cultivars

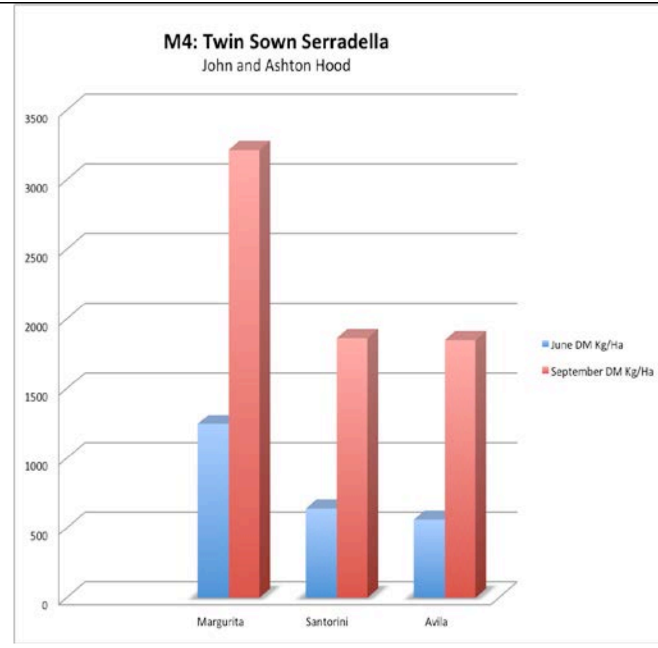
Treatment	Sowing Rate	Target seed density	Averag e plants no's at 8 WAS	Establis hment of germina ble seed	DRY Matt er by 11 Aug	DM on 8 Sept	DM on 8 Oct	Date of full Canopy Cover	Pod Dry weight 11 Dec 2015
Treatment 1 Margurita Serradella	250 mm row spacing: 6 Kg/Ha	200 seeds per sq. m	142	62.2%	2.22 t/Ha	3.46 t/Ha	5.34 t/Ha	Early August	0.27 t/Ha
Treatment 2 Margurita Serradella	500 mm row spacing: 3 Kg/Ha	100 seeds per sq. m	74	71.6%	1.32 t/Ha	2.43 t/Ha	3.85 t/Ha	Early Septe mber	0.39 t/Ha
Treatment 3 Santorini Serradella	500 mm row spacing 3 Kg/Ha	100 seeds per sq. m	73	70.7%	1.41 t/Ha	2.67 t/ha	4.11 t/ha	Late August	0.48 t/Ha

Establishment rates were relatively high (a 50% improvement on that recorded in Serradella establishment rates using conventional seeders). The canopy closure with more narrow rows was more than a month earlier assisting weed control. With poor finishing rains the pasture trials still produced good dry matter yields however pod yields were depressed. Budworm spraying with alpha Cypermethrin was less effective on the larger budworm and penetration into the heavy canopy was not optimal requiring respray. Santorini set more pod as earlier in maturity and less affected by high spring temperatures, less affected by budworm escapes and by the very dry finish in 2015.
The new Serradella pasture (2015) paddock was to be cropped in 2016 but with summer rains the Margurita serradella had cohorts emerging after each rain and grower decided to stock paddock.

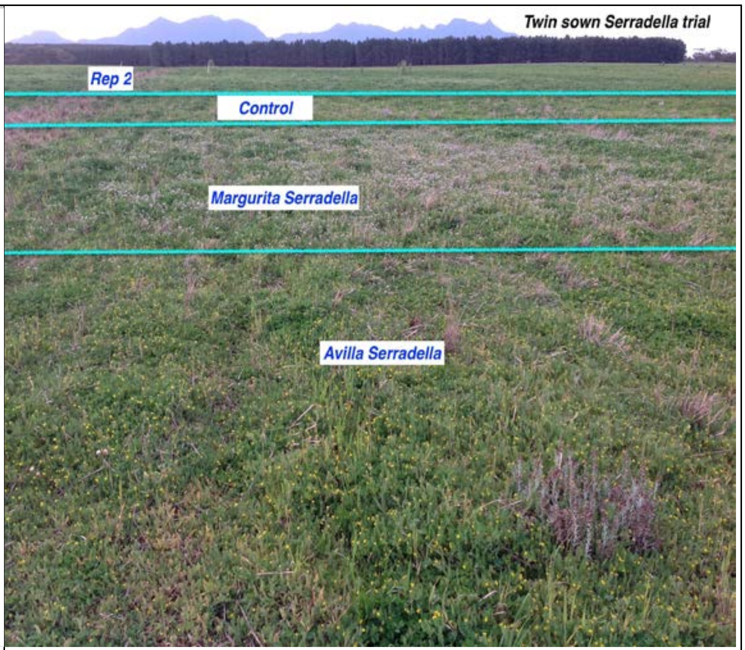
M4: MLA Trial: Evaluating twin sowing of pasture phases for Crop based rotations: 2015 Application of Serradella pod in front of seeding a cereal crop in 2015: Site M4: John and Ashton Hood

	M4 trial - John and Ashton Hood- Pod applied 21 May with barley sown 21 May 2015 - for pasture establishment 2016	*10m in from fence*		Legume Plant counts 5 April 2016
PLOT #	Treatment	Treatment	Pod rate	
1	Margurita pod applied in cereal crop 2015	1	38 kg/ha	39
2	Control	0	0	
3	Santorini pod applied in cereal crop 2015	*2*	38 Kg/ha	6
4	Avila pod applied in cereal crop 2015	3	38 Kg/ha	22
5	Margurita pod applied in cereal crop 2015	1	38 kg/ha	48
6	Avila pod applied in cereal crop 2015	3	38 Kg/ha	19
7	Control	0	0	
8	Santorini pod applied in cereal crop 2015	2	38 Kg/ha	9

With the summer rains cohorts began germinating from January onwards with staggered emergence. Margurita has performed the best in the twin sowing method although plant numbers overall have been lower than with summer sowing of pod method in the M5 trial (see below chart and M5 results below). For statistical analysis see website.



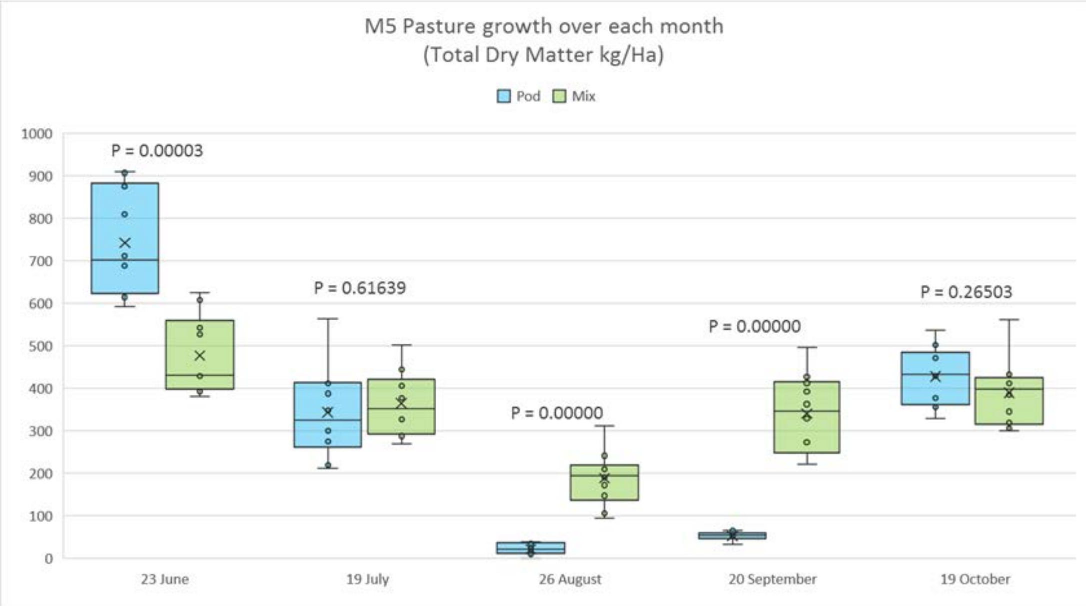
M4:Twin sown 2015 Serradella, 2016 DM production



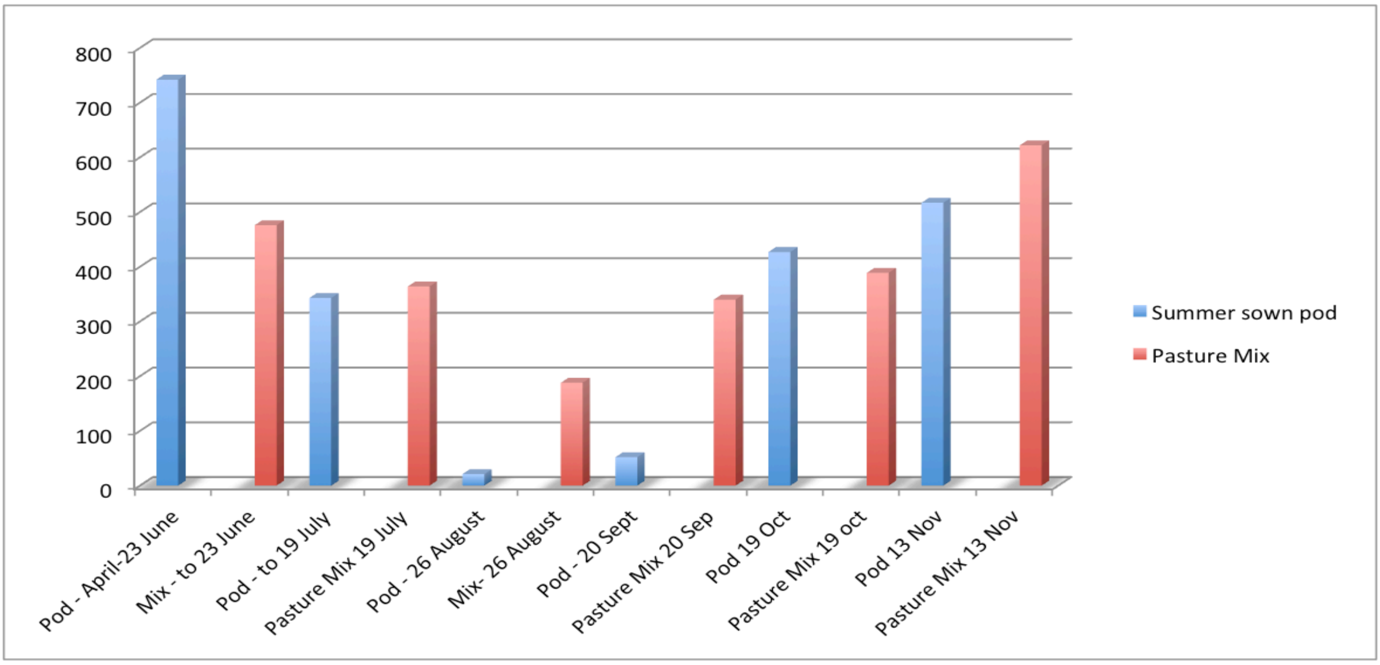
M4: Grazed and sprayed twin sown Serradella Photo 21 Sept 2016

M5: MLA Trial: Evaluating summer sowing of pasture phases for Crop based rotations:
2015 Sowing of Serradella pod in February 2016 versus direct seeding of bare seed pasture mixes:
Site M5: Mal and Marie Thomson

Pasture Growth from Summer sown Serradella pod ("Pod") vs Pasture mix with Saia Oats ("Mix").



Excellent Autumn growing condition s	June Waterloggin g	July Severe waterloggin g	August Severe waterloggin g	September Still waterloggin g	October improved condition s	Novembe r Serradella still growing



NOTE: With decile 10 rain-fall in total of summer, autumn and winter (5 Dec 2015 to 5 October 2016) the whole paddock including the trial site was affected by more severe waterlogging (perched water-tables) than experienced in last two decades.

Pasture mixes more productive than single species. Pasture mix (Saia Oats, Cadiz Serradella plus Monti Clover) sown 14 April 2016. Mal Thomson's trial had good establishment despite stubble fire but later waterlogging showing advantage of using pasture mixes (Mal's mix was Saia Oats, Cadiz Serradella plus Monti sub clover) with pasture mix plots out producing summer pod sown Serradella, which went into zero growth as plants died due to waterlogging.

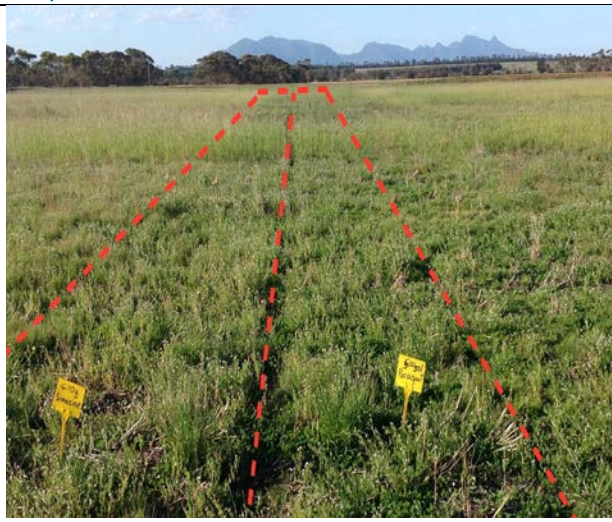
Mal's Pasture Mix
Mal's mix is Cadiz Serradella at 5 Kg/Ha, Saia Oats at 15 Kg/Ha and Monti sub Clover 5Kg/Ha.
Paddock stocking rate:
Mal's paddock has carried just over 10 dse/Ha for three months despite waterlogging.
SPRAY cross treatments applied 9 Aug 2016

The Dilemma: Pasture mixes can be more productive across paddocks but weed control (especially grasses if over-sowing with a cereal) more difficult.

Figure: M5 Mal Thomson sowing Margurita serradella pod summer Trial: February 2016 (note: sprayed out self sown barley)

Figure: M5 trial site on 5 April 2016 showing emergence from Summer sown (Feb 2016) Margurita pod at 38 Kg of pod/Ha. Partly burnt in April in stubble fire on 10 April. Photo 5 April 2016.

M5: Mal Thomson trial: Margurita Pod summer sown plot (RHS plot) vs Pasture mix with Saia oats (LHS plot). First replicate of treatments. Photo: 8 November 2016



M5: Margurita summer pod sown plot with cross treatments of herbicide sprays. Raptor showed best results Photo 19 October 2016

IWM Post emergent herbicide / Foliar fertiliser treatments across M4 trial

1. 500ml/Ha MCPA - Serradella 30-40% biomass reduction less than expected, no activity on toad rush
2. 500g of Simazine – very good activity on toad rush. Knocked Serradella biomass by about 30%
3. 500ml/Ha of Paraquat: Ok on toad-rush, ok on Serradella 20-30% biomass reduction
4. 1L /Ha of Paraquat: Good weed control but severe on Serradella: 80% biomass reduction
5. 50g Raptor: Very soft on Serradella. 40% reduction in toad-rush biomass& good brome-grass control.
6. 35g of Raptor& 700 ml Bromoxynil/Ha: Same weed control as Raptor, 15% Serradella reduction.
7. 1.5 bromoxynil: No activity on toad rush, 20% less biomass than Raptor and Bromoxynil.
8. 80 Litres /Ha Flexi N – no improvement on Serradella – main response from Toad rush and in Saia Oat: pasture mix plots!

M6: MLA Trial: Evaluating sowing of pasture species for waterlogged and marginal salinity: 2016 Pasture species 10 June 2016 (supplier delay) Messina versus Balansa: Site 6: Trial Host: Iain Mackie

M6: Messina (rear plot showing exceptional growth given delayed sowing) vs Balansa (front plot) on waterlogged and marginal salinity. Trial Host: Iain Mackie. Photo: 9 November 2016

M6: A real test for Messina vs Balansa: (seed had to be top-dressed on waterlogged site due to late arrival of seed on 10 June 2016) – this photo 6 weeks after sowing at end of July – ongoing water inundation and marginal salinity – site selection assured that test sowings would get a high challenge.

Dry Matter Yields 10 November 2016 (Note: plots not planted until June 10)

Legume Pasture for waterlogged& marginal salinity areas	Average dry matter yield (somewhat variable across plots) Kg/Ha	Pod yields Kg/Ha
Messina – Melitotus -legume	4285	394
Balansa – Clover - legume	3120	276

Recommendations

- Summer sowing of Serradella pod and twin sowing needed further testing as the SCF region has highly variable summers sometimes largely hot and dry but sometimes wet and mild. This is in contrast to the rest of Southern WA were hot dry summers are the norm.
- Most success in the trials has come from the summer sowing of Serradella pod (Margurita).
- Weed control in the pasture phase remains a significant issue (especially in a season where non-wetting causes staggered germinations for both the pasture species and the weeds. Herbicide resistance testing (HRT) is an essential part of testing new rotational systems. We need to monitor changes in HR status as an overall impact of system changes such as introducing a pasture phase in a cropping rotation. Ongoing HRT is being undertaken. Trials involving IWM were implemented across the broad-scale MLA pasture trials.
- Treatments involving +/- soil wetters or new seed coatings were planned trial treatments but due to the early breaks and high summer rainfall wetters not applied in 2015 or 2016.
- An initial claying treatment done in 2015 and a further trial with claying treatment applied in 2016 for M1.
- A trial hosted by Scott Smith with +/- clay treatments is being monitored for Serradella regeneration. In previous years the site was used by CSBP but no pasture data was gathered during the pasture phase in 2014. The 2018 season will be an opportunity.
- The M2 establishment methods trials and M3 and M4 are being measured for regeneration performance. The apparent flexibility of Margurita to wet or dry summers could be a significant

factor with our variable summers but test results indicate Santorini maturity is best for spraytopping .ryegrass.

- M5 (Summer sowing pods vs autumn sowing bare seed systems) and M6 (Messina vs Balansa on marginally saline and waterlogged areas) were recommended at the review and are in progress in 2016/17. Messina only arrived for sowing on 10 June (and was sown on 10 June) but has proved a very viable option for the marginally saline and waterlogged areas.

Acknowledgements

MLA for the three year funding of this project. John and Ashton Hood for hosting trials (M1, M2 & M4), providing guidance and equipment, hosting field Days and doing joint presentations at the State MLA workshops each year. Peter and John Diprose for hosting trials (M3) and providing access to their specialist Precision planter. Mal Thomson for hosting trial (M5) in 2016 and hosting part of the 2016 Spring Field Day. Iain Mackie for hosting the Messina trial (M6) on his Forest Hill property.

Dual Purpose Canola Demonstration

John Blake, SCF

This demonstration was set-up at the Hood's property at South Stirling's to investigate the potential of dual purpose crops, namely winter type canola variety **Hyola 970 CL**.

The trial (10ha) was sown on the 28th of October with 3.5 kg/ha of seed and 100 kg/ha of K-till Plus. Emergence was quite variable, ranging from 0-44 plants per square metre, averaging around 25 plants per square meter.

Sowing canola in summer was going to provide some challenges, namely insects and weeds. Although there was a bit of damage from insects we took the attitude of 'if it wasn't going to kill the canola then we would hold off spraying as we would be grazing biomass anyway. As for summer weeds, there are basically no options to control broadleaf summer weeds.

Grazing of the canola took place in the first 2 weeks of February, with 287 lambs being weighed onto the crop at an average of 40.4 kg. They grazed the crop for 2 weeks and weighed an average of 42.7kg.

Further grazing will be determined by seasonal conditions and plant growth. As the season progresses it will be interesting to see how growing a variety like this affects weed, disease and insect control.

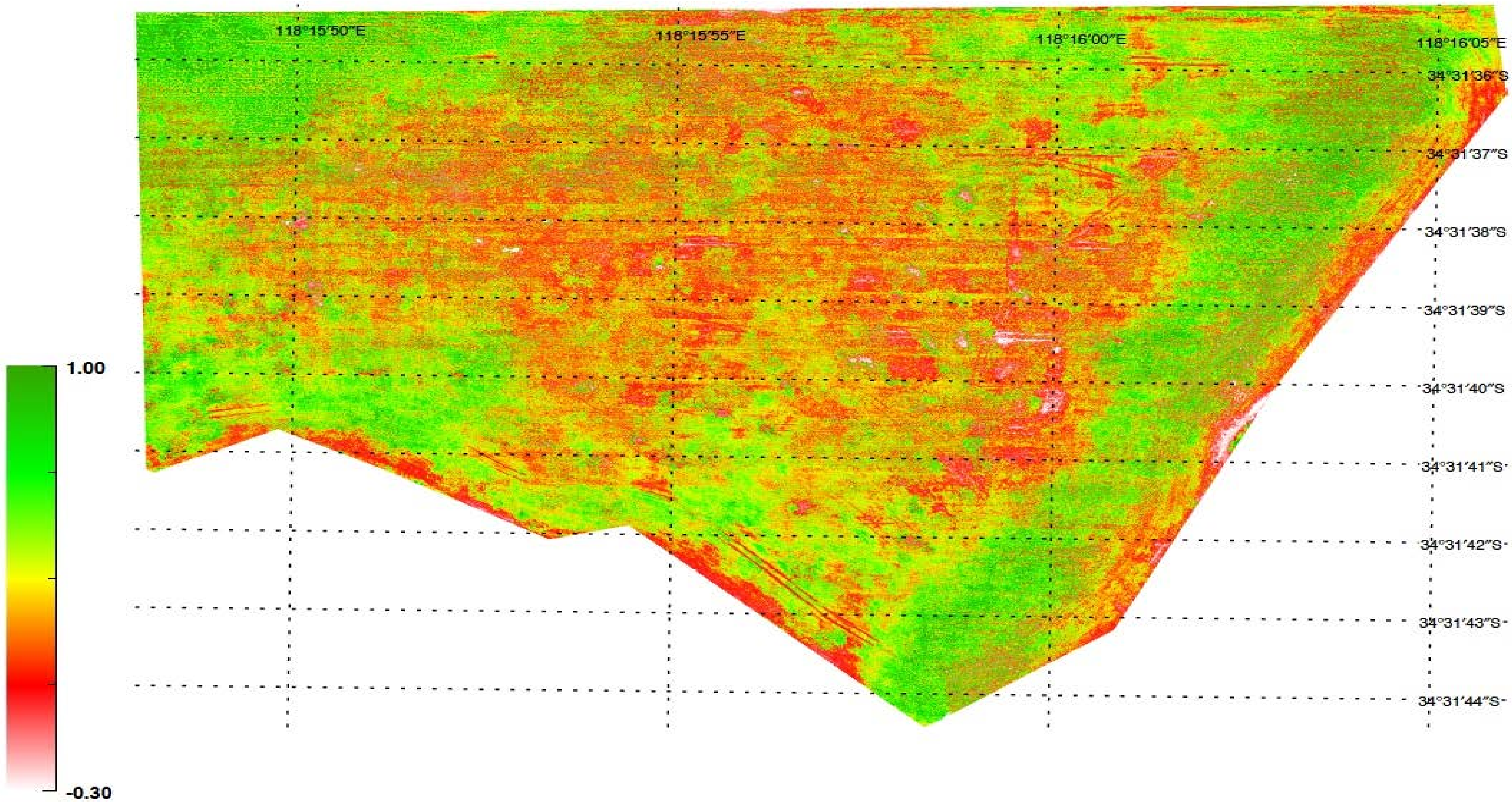


Figure 1: Drone image, taken on the 8th March 2017, of the summer sown canola demo crop at John and Ashton Hoods property in South Stirlings. The trial was sown on the 28th of October with 3.5kg/ha and 100kg/ha of K-till Plus. Grazing took place in the first two weeks of February, with 287 lambs being weighed onto the crop at an average of 40.4kg. Lambs were weighed off at an average of 42.7kg.

Effective Baiting Options for the Control of Conical Snails in the Albany Port Zone

Kathi McDonald, Stirlings to Coast Farmers, Albany, Western Australia.
Svetlana Micic, Department of Agriculture and Food, Albany, Western Australia.

Key messages

- Small pointed snails are an increasing problem in the Albany and Esperance port zones.
- A grower survey shows that while many farmers engage in a snail baiting program, 60% of these are unsure as to the efficacy of baiting on small pointed conical snail control.
- Caged trials show that all active ingredients in snail baits cause mortality to snails, however the amount of active ingredient has no effect on the rate of mortality, it is the number of bait points that has the most impact on numbers of snails killed.
- There is no difference in the efficacy of a rainfast versus a non-rainfast bait. However, caged trials suggest that non-rainfast baits lose their integrity after 14 days.

Aims

The aim of this project is to work out what are the most important factors affecting bait efficacy on small pointed snails. Is it rainfastness, bait formulation, active in the baits or the rate applied per hectare? Currently, this is confused by various formulations of various sized baits with differing rainfastness and reported palatability.

Introduction

Albany port zone RCSN have identified snails and slugs as an issue for the past 2 years at their RCSN meetings. Small conical snails are a growing issue for growers in the Albany and Esperance port zones. To date, control for snails has centred on baiting during the growing season. Baits will reduce snail populations; however, snails will also feed on decomposing organic matter.

Method

In consultation with the other grower groups in the Albany and Esperance port zones, and CBH and DAFWA, a survey of grower baiting practices was designed and distributed to over 200 growers via the online Survey Monkey program, and 'hard copy' paper versions completed at Spring Field days across the region in September and October 2016. Responses from 'hard copy' surveys were manually entered in to Survey Monkey, and all results analysed utilising the Survey Monkey analysis tool.

A series of three preliminary 'caged' trials were conducted in the shade house at the Albany DAFWA complex. A letter was sent to the range of companies producing registered baits to gain their consent for use of their product in the trials prior to commencing the caged trial comparing brands of baits. Those that responded in the negative had no product included.

Three caged trials were carried out to:

1. determine the optimum rate and density of the three major bait types for small conical snail control;
2. determine if rainfastness affects small conical snail control; and
3. determine the palatability of bait formulations on small conical snail control.

Results and Discussion

Bait practices grower survey

The main points from the bait survey are summarised below.

- Small pointed conical snails are an increasing problem in the Albany and Esperance port zones, with almost half of the survey respondents indicating snail presence on their farms. Almost 60% of those with presence reported a level of infestation that required a baiting program.
- Most growers are only recently becoming aware of the problem, although some have recognised snails as an issue for over five years.
- Canola and barley were the crops reported as most affected by snails (and canola by slugs).
- Snails were found across all soil types on respondent's farms, most commonly occurring on sandplain and duplex soils (these are also the most common soil types across the south coast). Slugs were predominantly recorded on clay and, to a lesser extent, duplex soils.
- Of those respondents that had applied baits in the past five years, most applied baits only once in the year, although 40% did apply baits twice. Most baits were applied in the post-seeding period, but some did also apply pre-seeding (generally those that applied twice a year applied baits pre- and then post-seeding).
- The level of infestation is the greatest consideration for respondents on whether to apply baits.
- Metaldehyde baits were by far the most commonly applied. These are also the most widely available with the largest range.
- Baits are mostly applied at recommended label rates, and are applied via spreader (baits alone). Some application via spreader (with fertiliser) or plane (aerial) was also reported.
- Respondents were mixed in whether they considered baits an effective control for snails, with almost 60% being unsure. Baits were considered an effective control for slugs by most.
- Apart from baiting, burning (of windrows and whole paddock) and good farm hygiene/biosecurity were considered as control measures.

Delivery to CBH of snail contaminated grain does not appear to have been an issue for most respondents, however almost 15% did record that they had some difficulty in the past five years.

Caged bait trials

In the caged trials, baits caused significantly ($p<0.001$) more snails to die than the control (nil baits) (Figures 1 and 2). However, there were no significant differences in how well the baits worked. Baits with the active ingredients metaldehyde, methiocarb and iron all caused similar mortalities to small conical snails (Figure 1).

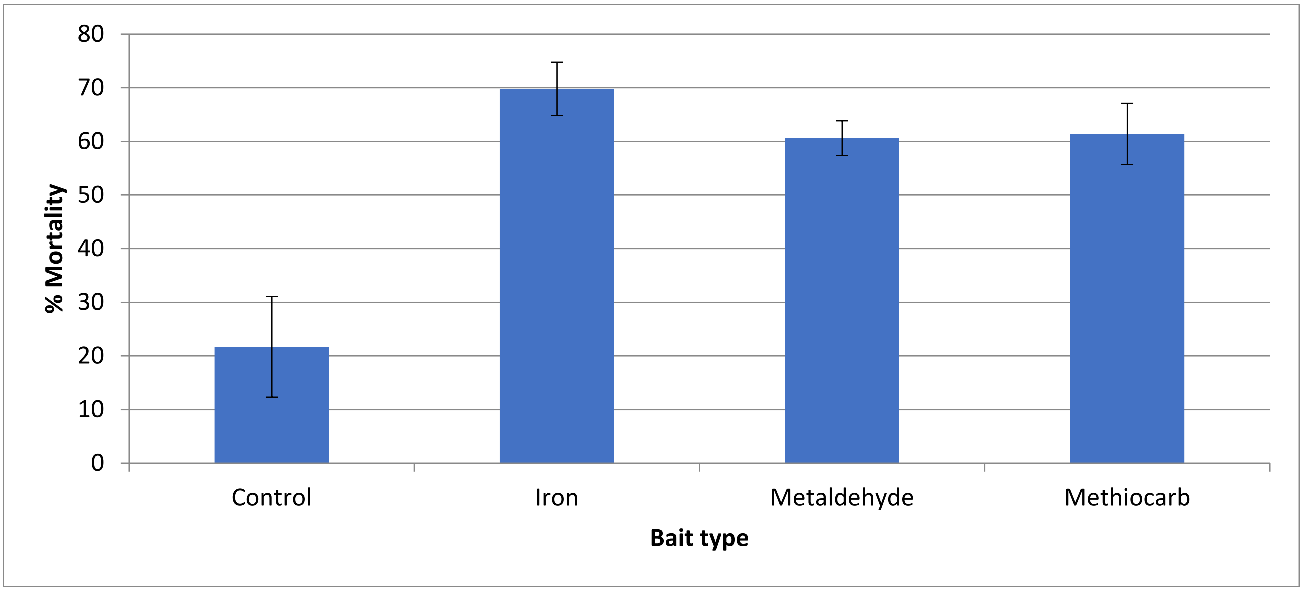


Figure 1: Percentage (%) of dead snails at Day 14 after being exposed to different bait types. Error bars represent the standard error of the mean.

Metaldehyde baits with a higher percentage of active ingredient did not cause more mortality than baits with less active (Figure 2).

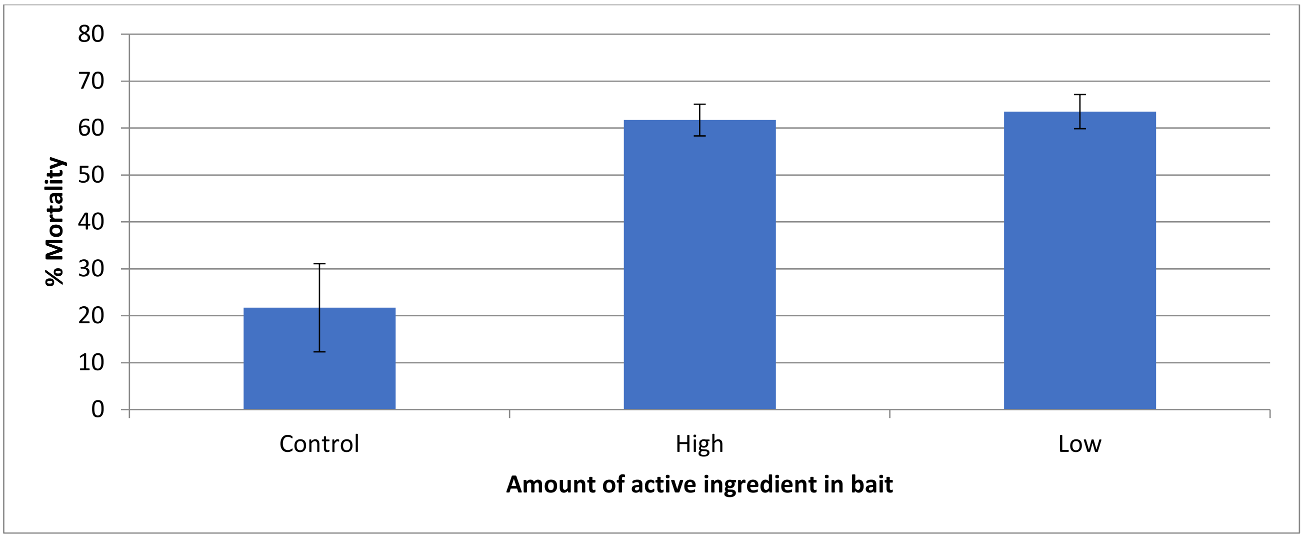


Figure 2: Percentage (%) of dead snails at Day 14 after being exposed to baits with the same active ingredient but varying amounts of active ingredient in each bait. Error bars represent the standard error of the mean.

However, the number of bait points was a significant ($p<0.001$) factor in snail mortality. The more bait points there were, the more snails were killed (Figure 3)

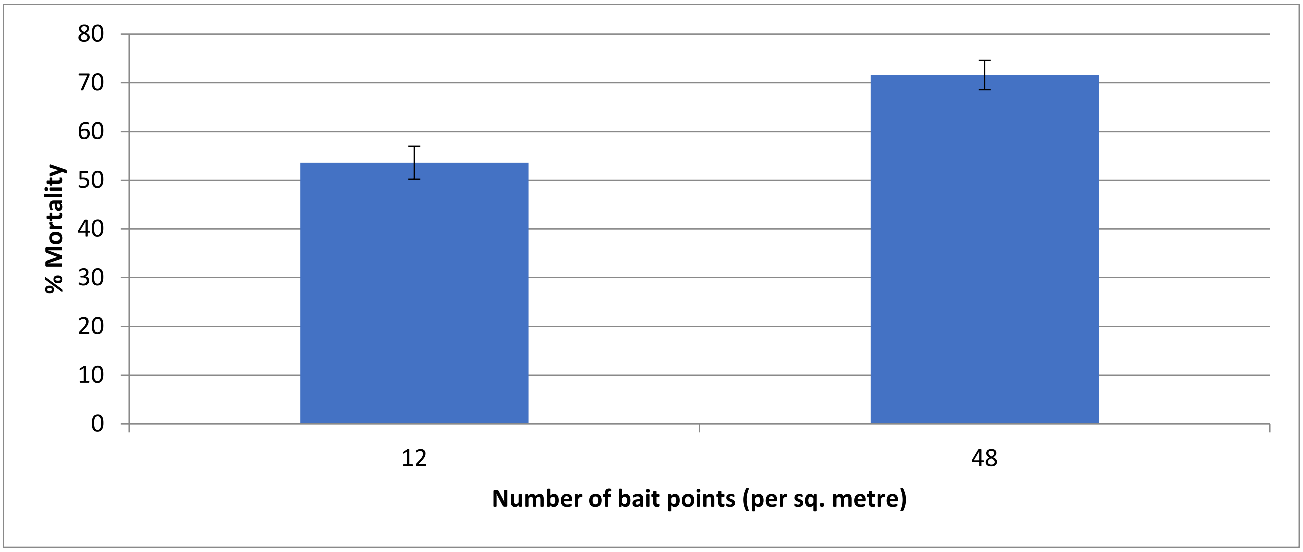


Figure 3: Percentage (%) of dead snails at Day 14 after being exposed to baits with either 12 or 48 bait points per square metre. Error bars represent the standard error of the mean.

Rainfast and non-rainfast baits caused similar mortalities to small conical snails (Figure 4). However, by Day 14, there was a difference in the structures of the baits. Non-rainfast baits had begun to degrade and were no longer shaped as a pellet, whereas rainfast baits still held their integrity as a pellet.

Analysis of photographs taken at Days 7 and 14, showed that over 80% of snails had not moved in baited enclosures, whereas 100% of snails had moved in the control. This indicates that by Day 7 snail death had already occurred in baited treatments.

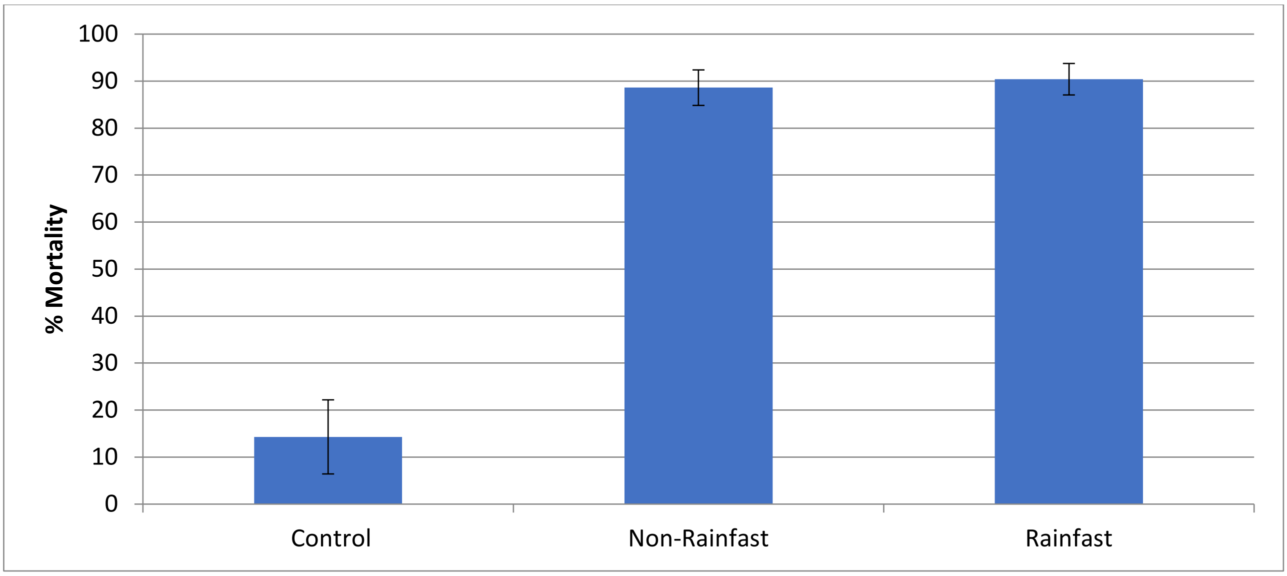


Figure 4: Percentage (%) of mortality in snails at Day 14 after being exposed to rainfast or non-rainfast baits. Error bars represent the standard error of the mean.

Metaldehyde based baits caused similar mortalities to snails as iron based baits. There was no significant difference ($p=0.178$) between these formulations. When all bait types were grouped together, metaldehyde and iron based baits caused similar mortalities in snails and were not significantly different ($p=0.164$).

Bait formulations containing iron caused similar mortalities in snails so were not significantly ($p=0.679$) different. However, different bait types containing metaldehyde were found to be significantly (p=0.038) different in the number of snails killed (Figure 5) when compared to the control. 4Farmers Bait 2 caused the least mortality.

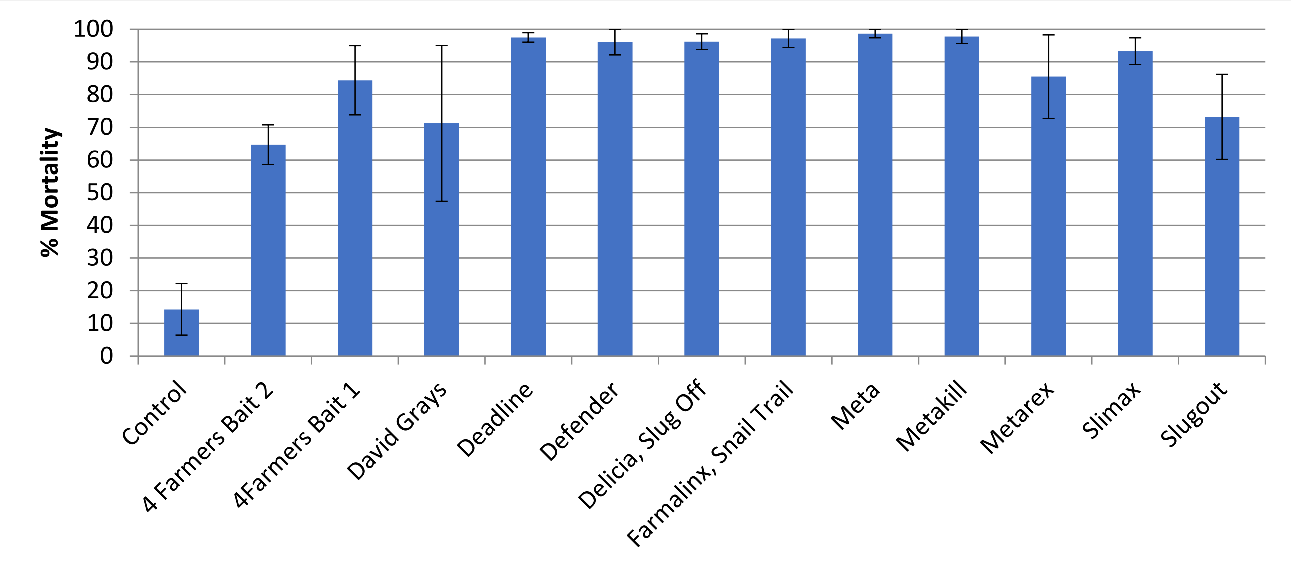


Figure 5: Percentage (%) of mortality in snails at Day 14 after being exposed to different metaldehyde based baits. Error bars represent the standard error of the mean.

The amount of active ingredient in the baits does not explain the differences above as baits with the lowest amount of active ingredient, eg Meta contains 15 gai/kg, caused 98% mortality to snails in this trial.

Conclusion

A survey of growers in the Albany and Esperance port zones was distributed to over 200 growers across the region, with 120 responding. The survey highlighted the increasing impact of small conical snails in the Albany and Esperance port zones, particularly in canola and barley crops. The report also shows that most growers with a snail issue, engage in a baiting program at least once a year, usually applying baits post-seeding with a spreader. There is a high level of uncertainty amongst growers as to the efficacy of baiting programs on small conical snail control.

In caged bait trials, all active ingredients were equal in causing mortality to snails. The amount of active ingredient per bait in these trials did not influence mortality in snails. However, the more bait points there were, the more snails were killed by the baits.

All active ingredients were equal in causing mortality to snails. The rainfastness of a bait, 14 days after application, did not impact on the mortality of snails. However, after 14 days it is highly probable that non-rainfast pellets would lose their integrity and decompose in wet conditions making it less likely that snails would come across it.

Iron based baits and metaldehyde based baits caused similar mortalities in small pointed snails.

There was no difference in the iron based formulations for causing mortalities. There did appear to be differences in metaldehyde based products in causing snail mortalities. Within the metaldehyde range, Deadline, Defender, Delicia, Farmalinx, Meta and Metakill caused over 95% mortality.

The field trials currently being set-up will test the efficacy of the best-bet baiting options in ‘real life’ paddock situations.

Key words

Small conical snails, baits, metaldehyde, methiocarb, iron, survey, baiting practices.

Acknowledgments

The research undertaken as part of this project is made possible by support of the GRDC RCSN and growers.

GRDC Project Number:

PFS74-2015-ALB3 "Effective baiting options for the control of conical snails in the Albany port zone"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The Three Seeder Trial

Andrew Slade, Jarrad Beech and Iain Mackie

All plots sown at same seeding rate – all seeders calibrated
All plots received same units of fertilizer
Sowing date: 20 May 2016

At 12 days after sowing emergence was significantly higher in shallow sowing by Andrew's machine but by day 32 all plots were more uniform and Iain's and Jarrad's plots had largely caught up.
Plant counts were conducted 32 days after sowing.
A large rain event (> 18mm) immediately after sowing favored the shallow sowing.

Seeder	Seeder 1			Seeder 2			Seeder 3 with paired rows		
Grower		Iain MACKIE			Jarrad BEECH			Andrew SLADE	
	Plot 1	Plot 4	Plot 7	Plot 2	Plot 5	Plot 8	Plot 3	Plot 6	Plot 9
Plot Averages	32.25	34.5	35.25	43	35.5	38	41.25	42	43.25
Ave plant count at 32 DAS		136	plants /m^2		152	plants /m^2		176	plants /m^2
Average depth of sowing		24mm			17mm			8mm	
% Emergence 12 days after sowing Obs: 2 June 2016		49%			53%			71%	

Results

Table 1: The raw data from the Three seeder trial conducted on Andrew Slade property west Kendenup in 2016. Trial was seeded on the 20th May.

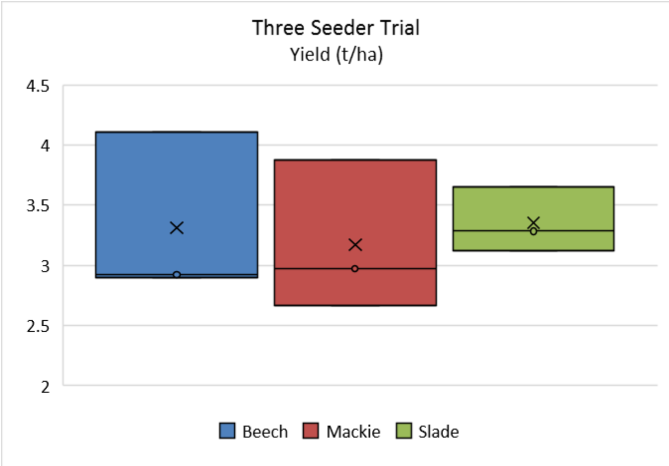
Average	Yield (t/ha)	Protein	Screening	Hectolitre
Beech	3.31	11.07	0.0088	77.78
Mackie	3.17	11.10	0.0091	77.21
Slade	3.35	9.50	0.0108	76.21
95% LSD	ns	1.14	ns	ns

Table 2: Summary of the raw data for the Three seeder trial conducted at Andrew Slade's property west Kendenup 2016. Cells highlighted in yellow indicate plots that had significantly less water logging than the rest of the trial site. The cells highlighted in blue indicate plots that received an extra 50Lt/ha Flexi-N post sowing pre-emergent.

Farmer	Treatment	Plot	Area	Weight (kg)	Yield (kg/ha	Protein
Mackie	1	1	0.779	3020	3876	11.3
Beech	2	2	0.779	3200	4108	10.6
Slade	3	3	0.871	3180	3650	9.9
Mackie	1	4	0.779	2080	2670	11.1
Beech	2	5	0.779	2260	2901	11.4
Slade	3	6	0.871	2860	3284	10.1
Mackie	1	7	0.801	2380	2971	10.9
Beech	2	8	0.779	2280	2926	11.2
Slade	3	9	0.871	2720	3123	8.5

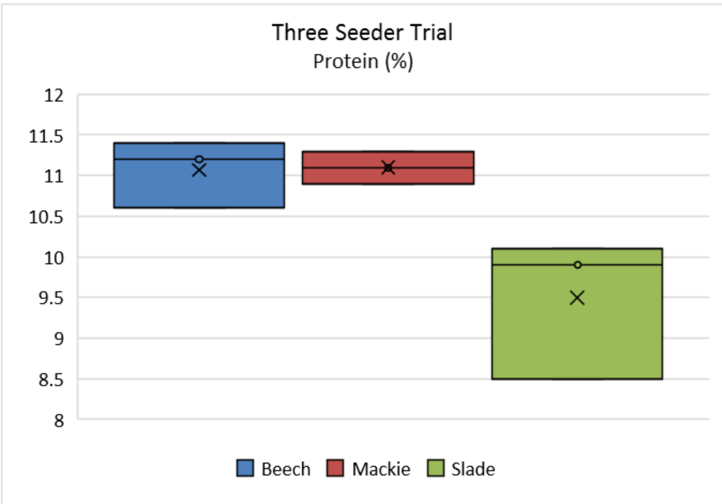
Yield (t/ha)

There is no significant difference between the average Yields (P = 0.92).



Protein

Beech and Mackie had significantly higher Protein than Slade (P = 0.02) (95% LSD = 1.14).



Discussion

Yield

No significant yield differences between seeders were recorded. This result could be misleading according to Andrew Slade. Plots one and two were adjacent to the bush. The plots closer to the bush suffered less water-logging over the season and possibly explains the higher yield's recorded in plots one and two. Removal of the first replicate (plots 1-3) indicates there could be a difference in yields.

Yield mean of replicate two and three (i) Beech 2.913t/ha (ii) Mackie 2.825t/ha (iii) Slade 3.204t/ha. *Note: Statistical analysis not yet completed on replicates two and three.*

Protein

The analysed data indicates that Andrew Slade's seeding system achieved significantly less protein than the other two farmers set-up. However, the extra 50Lt/ha of Flexi-N applied to plots seven (Mackie) and eight (Beech) were not accounted for. Therefore the third replicate should be excluded from the data set to be more accurate. Mean of proteins with replicates one and two only (i) Beech 11.0% (ii) Mackie 11.2% (iii) Slade 10.0%

The raw means indicate there is still a likely difference between Slade's and the other two farmers. This difference is possibly explained by the higher yields achieved by the Slade's seeding system. *Note: Statistical analysis not yet completed on replicates two and three.*

A significant rainfall event (18mm) immediately after sowing would have aided germination across the trial site. This would have reduced any potential differences in the seeding systems given the conditions were close to ideal. Further trials conducted in less than ideal sowing conditions or on non-wetting soil types would more likely see differences in yield or plant counts.

This trial was farmer driven with all of the work completed voluntarily by Jarred Beech, Andrew Slade and Iain Mackie. Stirlings to Coast have more capacity to complete such trials in the future with an expanding research team and more resources.

IF YOU HAVE AN IDEA FOR A TRIAL, PLEASE TALK TO NATHAN AND JOHN ABOUT IT.

SCF/SCNRM Lime Efficiency Trial
Greg Mengler, Tenterden

John Blake, SCF

Key Messages

- Significant lime response in third year after application
- Sub soil acidity can be addressed with lime incorporation but may not be most cost-effective treatment – requires further seasons of testing

Introduction

This trial is one of two trials in the SCNRM Lime Efficiency project. It has funding support from South Coast NRM in the Soil Health program. The site has sub soil acidity and soil tests by DAFWA, SCF/CSBP (John Blake) and Precision Soil Tech (Wes Lefroy) have confirmed that trial is relatively uniform in sub soil acidity.

Purpose of Greg's Trial

To determine how best to ameliorate subsoil acidity.
Greg applied lime treatments in March 2014 – additional treatments in 2015.

Trial Results

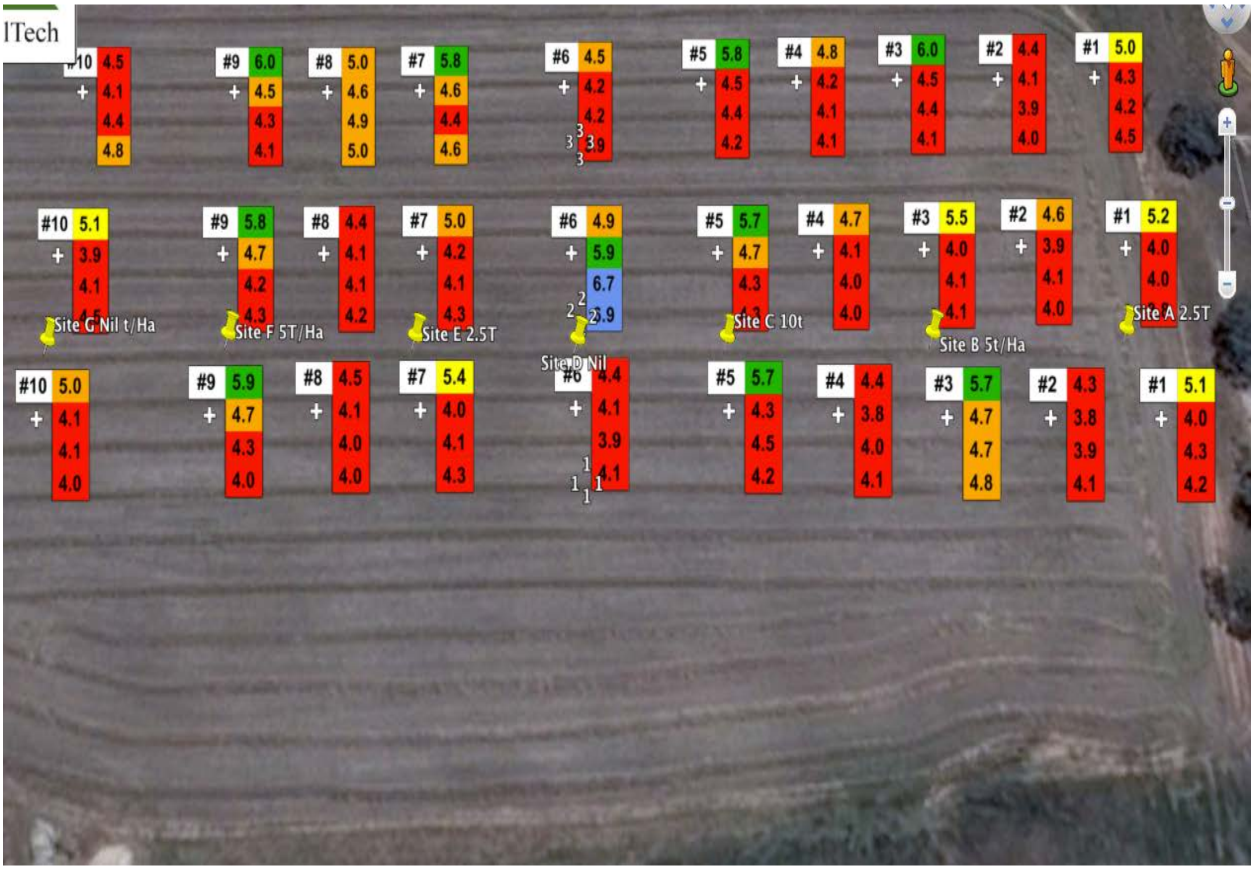


Image 1: Soil Test results – February 2015: Note very low pH in sub-soils

There is need is to get the lime into the subsoil so additional treatments are being tested. Crop responses prior to 2016 had not occurred as lime remains in the topsoil and not in the subsoil where the soil acidity is high. In March 2015 two trial plots received a Mould-board plough treatment after lime application to incorporate lime into the 20-30 cm subsoil layer. During the 2015 season the mould-board treatment had very low canola plant density and yield and this may have boosted plot cereal yield in 2016 and was certainly a cost of treatment.

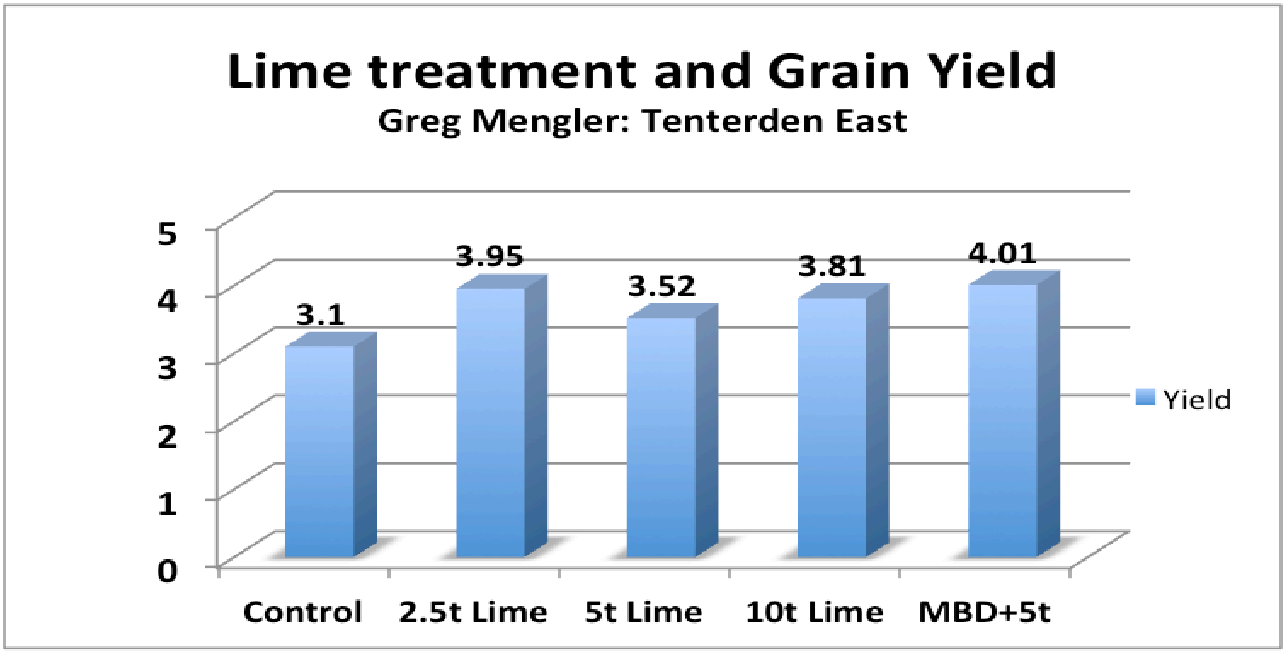


Figure 1: Lime responses in 2016 across topdressing and mould-board treatments.

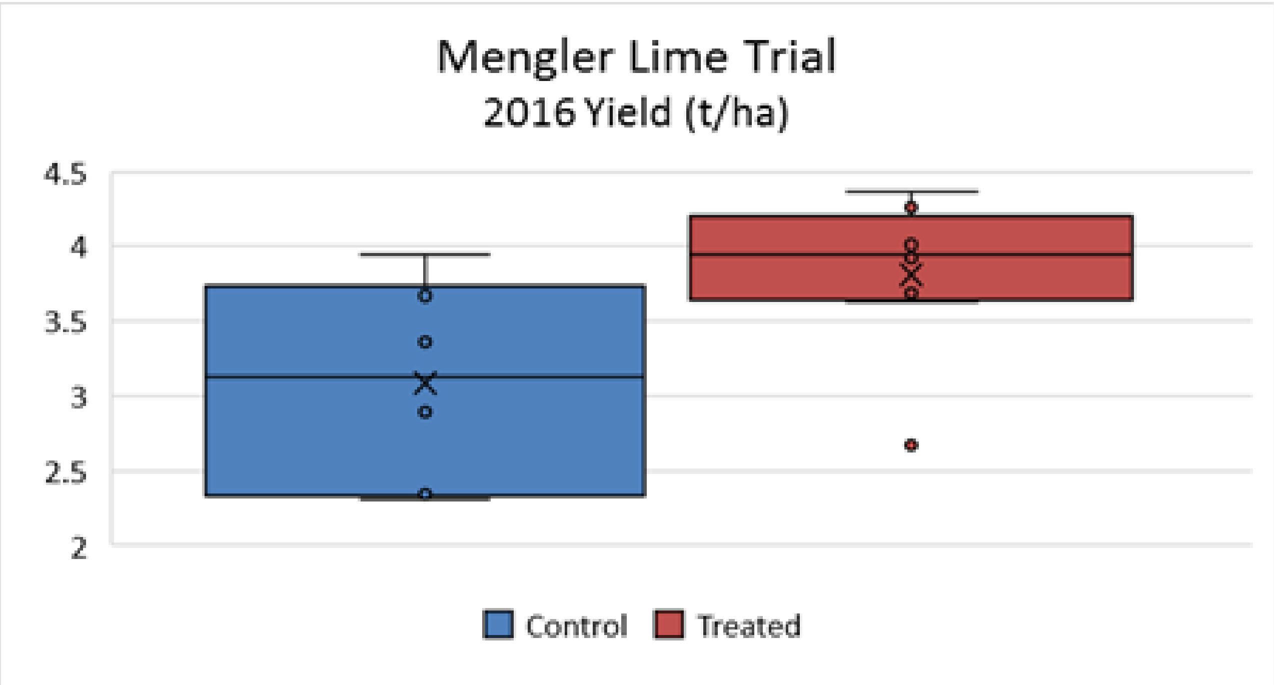


Figure 2: Statistical analysis – significant lime response across all treatments.

Note: The plot yields were measured in 2014 (Wheat) and 2015 (canola). Results showed no significant response to lime treatments. There were negative yield responses to mould-boarding treatments in 2015.

Image 2: UAV image of Greg's Lime trial 13 October 2017 showing biomass responses in lime treated plots

Conclusions

There was a significant lime response in third year after application of lime. In the first two years of the trial there was nil response to lime treatments measured. Lime responses could continue to be seasonally dependent and crop type dependent and the trial will be continued to monitor lime value for each phase of the rotations.

Sub soil acidity can be addressed with lime incorporation but may not be the most cost effective treatment – requires further seasons of testing. Other methods of lime incorporation maybe tested in the lime sources trial at Red Gum Farm (Iain Mackie).

Understanding the Barley Leaf Rust Pathogen Is the Key to its Successful Management

Kithsiri Jayasena[1], Geoff Thomas[2], Robert Park[3] and Laurie Wahlsten[1]
[1,2]DAFWA, [1]Albany, WA 6330, [2]South Perth WA 6151, [3]University of Sydney, Plant breeding Institute, NSW 2567

Key Messages

- Barley leaf rust (LR) was observed on barley regrowth in the lower Great Southern and South Coast of WA in the summer/autumn of 2016. This contributed to the first observations of infected barley crops in the region in July 2016. All barley varieties including those with Adult Plant Resistance (APR) were under severe disease pressure and responded to application of fungicide.
- The high levels of LR in 2016 and the possibility of barley regrowth in autumn 2017 means a significant LR risk for the 2017 season and fungicide programs for APR varieties should be considered.
- LR is a social disease and all growers should be proactive in eliminating the volunteer barley green bridge. To minimise early onset of LR, the regrowth barley should be eliminated at least 4 weeks before seeding.
- Star of Bethlehem (an alternate host) should be sprayed to eliminate the likelihood of new pathotype developing in the region.
- Selecting varieties with adult plant resistance genes will reduce grain yield loss. However, performance of these varieties against LR is influenced by seasonal weather, time of disease onset, crop agronomy, and is hard to predict season to season. Depending on the LR pressure in the crop they may need early foliar fungicide intervention to reduce development of disease on plants during the growing season.
- Oxford possess two partial resistance genes (*Rph20* and *Rph24*), and under high LR pressure application of foliar fungicides increased yield up to 64 per cent.

Background and Aims

Leaf rust (LR) caused by fungal pathogen *Puccinia hordei* is an important disease of barley (*Hordeum vulgare*). The potential losses due to LR have been estimated to be A$21 million annually with present losses around A$11 million per annum (Murray and Brennan, 2009) in Western Australia (WA). Growing susceptible varieties on the South Coast of WA can result in yield losses of around 18% to 49% depending on seasonal disease pressure. Also, heavy LR infection can significantly impact grain quality, increasing screenings which is one of the key parameters for determining the malt or feed grade.

The annual recurrence of LR in South Coast crops is mainly due to the abundance of susceptible varieties and retention of summer regrowth for stock feed. As LR can only survive in living plants, summer rains can encourage the regrowth of barley which in turn can harbour the pathogen and contribute to the reinfection of new crops.

Until 2015, Leaf rust has been managed by the use of resistant varieties in conjunction with the application of foliar fungicides. The use of varieties with major gene (*Rph3*) to manage risk has been ineffective from 2013, due to detection of a virulent pathotype (5457P-) in the southern region of WA. At present, 5457P- is widely distributed across barley growing areas WA and has become the dominant pathotype.

The weed species *Ornithogalum umbellatum* (commonly called "Star of Bethlehem") is an alternate host for LR and supports the sexual cycle of the fungus. This alternate host was detected in 2013 near Ravensthorpe, on the South Coast of WA. While this detection is thought to have been eradicated, the risk of further outbreaks and potential extent of distribution of this alternate host at present is not known.

The expression of Adult Plant Resistance (APR) in a variety varies from tillering (Z20) to full head emergence growth stage (Z59) and is primarily influenced by temperature and other environmental and plant growth factors (R. Park, pers. comm.). In the 2016 season, considerable concern was raised among growers and agronomists as to the level of LR that was present in some varieties carrying APR and questions regarding the use of fungicide raised.

The aim of this paper is to present research information available on role of foliar fungicide mixtures with new chemistry against barley LR in a variety with known APR.

Materials and Method

Fungicide Efficacy Studies

An experiment was conducted in 2016, near Wellstead (Latitude -34.456838° and Longitude 118.433749°). Barley variety Oxford was sown at 75kg/ha on 22 May using a farmer's air seeder. Seed treated with and without seed dressing fungicide Systiva® @ 150mL/100kg seed was sown as alternate strips onto 2015 Oxford stubble. The strips were 13m wide and 50m long and subsequently pegged to create 13m by 10m plots for foliar fungicide spraying. The trial design was strip plot with 4 replications.

Foliar fungicides were applied across the plots with and without the seed dressing Systiva®. Registered and unregistered foliar fungicide formulations (mixtures with different actives) were used. Except for Prosaro® all other fungicide mixtures containing products listed in Table 1 were applied at Z35. Prosaro® was applied to all the plots except for untreated plots as a second spray at Z65. For complete disease control (yield comparison) three fungicides were used on the following sequence Radial® at Z25, Tilt® at Z35 and Prosaro® at Z65.

The application timings and rates are shown in Table 1. The percentage leaf area affected by disease on all open leaves was recorded at bi weekly intervals. GenStat 16th Edition was used to analyse the data. To reduce the variance in the % leaf area diseased, the data was analysed after angular transformation. Plots were machine harvested for grain yield.

Table 1: Foliar fungicide mixtures, active ingredients, rates used and growth stage at application at Gnowellen, 2016

Fungicide	Active constituents	Rate (mL/ha)	Growth stage (Zadok's)
Radial®	75g/L azoxystrobin and 75g/L epoxiconazole	420	25, 35
Prosaro® 420SC	210g/L prothiconazole and 210g/L tebuconazole	150	65
Tilt® 250EC	250g/L propiconazole	500	35
Product 1	75g/L bixafen and 150g/L prothioconazole	500	35
Product 2	41.6g/L epoxiconazole and 66.6g/L pyraclostrobin and 41.5g/L fluxapyroxad	750	35

Results and Discussion

Fungicide Efficacy Studies

The LR pressure was high at the trial site. Disease was first evident at Z22 in low levels in untreated plots. LR severity assessment at early ear emergence (Z53) on open top three leaves revealed that there was no difference between seed dressing with Systiva (2.7%) treatment and untreated (3.1%) (data not shown).

The fungicide efficacy study shows the combination of the fungicides mixtures on disease severity and yield (Table 2). These products tested were effective in reducing LR severity (Table 2). The average LR severity on top three leaves (Flag to Flag-2) varied from 9% (Product 2) to 45% (untreated) among the treatments at milk development stage (Z72). Furthermore, in untreated plots the LR severity on top three individual leaves (Flag, Flag-1 and Flag-2) were 14%, 46% and 90% respectively (data not shown).

All foliar fungicides reduced LR severity by over 67% compared to untreated. Treatments 3 and 4 (with Products 1 and 2) gave greater control to LR than the other two treatments (Radial® followed by Prosaro® or Radial® followed by Tilt® and Prosaro®) but did not differ from each other. There was no difference between the disease severities in Treatment 2 (Radial® followed by Prosaro®) or Treatment 5 (Radial® followed by Tilt® then Prosaro®).

Table 2. Effects of fungicide foliar sprays on leaf rust severity and grain yield in Oxford barley at Gnowellen, 2016.

No	Foliar Treatments	Disease Severity on Z75 (18 Oct) *ang(avF to avF-2)	Yield (t/ha)	% yield increase over nil
1	Nil (untreated)	45a♣	1.6a	-
2	Radial at Z35 & ♠Prosaro at Z65	15b	2.2b	38
3	Product 1 at Z35 & Prosaro at Z65	10c	2.6b	64
4	Product 2 at Z35 & Prosaro at Z65	9c	2.4b	52
5	Radial at Z25 +Tilt at Z35 + Prosaro at Z65	14b	2.4b	54
		<0.001	<0.006	
	lsd(5%)	2.6	0.49	

Conclusion

Oxford barley is purported to possess several rust resistance genes (*Rph3*, *Rph20* and *Rph24*) and in the DAFWA 2017 Barley variety guide is categorised as susceptible (S) as a seedling and resistant (R) as an adult plant. In March 2016, Oxford barley regrowth with heavy infection of LR was observed in South Stirling area. Pathotype testing by Plant Breeding Institute at the University of Sydney revealed the pathotype present was 5457P-.

This observation was further confirmed during the 2016 cropping season, indicating that in at least some situations, Oxford is vulnerable to heavy infection by *P. hordei*. This could either be because early onset of infection in susceptible seedlings impacts APR expression or that the slow rusting genes *Rph20* and *Rph24* do not provide adequate protection in the South Stirling environment.

This trial reinforces earlier DAFWA findings that varieties containing APR genes will still benefit from well-timed foliar fungicide application when disease pressure is very high. Application of foliar fungicide mixtures containing different actives reduced disease severity and increased the grain yield. Two unregistered products tested against LR were promising compared to current existing registered foliar fungicide products.

Previous DAFWA trials have demonstrated the value of improved resistance for slowing LR development and limiting yield losses (Jayasena et al 2015). However, in the highly favourable environment of WA particularly in the lower Great Southern and South Coastal areas where LR can be present from as early as stem extension, APR varieties such as Oxford or Flinders can benefit from a programmed foliar fungicide approach.

Key words

Barley, Leaf Rust, Alternate Host, Fungicide.

Acknowledgements

The authors acknowledge the trial site provided by Mark and Robin Slattery and financial assistance from Grains Research and Development Corporation, DAW00229. Fungicides used in field testing were provided by Bayer, Syngenta, ADAMA and BASF.

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Jayasena K. Tanaka K. Wahlsten L. and Lambert V (2015) Barley varieties with adult plant resistance stand up for leaf rust. Agribusiness Crop Updates, Crown Perth, 24th - 25th February, 2015 (paper)

GRDC Project Number: DAW00229

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Survey of the "Red Leaf Clover Syndrome"

Perry Dolling (DAFWA, Katanning)

A pasture survey of 9 paddocks in mid-August occurred after farmers were concerned about their subterranean clover turning red and then dying. Samples of subterranean clover were taken from each paddock and sent to Martin Barbetti's laboratory at the University of WA. There, Ming Pei You assessed the levels of disease (rotting) on tap and lateral roots and also assessed the extent of nodulation. All samples had red leaf symptoms. The survey was made possible through the Grain and Graze III project.

Basic information of each paddock showed Dalkeith as the dominant cultivar, which is not surprising and many of the soils were gravels (Tables 1 and 2). The results also showed that many of the paddocks as a whole were being badly affected by root disease (Table 1) which backs up the concern the farmers had about the disease.

Table 1: Location of paddocks, subterranean clover details and percentage of paddock affected by disease

Sample No.	Location	Sub-clover cultivar	Sub-clover %	% of paddock affected by disease
1	Tambellup	Dalkeith	40	50
2	Tambellup	Nungarin[A]	10	100
3	Kendenup	Dalkeith	80	20
4	Kendenup	Dalkeith	80	5
5	Mt Barker	Dalkeith	5	70
6	South Stirlings	Dalkeith	80	40
7	South Stirlings	Dalkeith	50	40
8	Narrikup		10	10
9	Tambellup	Dalkeith	85	5

[A] Paddock also contained Santiago medic and balansa clover

Table 2: Soil type, drainage and rotation details for each paddock

Sample No.	Soil type	Site drainage	Rotation
1	Sandy loam to gravel	Moderately drained	Crop 2015
2	Heavy clay loam	Waterlogged	2-3 years crop
3	Sand over gravel over clay	Free draining	2014-2016 pasture
4	Gravel loam/clay	Free draining	2013-2016 pasture
5	Gravel/sand/loam	Free draining	Pasture odd crop
6	Gravel loamy sand	Free draining	Crop rotation
7	Loamy sand	Free draining	Crop rotation
8	Loamy sand over gravel	Waterlogged	Pasture
9	Gravelly sandy loam	Free draining	Crop 2015

The root disease assessments showed that the average tap root disease level was 62% and the average lateral root disease was 75% (Table 3). Disease is assessed on a 0 -100% disease index, and scores 60% or more are considered severe. It was clear that the plants were being severely affected by root disease. The average nodulation index was 40% (Table 3). This index works the opposite way to the disease index so the greater the percentage the more nodules there are. However, 40% indicates nodulation was poor, way less than satisfactory as a score of 60% is a realistic minimum required.

Table 3. Summary of the root disease and nodule number from samples taken from 9 paddocks

Sample No.	Tap root disease index (%)	Lateral root disease index (%)	Nodulation index (%)
1	66	77	40
2	60	85	25
3	56	69	34
4	72		
5	64	80	28
6	58	70	52
7	60	72	45
8	55	60	60
9	71	84	33

So, one of the first questions to ask is the root disease the primary cause of the red clover syndrome or have the plants been stressed by another factor such as a virus? Martin Barbetti says that root disease is widespread and almost universally severe across WA, varying less or more in severity depending upon the season, the cultivar, the age of the stand since last cultivated and the management practices. However, these soil borne pathogens never miss any opportunities on attacking stressed plants. You frequently get red plants from root disease *per se* but we do see some situations where you can get red plants with not very severe root disease. These latter situations have occurred widely but sporadically in southern WA since the early 1980s but it has never been possible to pin down the exact cause where the red leaf syndrome occurs and is not primarily a root disease cause. Investigations historically have also included examination for a viral cause, and while such a red leaf symptom can be associated with a virus, this also has not been a conclusive cause of what is typically described as ‘red clover syndrome’. The true cause of ‘red clover syndrome’, as distinct from root rots per se, remains undetermined; probably because there has never been funding available to properly investigate this syndrome, despite its severe adverse impact over many years.

Where root disease is severe, there are four main pathogens; *Pythium*, *Phytophthora*, *Aphanomyces* and *Rhizoctonia* and they operate in a complex of three or more. This makes management of the disease challenging. We also know that environmental factors such as temperature, soil type and soil moisture have a major but complex role in determining the expression of the disease. The only strong management control is cultivation but the researchers from UWA are working on other ways to control the disease. UWA trials on an MLA funded project showed that using more disease-resistant or disease-tolerant cultivars across Australia in 2015 and 2016 significantly increased plant productivity by up to 4 to 5-fold. This opportunity to identify cultivar resistances and cultivar field tolerances to the soil borne pathogen complex offers the best and most cost-effective, long term, and economically feasible means of managing damping-off and root diseases in subterranean clover across southern Australia. However, despite this tremendous opportunity to benefit producers, this opportunity is unlikely to be realised unless there is ongoing commitment by Industry funding to support such an approach and to realise this potential.

Detection of Snails in Grain and in the Field and Getting Sprays to Where the Snails Are

John Moore, Department of Agriculture and Food, Albany, Western Australia.
Svetlana Micic, Department of Agriculture and Food, Albany, Western Australia.

Key Messages

- Snails may be detected in grain as it is being harvested using a mobile phone mounted in the bin.
- Mobile phones can be programmed to detect snails on the ground using WheelCam
- Time lapse photography and analysis can be used to study the behaviour of snails over many months.
- Nozzle choice can help deposit sprays where the snails are located around the time of spraying.

Aims

To determine if mobile phone technology can be used to map and study snails in the field.

Introduction

Snails are becoming a pest of crops on the South Coast of WA. More stringent export standards have recently been imposed limiting the level of snail contamination in grain. Mobile phone technology has advanced rapidly in the last decade allowing new methods of detection, mapping and surveillance to be implemented.

Method

GrainCam
A device was made that delivers grain from the bubble auger on the harvester to a plate so that it may be photographed with a mobile phone (see figure 1). The images are then analysed for the presence of Small Pointed Snails (*Prietocella barbara*).

WheelCam
A mobile phone was attached to the wheel of a Ute or harvester (see image 3) and programmed to take close up photographs of the ground and record the GPS location and time (see image 4). An image is taken with each revolution of the wheel and this eliminates motion blur.

VideoCam
Mobile phones were set up in the field with time lapse programs to record the presence and behaviour of Small Pointed Snails from October to March. Weather, soil moisture and leaf wetness were recorded at the site (see image 6).

Spray Deposition
Fine, medium and coarse quality sprays were compared using water sensitive cards placed in a canola canopy to measure spray deposition.

Results and Discussion

GrainCam

The device was tested in the laboratory as there were insufficient snails present at the sites being monitored at harvest. Preliminary image analysis is showing promise but the algorithms need to be improved to reduce the number of false positives and false negatives (see image 2).

Image 1: The GrainCam.

Image 2: Image analysis to detect Small Pointed Snails in GrainCam Images.

WheelCam

Snails could be mapped by manually inspecting the photos (see figure 1). Work is underway to use image analysis to see if the process can be automated as it is currently very time consuming. Collaborative work with SARDI and University of Adelaide is planned.

Image 3: WheelCams attached to a Case Harvester.

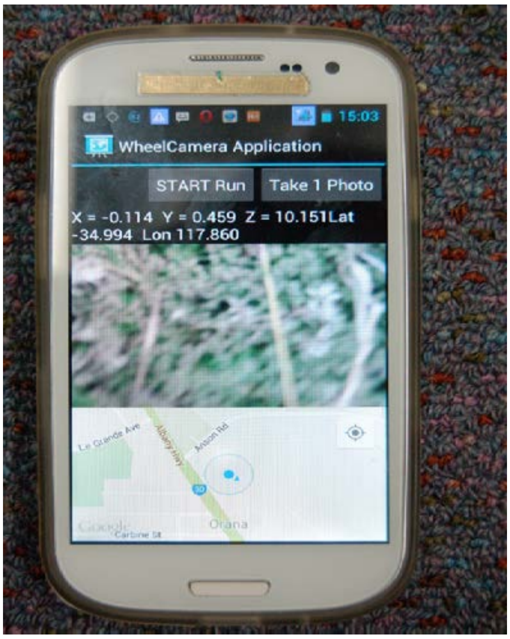

Image 4: The WheelCam app on a mobile phone.

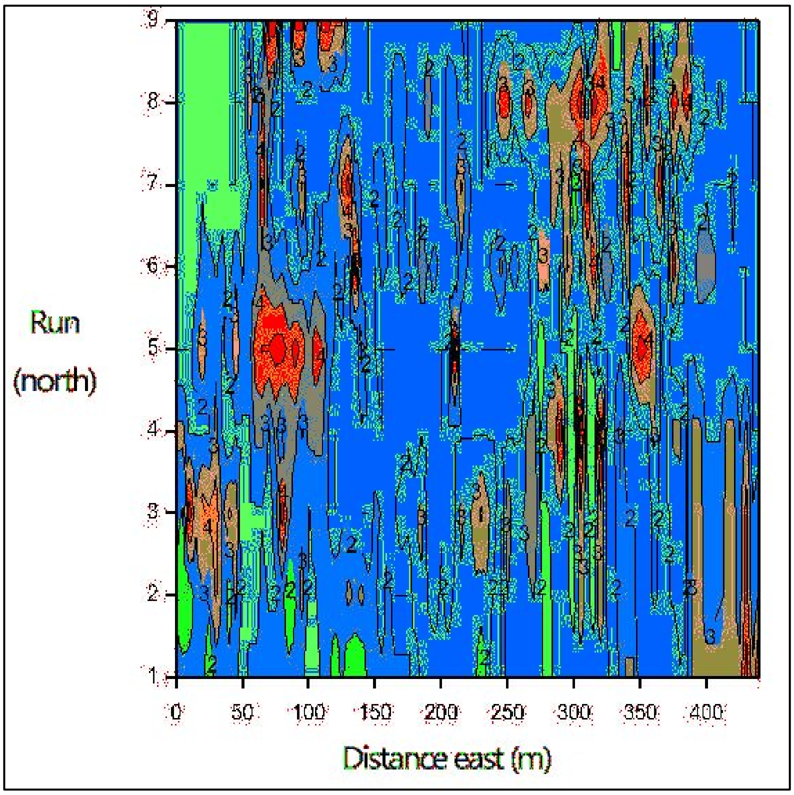

Figure 1: Map of snail densities from the field.

VideoCam

This is showing interesting results with snail activity continuing spasmodically over the whole summer period this year. Weather data is shown below. Currently these images are being manually processed. Work has started on motion detection programs (see figure 2)

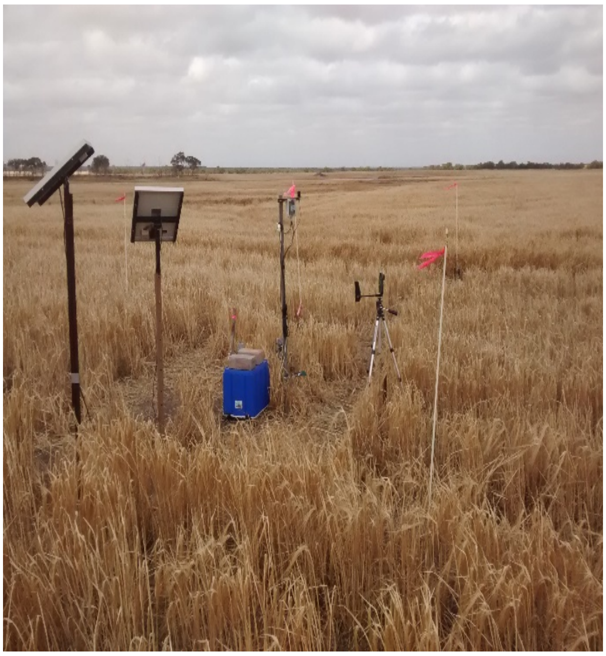

Image 5 & 6: The VideoCam setup and weather stations.

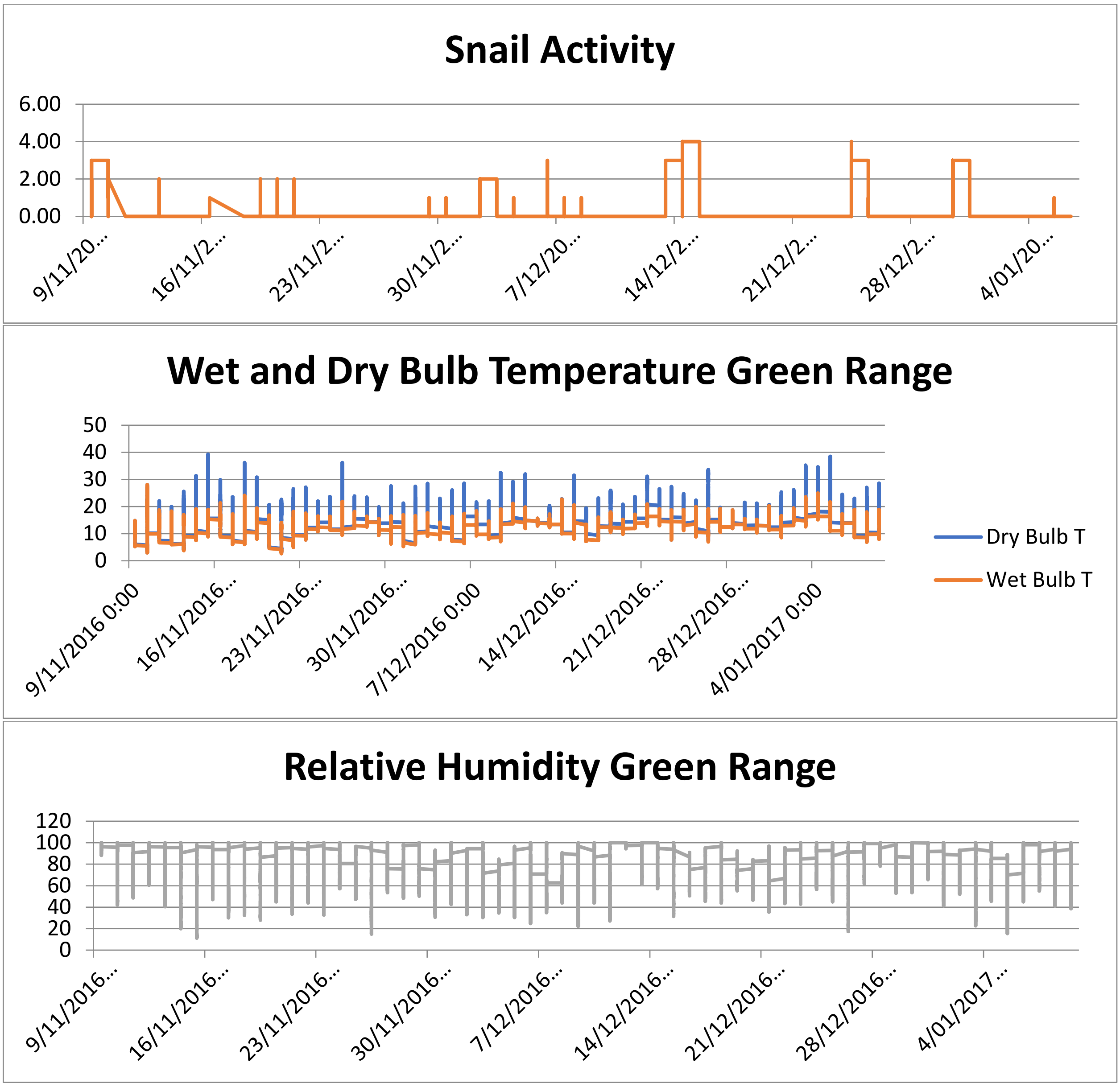

Figure 2: Snail activity with time and weather data.

Spray Deposition

Fine quality sprays deposited more spray at the top of the canopy. Nozzles producing coarse droplets (like the air induction nozzles) deposited fewer droplets at each level in the canopy because their droplets are bigger (see figure 3). When percentage cover is considered the fine nozzle deposit more spray at the top of the canopy but there is little difference deep in the canopy. (see figure 4).

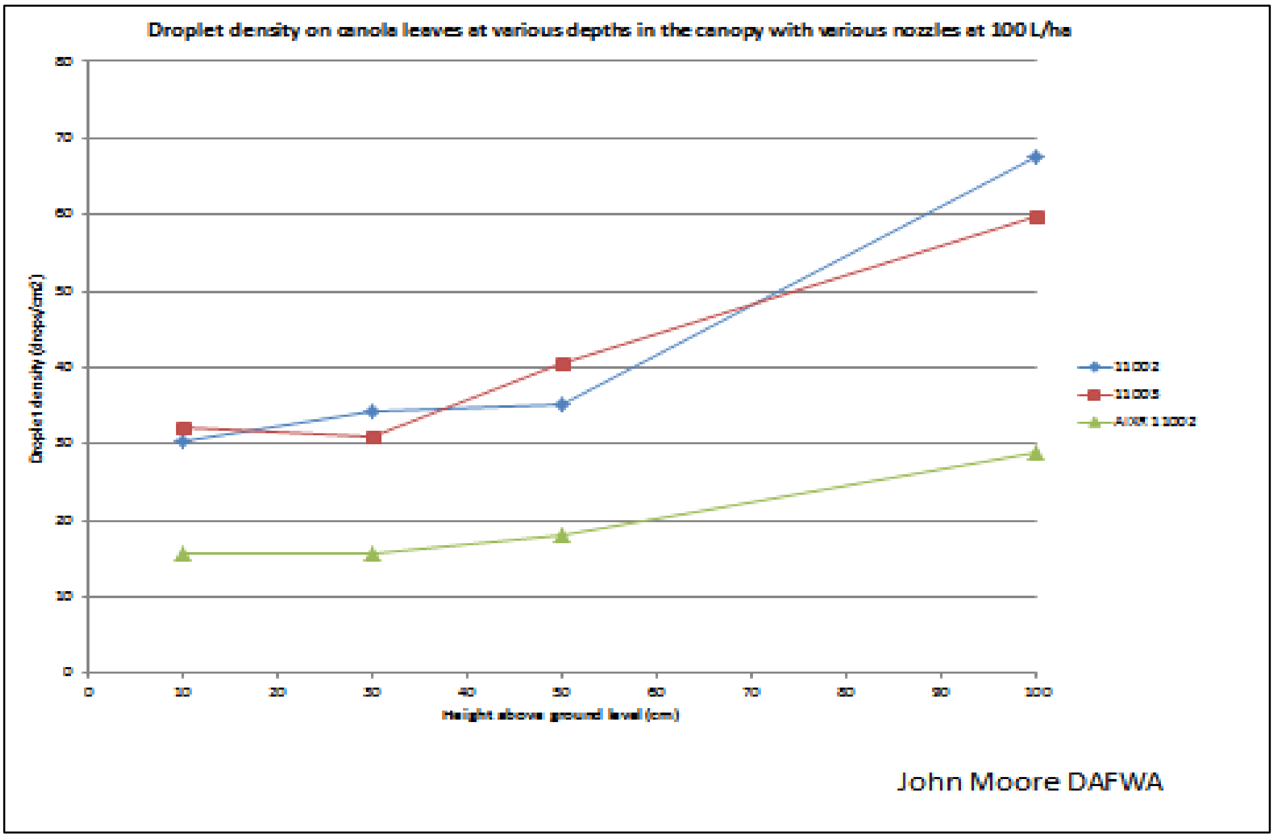

Figure 3: Droplet density at various heights in a canola canopy.

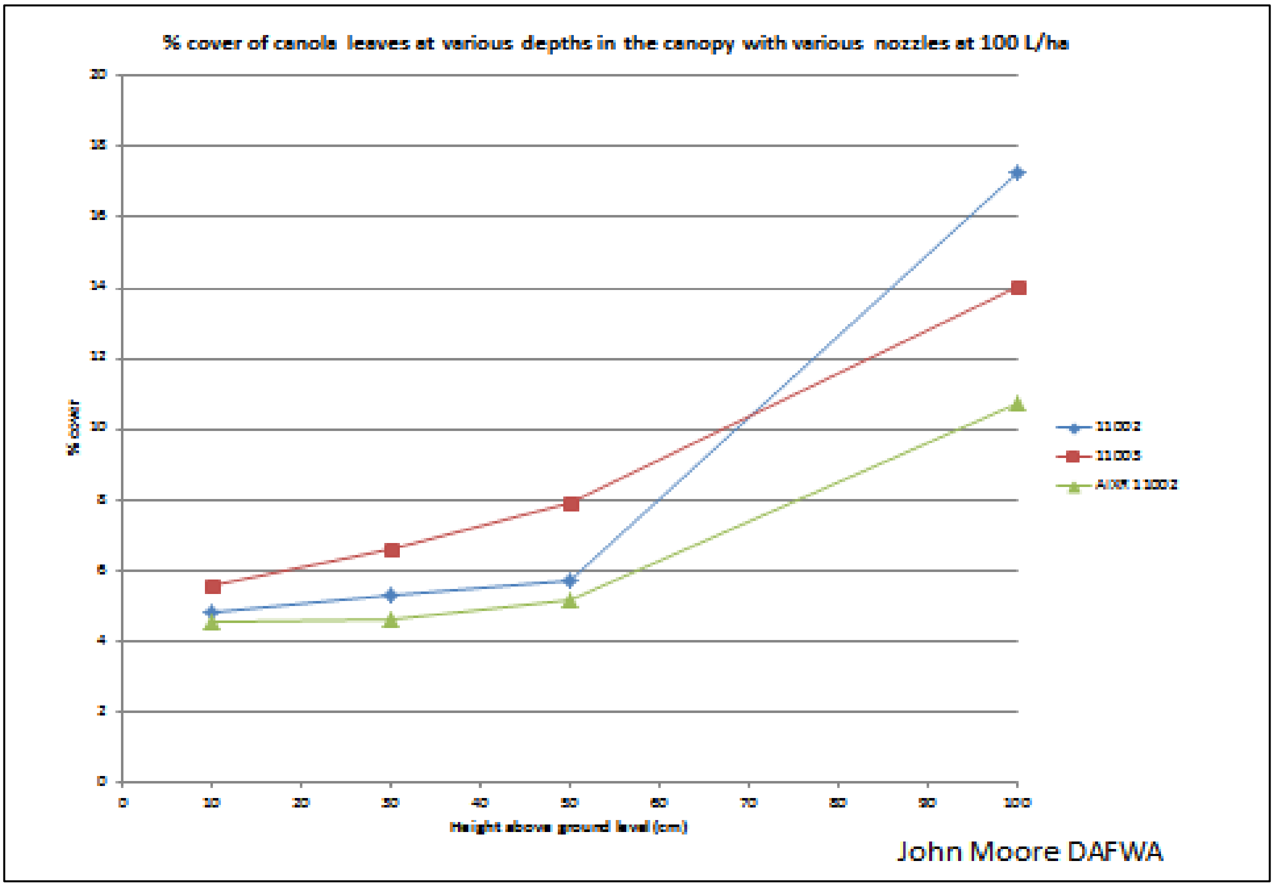

Figure 4: The effect of various nozzles producing fine, medium and coarse spray qualities on the percentage cover of spray at various heights in a canola canopy.

Conclusion

A better understanding of snail biology and distribution will help growers target controls and avoid grain contamination.

Key words

Apps, canopy penetration, control, GrainCam, grain contamination, image analysis, mapping, mobile phones, nozzles, *Prietocella barbara,* Small Pointed Snails, spray quality, VideoCam, WheelCam, weather.

Acknowledgements

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GRDC Project Number

DAW 251 and R4R 88801492 "Improving the Efficiency of Slug and Snail Controls"

2016 UAV Rhizo Summary

Andrea Hills[1], Daniel Huberli[2], Geoff Thomas[2], Phil Goulding[2]
DAFWA [1]Esperance, [2]South Perth

The Adams family set up large scale rhizoctonia trial which had three treatments:

1. Untreated – untreated seed sown with fertiliser and flutriafol,
2. Systiva® treated seed
3. Uniform® treated fertiliser (400 mL/ha) and untreated seed

These were sown in double width strips from a paddock edge with the remainder of the paddock sown with Uniform treated fertiliser (Image 1). Using UAV normal and NDVI images and ignoring patches, five areas with relatively even crop growth were selected for use in patch mapping. Patches and nearby healthy crop were sampled in August for soil (PredictaB) and plant roots (disease scoring). UAV images were also taken in August and patches plus nearby healthy crop were hand cut for dry matter and grain yield prior to harvest. There was waterlogging in all the treatment strips during the year.

Image 1: South Stirlings site with treatment strips of Untreated (red), Systiva treated seed (blue) and Uniform treated fertiliser (yellow).

The Adams barley developed rhizoctonia which accounted for 0.6 % of paddock area which was half of 2015 levels (1.2 %). The overall number of patches also reduced from 4,280 to 1,761. At all three sites monitored in this project, rhizoctonia levels were substantially lower than the previous year as summer rain is known to reduce rhizoctonia levels.

The Uniform treated areas had a significantly higher grain yield (Table 1) and dry matter at maturity (Table 2) relative to the Untreated area. On average, Uniform increased grain yield by 700 kg/ha. 400 mL/ha of Uniform costs $24/ha so at $200 /t for grain, would have returned roughly $140 /ha.

Patches in the untreated area showed the greatest yield reductions averaging only 41% of heathy yield while patches in Systiva yield was significantly better (59% of healthy) and Uniform (51%) was between these.
Neither of the treatments improved grain quality and grain from the Uniform treated areas had a significantly decreased grain weight which is likely to be a result of its increased yield overall.

Despite the excellent moisture availability during spring, grain from plants inside patches still had significantly higher screenings relative to the surrounding crop (4.1 vs 6.0%). Grain brightness was better inside patches as those plants tend to mature later than the surrounding healthy crop.

Table 1. Grain yield (t/ha) at the South Stirlings in 2016.

	Treatment			
Position	Untreated	Systiva	Uniform	Average
Healthy	5.87	5.63	6.34	5.97
Patch	2.38	3.35	3.25	2.99
Average	4.12	4.49	4.82	4.48

ANOVA	p-value	lsd (5%)
Position	<.001	0.442
Treatment	0.045	0.541
Pos.Treatmt	0.810	-
%cv	3.3	

Table 2. Crop Biomass (t/ha) at maturity at the South Stirlings in 2016.

	Treatment			
Position	Untreated	Systiva	Uniform	Average
Healthy	11.31	11.54	12.66	11.84
Patch	4.56	6.70	7.50	6.25
Average	7.94	9.12	10.10	9.05

ANOVA	p-value	lsd (5%)
Position	<.001	1.260
Treatment	0.003	1.543
Pos.Treatmt	0.400	-
%cv	3.4	

Unsurprisingly there was significantly more root disease on plants within patches than in nearby healthy crop. Neither Systiva nor Uniform significantly reduced root disease relative to Untreated plants although there was an improvement (Figure 1).

PredictaB test results showed a high level of rhizoctonia inside patches but this was lower than in 2015. There were also low-moderate levels of root lesion nematodes (*P. negletus*) which Mark and family are aware of, a low level of crown rot and some Pythium root rot (which enjoys wet soils).

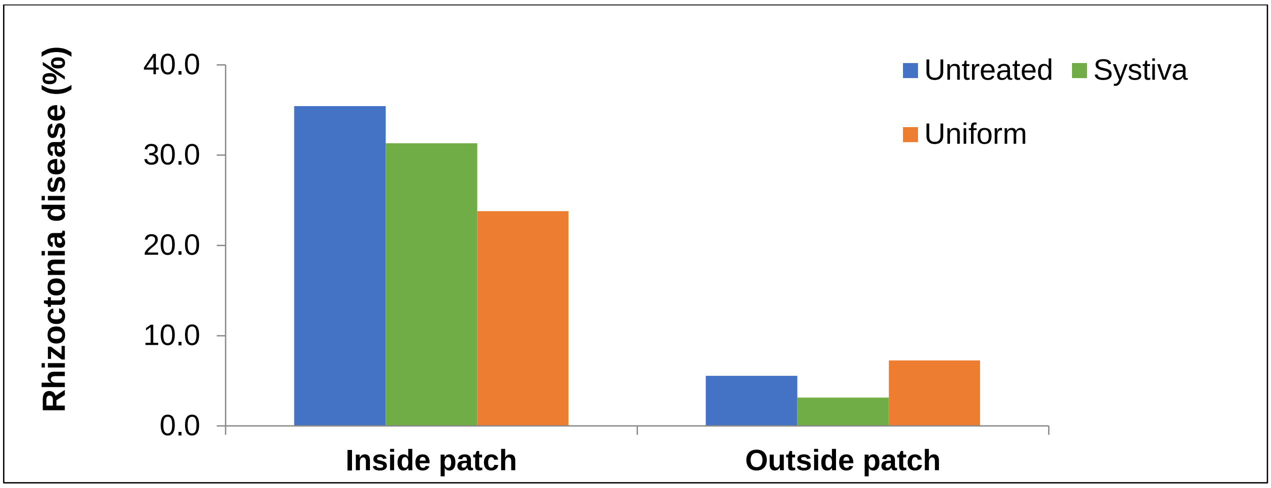

Figure 1: Rhizoctonia disease on plant roots in Untreated, Systiva and Uniform strips inside or outside rhizoctonia patches at the South Stirlings.

Rhizoctonia Results Over Two Years

One difficulty with rhizoctonia is that it does not occur at a regular rate across a paddock so that selecting areas to do comparisons on can be difficult which is why it is useful to have large scale treatments to iron out some of the variation. Unfortunately, we don't know why some patches form while others do not. Although the incidence of rhizoctonia fell across all treatment areas relative to 2015, the decline in the Systiva and Uniform treated areas was even higher (Figure 2).

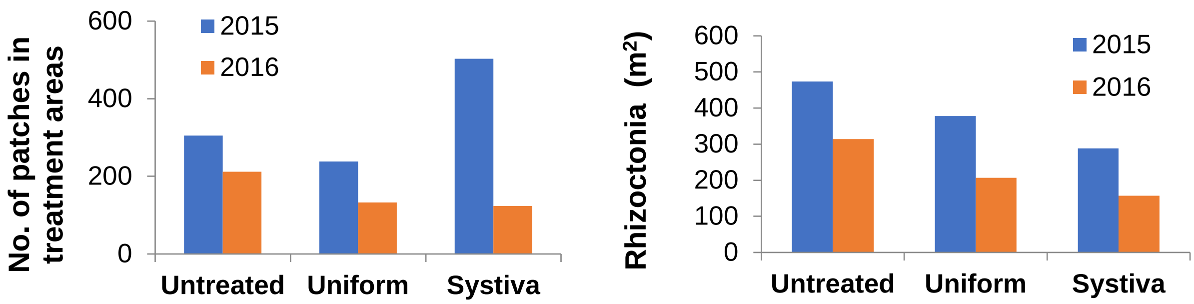

Figure 2: Number and area of rhizoctonia patches in treatment areas in 2015 and 2016; no treatments were applied in 2015.

Conclusions

Results indicate that Uniform significantly improved crop yields in a second-year barley crop and in a wet season; in dry years' root diseases such as rhizoctonia generally have even greater effects on grain yield and quality. Systiva seed dressing, which is registered for rhizoctonia suppression, also showed some improvement over the untreated areas of the paddock. In DAFWA researcher Daniel Huberli's work, he showed that the ideal system to combat rhizoctonia is to apply Uniform as a liquid in-furrow along with a seed dressing registered to supress rhizoctonia such as EverGol Prime. While Uniform is not a cheap option, results here indicate that the yield response may be worth considering. The yield monitor data has not been assessed yet, which will provide more interesting cross year and treatment comparisons.

Both Systiva and Uniform are now registered for a number of foliar diseases including net blotches and leaf rust which weren't considered in this analysis.

UAV Mapping of Crop Diseases in Rotations

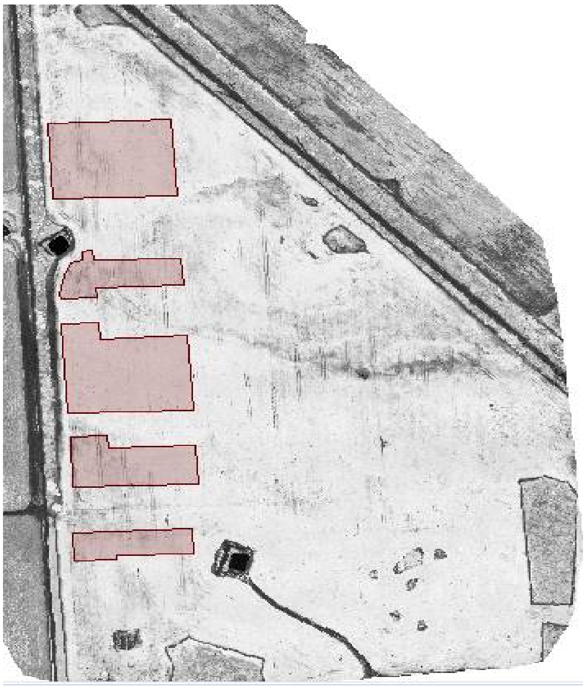

Image 2: 2016 areas used in treatment analysis – refers to the parts of a paddock that included the Untreated, Uniform and Systiva treatments applied where the growth appeared relatively even.

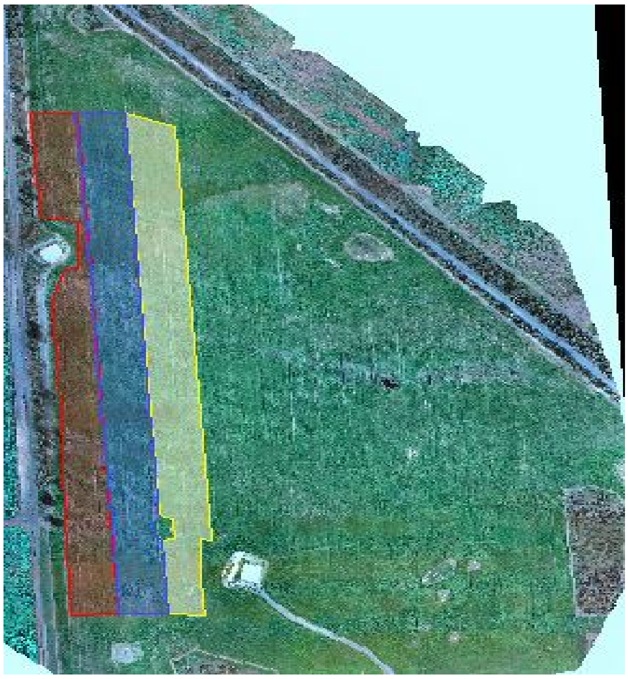

Image 3: 2016 treatment areas - refers to the strips of Untreated,

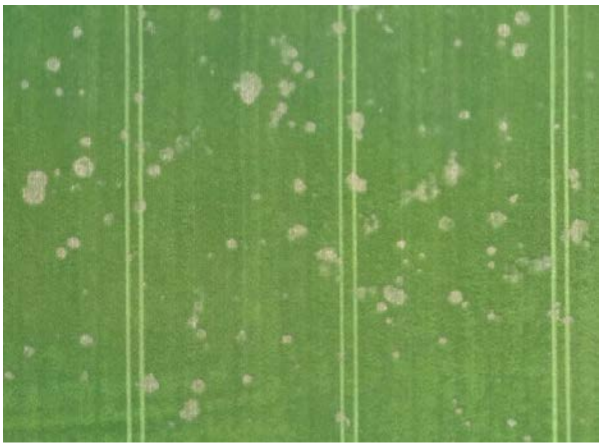

Image 4: Sth Stirlings rhizo & nem patches 2016- close up of rhizoctonia patches and some that are likely to also have nematodes present as they do not have the typical symptoms (there are full sized plants inside the patch).

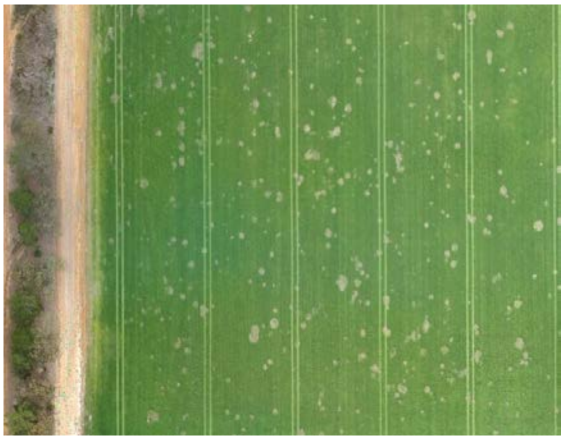

Image 5: Sth Stirlings rhizo 2015 closer – some patches closer up,

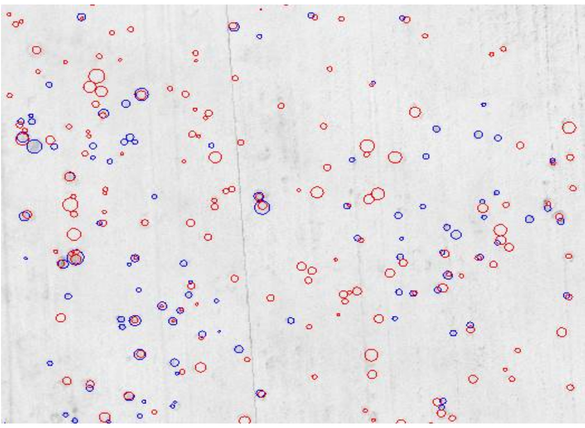

Image 6: Sth Stirlings rhizo 2015&2016 close up – shows rhizo patches from 2015 (red) and 2016 (blue).

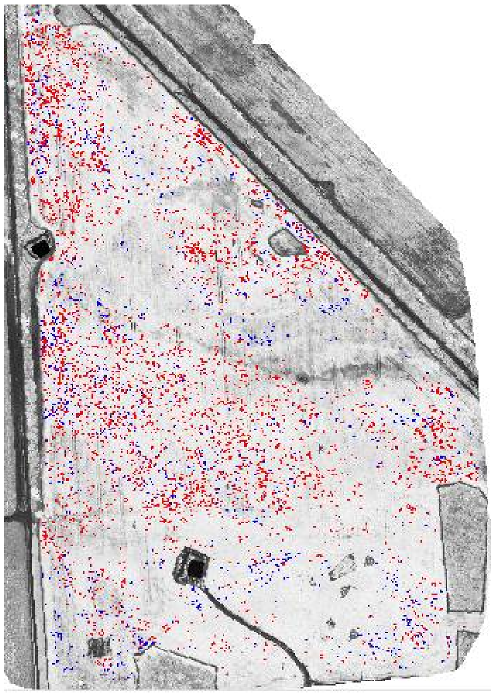

Image 7*: Sth Stirlings rhizo 2015&2016 overlaid – rhizoctonia patches from both years 2015 (red) and 2016 (blue).*

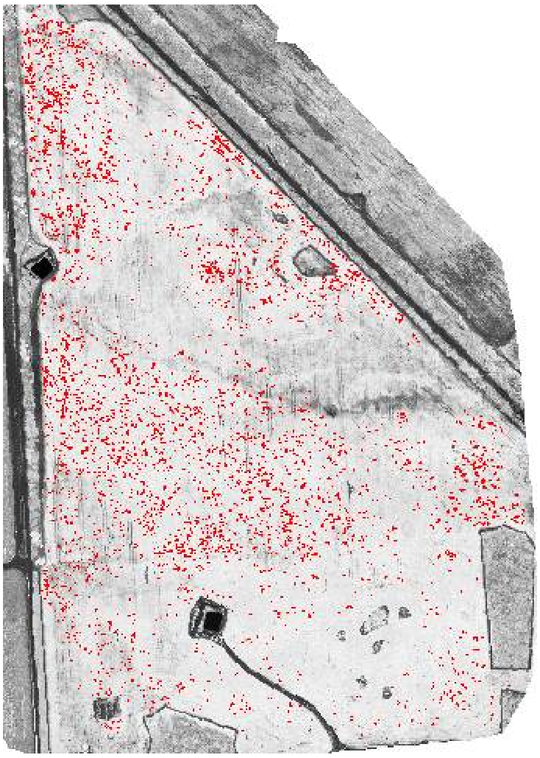

Image 8: Sth Stirlings rhizo 2015 – rhizoctonia patches at a paddock scale. Represents 1.2% by area. Image underneath is the 2016 NDVI in greyscale where dark = reduced/no growth.

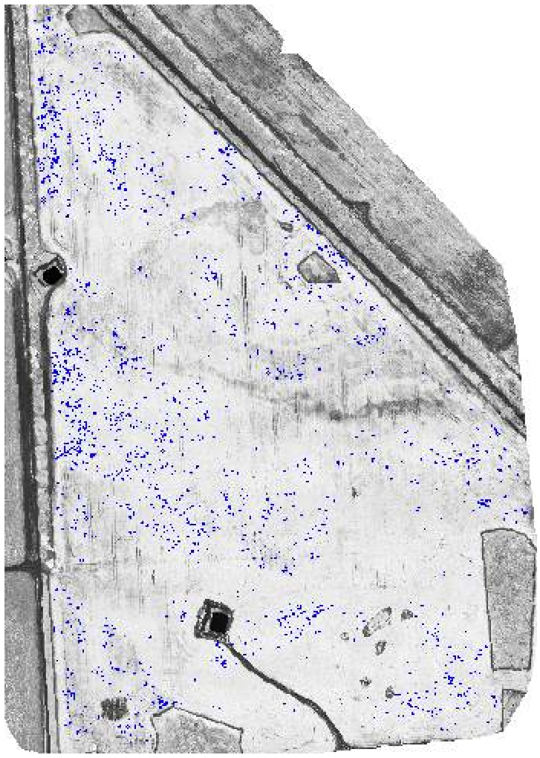

Image 9: Sth Stirlings rhizo 2016 – rhizoctonia patches at a paddock scale. Represents 0.6% by area. Image underneath is the 2016 NDVI in greyscale where dark = reduced/no growth.

Figure 4: Sth Stirlings rhizo 2015 – normal (red, green, blue) image of the paddock mapped by UAV for rhizoctonia patches.

Acknowledgements

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