LEADA

Lower Eyre Agricultural Development Association

Presents

The Lower Eyre Peninsula Harvest Weed Seed Management Expo

13 March 2018

Kapinnie Sports Club

Wish to acknowledge the support from the following Organizations to help make this event and all our trials possible

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GRDC Grains Research & Development Corporation

Australian Government | National Landcare Program

Government of South Australia | Eyre Peninsula Natural Resources Management Board

SAGIT

Natural Resources Eyre Peninsula

Regional Landcare Facilitator

Our Vision: *LEADA is committed to providing support and attracting research activity to the Lower Eyre Peninsula. It is driven by local issues and the search for solutions that suit local systems.*

Our mission**:** *A grower group that specifically addresses issues and solutions to improve farming systems in your area.*

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GeorgePedlerAg
INDEPENDENT CONSULTING SERVICES

PROGRAM FOR THE DAY

1.00pm	**Registration**
1.30pm	**Bruce Morgan, Chair, LEADA,** Welcome
1.35pm	**Greg Condon, Grassroots Agronomy** – Using innovative agronomy to smash herbicide resistant weeds
2.35pm	**Andrew Ware and Blake Gontar, SARDI** – Lower Eyre Peninsula 2017 Trial Updates
3.20pm	**Afternoon Tea**
3.45pm	**Jacob Giles, SARDI** – High Density Seeding Rate Trial results and Snail work – what's going on?
4.10pm	Bus to Billy Pedler's
4.30pm	**Billy Pedler, Farmer** – Chaff Decks – Paddock and harvester inspection
5.15pm	Bus back to Kapinnie Clubrooms
5.30pm	**Michael Walsh, University of Sydney** – Harvest Weed Seed Control – What we have learned
6.30pm	**Stubble Initiative** – Where to from here
6.45pm	**Bruce Morgan, Chair, LEADA** – Close
7.00pm	**Tea and Static Displays**

THANKS TO OUR 2017 SPONSORS

CONTENTS

LEADA Committee 2
Program for the Day 3
Thanks to our 2017 Sponsors 4
Contents 5
Chairman's Introduction 6
Harvest weed seed control – growers spoilt for choice 7
Canola: Understanding what varieties to plant and when to plant them 14
Sclerotinia in canola on Lower Eyre Peninsula 21
Improving eyespot disease prediction and refining management strategies based on risk 32
Baiting round snails prior to egg laying in accordance to environmental conditions on lower Eyre Peninsula, 2017 36
The effect of increased sowing density on yield when sowing late and is influence on yield determining factors 40
Pre-emergent herbicides in a dry sown scenario 45
Harvest weed seed control – what we have learned 49
Soil moisture probe network – using soil water information to make better decisions on Eyre Peninsula 54
Optimising inoculation of pulse crops 58
Trial Results 2017 67
Pulse Check Groups Prepare for the 2018 Growing Season 72
Copper Management for the Future 74

CHAIRMAN'S INTRODUCTION

Bruce Morgan

Welcome all members, sponsors, industry professionals and guests to another year of LEADA research and extension.

2017 across lower EP saw a very dry start to the season with little or no rainfall before July, with average rainfall in the growing season; however the pattern and timing of falls resulted in average yields for many. Rainfall received at harvest time was not welcomed, but all in all most farmers were happy with the season, considering the dry start.

LEADA continued to focus on attracting funding for research and extension across lower EP in 2017. A strategic review of research priorities for the region directed project proposals into profitable pulses and pastures; cover crops and soil carbon; summer fodder trials and continuing soil amelioration work, amongst many others.

LEADA had a productive 2017 with continuation of our major GRDC Stubble Management project with a focus on chemical rates for ryegrass control. We continue to support the Soil pH work being carried out by Rural Solutions SA (PIRSA).

LEADA was successful in gaining some new grants that are in full swing currently:

- SAGIT funded project looking at Copper management for the future;
- GRDC Southern Region Pulse Extension project where LEADA is one of 9 areas to establish Pulse Check discussion groups;
- EPNRM Sustainable Ag Grant to test soils for biology information on two paddocks that have been sown with cover crops and paddocks alongside with no cover crops;
- National Landcare Program to case study treatment for low pH soils (case studies are included in this booklet)

LEADA continues to offer small grants for members and last year contributed funds to assist 2 projects across the region.

The LEADA committee welcome new member Mark Dennis. Thanks to outgoing committee members Jamie Phillis and Tim Richardson for their service to LEADA and agriculture across LEP.

LEADA congratulates Andrew Ware, SARDI on winning the GRDC Southern Region 2018 Emerging Leader Award. It's been said that he is fast becoming a respected agronomic authority, not only in South Australia, but beyond. LEADA would also like to take the opportunity to thank Andrew for his contribution to agriculture on Eyre Peninsula and the support and guidance he and his team at SARDI provide to LEADA.

We are now looking forward to a positive 2018. Thanks to our ongoing sponsors and funders, thanks to the ongoing support from PIRSA through SARDI and RSSA delivery, thanks to ongoing relationship with EPNRM and thanks to committee for their support and input.

Bruce Morgan
Chair

HARVEST WEED SEED CONTROL – GROWERS SPOILT FOR CHOICE

Greg Condon, Grassroots Agronomy

Greg Condon,[1,2] and Kirrily Condon[1,2].

[1]Grassroots Agronomy; [2]Australian Herbicide Resistance Initiative.

Keywords

- weed seed banks, integrated weed management (IWM), herbicide resistance, annual ryegrass, wild radish, harvest weed seed control (HWSC), narrow windrow burning (NWB), chaff cart, chaff lining, chaff decks, Integrated Harrington Seed Destructor (iHSD).

Take home messages

- harvest weed seed control (HWSC) comes in many forms – bale, burn, graze, mill or rot
- match the HWSC tactic to your farming system, crop types and location
- capturing weed seeds in the chaff fraction when chaff lining or using chaff decks requires attention to detail in harvester setup
- HWSC can not be used effectively in isolation – adopt the 'big six' and top shelf agronomy to drive weed numbers to zero

Background

Herbicide resistance remains an ongoing challenge for Australian grain growers but the industry is continually innovating to minimise the risks. Non-chemical tools are becoming mainstream practice so that growers and advisers can deal with herbicide resistance by reducing weed seed banks and protecting chemistry.

One of the most popular weed management tactics being adopted in recent years is harvest weed seed control (HWSC). This process takes advantage of seed retention at maturity by collecting weed seeds as they pass through the harvester. Problematic weeds such as annual ryegrass, brome grass and wild radish retain 77-95% of their seed above a harvest cut height of 15cm at maturity, creating an ideal opportunity for seed collection.

Seed retention will change over time with the proportion of retained weed seeds declining the longer harvest is delayed past crop maturity. Therefore, crop and weed maturity will have a significant impact on the success of HWSC. Harvest height is equally important for HWSC, with a 15cm cut height preferred to capture 80-90% of the ryegrass seed at maturity - this can be challenging in high yielding cereals or bulky hybrid canola crops.

In the southern cropping region, low harvest height has been a barrier to adoption with growers not wanting to slow harvest down, incurring higher fuel costs and reducing harvester efficiency. Growers and researchers have since been looking at tactics that will enhance the efficacy of HWSC without slowing harvest. One option being adopted is sowing crops at narrower row spacings or higher plant populations. Weeds are then forced to grow taller to compete for light, therefore producing seed higher in the crop canopy. Stripper fronts are also being investigated to gauge any differences with weed seed capture and harvest efficiency, reducing the need to cut low whilst minimising fuel consumption.

HWSC practices

Originally pioneered 30 years ago with chaff carts in Western Australia, HWSC has now been adopted nationally as growers tailor their options to suit different farming systems and locations. The HWSC options are all slightly different with narrow windrow burning (NWB) and bale direct taking in both straw and chaff for burning or baling. Newer HWSC practices only take in the chaff fraction containing weed seeds for rotting, grazing or destruction through a mill. This includes chaff lining or chaff decks, chaff carts and emerging mill technology using the Integrated Harrington Seed Destructor (iHSD) or Seed Terminator.

Research by Walsh et. al., 2014 (https://ahri.uwa.edu.au/harvest-weed-seed-control-tools-they-all-work/) highlighted that HWSC tactics are equally effective in reducing weed seed production. The use of chaff carts, NWB or iHSD were compared at 24 sites across Australia with an average reduction in ryegrass of 60% germination the following autumn. This was achieved by removing 70-80% of the seed at harvest through either burning or destruction of weed seeds.

Research has recently commenced to gauge the impacts of chaff lining and chaff decks on the rotting of weed seeds under different crop types. Preliminary data suggests poor seed survival under canola or barley chaff because of an allelopathic effect, however in wheat there was high ryegrass seed survival underneath the chaff row which is unexplained. Michael Walsh from Sydney University and John Broster from Charles Sturt University are currently working to quantify the value of rotting under chaff line and chaff deck systems.

Each HWSC practice has its own benefits and challenges with growers leading the charge, working with a small group of researchers to develop harvester modifications that maximise weed seed control with harvest height and seed retention. For HWSC to be successful at the farm level the practice needs to be both cost effective and practical to fit in with existing operations.

HWSC cannot be used in isolation for weed management; growers and advisers should implement a range of diverse weed management practices to drive weed numbers down. Defined as the ‘Big six’ (www.weedsmart.org.au/the-big-six), these management practices include diverse rotations, mix and rotating herbicides, crop competition, double knocks, crop topping/hay to stop seed set and HWSC. The ‘big six’ complements best practice agronomy such as calendar sowing combined with effective pre-emergent herbicide packages.

HWSC adoption

An online twitter survey was conducted in November 2017 by WeedSmart with 269 growers responding. The results indicated that HWSC practices are changing, with NWB declining at the expense of chaff lining and chaff decks. 32% of growers were planning to use NWB in 2017 whilst 26% would be chaff lining and 9% using chaff decks. Chaff carts were stable at 13%, mill technology at 3% and 14% would be doing nothing.

The overall trend is positive and reflects the high value growers are increasingly putting on HWSC as a mainstream weed management tool, it does not come easy and looking at each practice in detail (table 1) highlights what growers and advisers need to be aware of.

Table 1: HWSC options

HWSC tactic	Indicative cost	Labour required	Crop residue removed	Positives	Negatives	Best fit
NWB	$200	Burning rows	Chaff & straw 40-100%	Low cost	Nutrient removal. Smoke. Fire escapes	Low rainfall, canola and pulses
Glenvar Bale Direct	$340,000	Pick up bales	Chaff & straw 40-50%	Profit from bales	Nutrient removal, cost	Market for bales
Chaff carts	$15,000-$80,000	Graze, burn heaps	Chaff only 15%	Feed value for sheep	Burning of piles	Mixed farmers
Chaff lining	$200 to $4500	Minimal	Chaff only 15%	Low cost, no burning, weed seeds left to rot	Insects & mice in chaff rows	Everywhere except small, windy paddocks; Suits both mixed farmers & intensive croppers
Chaff decks	$15,000 to $20,000	Minimal	Chaff only 15%	No dust on tramlines, no burning	Insects & mice in chaff rows, chaff rows driven over	CTF farmers both mixed and intensive croppers
iHSD	$165,000	Minimal	0%	No loss of residue	Still in the development stages, cost	Intensive croppers
Seed Terminator	$100,000	Minimal	0%	No loss of residue	Still in the development stages, cost	Intensive croppers

Narrow windrow burning (NWB)

Developed in the northern WA cropping zone NWB has been highly effective at reducing annual ryegrass and wild radish seed banks across the nation. A chute is attached to the back of the harvester to concentrate straw and chaff into a 500-600mm narrow windrow, these rows are then burnt the following autumn. The practice is low cost and highly effective with rows burning hotter for longer than a standard stubble burn. Up to 99% of weeds seeds are controlled in a well managed hot burn where temperatures reach 400°C to 500°C for at least 10 seconds.

Despite its simplicity and popularity, the practice is now in decline due to several factors. Burning is the major challenge, especially if fire escapes from the rows to burn the whole paddock or trees. Rows becoming wet after summer rains can create challenges waiting for the rows to dry out for the fire to burn hot enough and destroy weed seeds. Nutrient redistribution and ground cover loss are also key issues for growers using NWB, particularly on lighter soil types.

Smoke in built up rural communities has been problematic for NWB, where smoke lingers late into the evening when wind inversions occur. Some growers are actively looking at alternative options to NWB, whilst for those where the process works it will remain a key tool in their HWSC toolbox.

Glenvar Bale Direct

Chaff and straw are collected during harvest then baled directly using a baler attached to the harvester. There is a moderate level of groundcover removal with straw and chaff removed, whilst weed seed removal is high. A large capacity harvester is needed to operate the baler but does not slow the harvesting operation down. Growers would require access to markets to utilise the bales for bedding or as a feed source.

Chaff carts

The first HWSC tool introduced from Canada for the collection of chaff material for feeding to sheep. A cart is towed by the header which collects chaff and weed seeds then dumps it in piles for grazing or burning. The original blower delivery system was improved with a conveyor belt elevator which allows some small straw into the chaff fraction. The increased oxygen levels in the chaff has resulted in a quicker, hotter burn. Burning of chaff piles has created similar issues to NWB with chaff piles smouldering for long periods.

New research is proving the value of chaff dumps not only for weed seed reduction but also sheep feed (https://ahri.uwa.edu.au/chaff-carts-good-for-the-crop-and-the-sheep/). Chaff piles can be grazed by sheep directly or baled for sale into feedlots or other associated markets. Ed Riggall is a sheep consultant from WA who has found that sheep grazing chaff piles gained 3kg/head more over three weeks than those without chaff piles. This was despite the sheep taking one week to get used to the chaff piles. Chaff piles are reducing supplementary feeding costs and increasing scanning results while reducing weed seed numbers. Studies have shown that sheep do not spread weed seeds, with only 3-6% of seed remaining viable after passing through the rumen. Cattle are less effective at destroying ryegrass seed with 15-20% of the seed remaining viable.

Chaff lining

Developed by Esperance grain growers, chaff lining involves separation of the chaff and weed seed fraction from the straw residue, with chaff dropped into a narrow line behind the harvester via a chute attached to the main sieve. The chaff line remains on the soil surface where weed seeds are left to rot, while the straw travels through the rotor to be chopped and spread.

Chaff lining is repeated on the same runs year after year to allow weeds to continually rot in a defined area. There is limited research data to quantify the full impacts of seed rotting but observations to date indicate the undisturbed chaff row is a hostile environment for weed seeds. Growers don’t need to be on a full controlled traffic farming system but ideally the header needs to run on the same lines each year.

Chaff lining is low cost, involves no burning and growers have the option to graze chaff lines with similar feed values as that found with chaff carts. Chaff lines have been successfully grazed in stubble over summer but also in winter when sown to a dual-purpose grazing crop.

Harvester setup is critical to maximise weed seed capture with growers adding a separating baffle above the sieves to ensure chaff stays out of the straw and exits via the chute. Grain needs to be threshed hard to get weed seeds out of the head, with the grates of the harvester opened up to get as much material out of the rotor and onto the sieve for collection.

Growers have built their own chutes and baffles to suit a wide range of harvesters with 2017 being the first season many growers adopted the practice. There were several situations where chaff lining setups caused issues at harvest including a build up of excess fine chaff on the air cleaner or blockages at the rear of the baffle in canola. Refinements to chaff lining are ongoing as growers work with each other and industry to achieve continuous improvement with the practice.

Chaff decks

The chaff deck system operates on a similar principle to chaff lining but the chaff material is directed onto dedicated wheel tracks in a CTF system. Known also as chaff tramlining and developed in the Esperance region of WA, weed seeds exit the harvester off the sieves in the chaff fraction whilst straw is chopped and spread with no loss of harvest efficiency. Weed seeds are exposed to the same rotting effects as in chaff lining but there half the material given the split across the two wheel tracks.

Dust generated when summer spraying is minimised due to the presence of the chaff on the tramlines. Conversely the weed seeds are exposed to a level of disturbance on tramlines which increases their potential to germinate as opposed to continually rotting. This contrasts with chaff lining where the single chaff row is not exposed to any wheel traffic and potentially optimises its rotting potential.

Chaff decks systems have opened new opportunities for alternative forms of weed control not previously thought possible. Weed seed collection has been so effective that very dense populations have emerged in defined rows on the tramlines in crop. Due to the nature of permanent CTF tramlines, growers can use a range of alternative chemistry or cultural practices throughout the season and not affect the main crop. For example, in a 12m CTF system only 8% of the paddock is dedicated to wheel traffic therefore weeds in the chaff lines can be targeted using non-chemical options such as microwave, baling or crimping as potential forms of site specific weed control.

Agronomy for chaff rows created by chaff decks and chaff lining is a key issue and growers need to be aware of some issues that need to be managed. These include:

- Sow through the chaff rows with either a disc or tyne, unsown rows become too weedy without any competition, increase sowing rate on these rows if practical;
- Increase herbicide rates on the chaff rows using higher output nozzles for all passes including knockdown, pre-emergent, post emergent and crop topping;
- Graze with sheep where available to help to reduce the bulk of chaff rows
- Monitor for pests such as mice, earwigs, millipedes and slaters which can breed up in chaff rows, especially when sowing canola and consider on-row baiting or insecticide.

Integrated Harrington Seed Destructor (iHSD)

Recognised as the ultimate form of HWSC, the mill technology conceived by Ray Harrington is now reaching commercial reality for growers. The iHSD comprises of two hydraulically driven cage mills that are mounted within the back of the harvester (just below the sieves). The mills can destroy 93-99% of the weed seeds and then spread the material back out on the paddock without any loss of stubble or nutrients. Suitable for fitting onto all class eight, nine and ten harvesters the mill has been tested to destroy 96% of annual ryegrass seeds, 99% of wild oat seeds, 99% of wild radish seeds and 98% of brome grass seeds in the chaff.

Seed Terminator

Developed by Nick Berry and his group in South Australia the Seed Terminator uses a multi stage hammer mill on weed seeds in the chaff fraction. The mill uses a combination of processes to shear, crush, grind and high impact to destroy over 90% of weed seeds. More research is under way to further quantify this weed seed kill. The mill is mechanically driven with three stages of screen to sort material for size and can be operated at dual speeds of 2800 and 2950 RPM.

Conclusion

Growers now have available a diverse range of HWSC tactics at their disposal depending on their farming system, location and scale. The options are becoming less labour intensive with a shift away from burning of windrows towards chaff lining or mill technology which leave crop residues and nutrients in place. Although intensive croppers have previously been the major adopters of HWSC, mixed farmers can also benefit through grazing chaff dumps or chaff lines while reducing weed seed banks.

HWSC is part of a broader weed management package that includes improved herbicide management as well as crop competition, diverse rotations, double knocking and croptopping or hay to stop seed set. The implementation of some or all these tactics will ensure growers keep weed seed banks low but more importantly, remain profitable.

Useful resources

Broster J, et al (2015) Harvest weed seed control: ryegrass levels in south-eastern Australia wheat crops. 17th Australian Agronomy Conference.
http://agronomyaustraliaproceedings.org/images/sampledata/ASA17ConferenceProceedings2015.pdf

Walsh M, et al (2017) High levels of adoption indicate that harvest weed seed control is now an established weed control practice in Australian cropping. Weed Science Journal of America 31, 341-347.

https://ahri.uwa.edu.au/harvest-weed-seed-control-tools-they-all-work/

https://ahri.uwa.edu.au/chaff-carts-good-for-the-crop-and-the-sheep/

Subscribe to AHRI Insight for short and sharp newsletters relating to more crop, less weeds: www.ahri.uwa.edu.au

Visit WeedSmart for practical info and videos: www.weedsmart.org.au

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CANOLA: UNDERSTANDING WHAT VARIETIES TO PLANT AND WHEN TO PLANT THEM

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1 SARDI, New Variety Agronomy

GRDC project codes: DAS00163, CSP00187

Keywords
Canola, variety, phenology.

Take home messages

- HyTTec Trophy, InVigor T 4510, Pioneer 43Y92, Pioneer 44Y90 and Nuseed Quartz all performed well in South Australian NVT trials in 2017;
- Time of sowing experiments demonstrated benefits from matching sowing date to variety phenology;
- Optimal start of flowering time provides a target range for flowering to start within to minimise frost/heat/ water stress and maximise yield for a particular environment;
- Once the development triggers/phenology for a variety are understood an optimal sowing date can be derived to match the optimal flowering time.

Background

The selection of the most suitable canola variety for a particular situation needs consideration of maturity, along with timing of sowing opportunity, herbicide tolerance, blackleg resistance, and relative yield.

Canola variety evaluation in South Australia occurs at 12 sites, that form part of the National Variety Trial (NVT) network (DAS00163). Evaluation of triazine tolerant (TT) and imidazolinone (Imi) tolerant lines, in separate trials, occurs at each of the 12 sites, and evaluation of conventional lines occurs at seven sites.

Research to better understand the yield drivers of canola in eastern Australia commenced in 2014, and has continued since, with the aim to improve canola profitability through gaining a better understanding of how phenology and environment can be best matched to improve canola yields. This research is targeted at low to medium rainfall zones of eastern and southern Australian cropping regions and is a collaboration between CSIRO, NSW DPI and GRDC, in partnership with SARDI, CSU, MSF and BCG (CSP00187). The project links closely with similar GRDC supported projects in Western Australia and high rainfall zones (HRZ).

2017 Season

The break to the 2017 season was variable and quite patchy across much of South Australia. Where it occurred before May it was followed by a lengthy dry/ well below average rainfall period through much of May and June. This resulted in poor canola establishment in some areas, particularly on Eyre Peninsula and parts of the Mallee.

Growers on Lower Eyre Peninsula reported that, despite poor establishment and the delayed start to the season, dry sown canola crops were still profitable. However, on Upper Eyre Peninsula there were many instances of canola crops failing.

Elsewhere in the state, parts of the South East experienced waterlogging and several frost events negatively impacted canola crops in the Mallee. Otherwise canola yields were in line or slightly above recent averages.

South Australian NVT Canola 2017 Results

In 2017, NVT canola trials in South Australia yielded from 1.2t/ha at Lameroo to 3.29t/ha at Arthurton (table 1). The top yielding TT varieties were newly released Nuseed variety, HyTTec Trophy and as well as Bayer's InVigor T 4510, both hybrid varieties. Open pollenated TT varieties yielded significantly less than the top performing hybrids at all South Australian sites in 2017.

Highest yielding entries in 2017 Imi tolerant canola trials were newly released 43Y92 CL and 44Y90 CL, both from Pioneer Brand Seeds. Conventional trials saw the newly released Nuseed Quartz as the top performing variety in 2017.

All three 2017 Eyre Peninsula canola trials were abandoned due to the late break to the season. The trial site at Bordertown was also abandoned.

Table 1: 2017 South Australian NVT canola yields (expressed as % of site mean yield).

Variety/ Site	Riverton	Spalding	Turretfield	Arthurton	Minlaton	Lameroo	Keith	Frances
Triazine Tolerant								
ATR Bonito	-	84	89	-	95	93	94	-
ATR Mako	92	-	96	94				-
ATR Stingray	-	89	93	91	97	-	95	-
ATR Wahoo	97	-	-	-				103
DG 560TT	100	-	96	99	101	-	101	94
DG 670TT	105	-	103	104				107
Hyola 350TT	-	108	-	100	105	98	95	106
Hyola 559TT	94	108	93	101				93
Hyola 650TT	104	-	94	104				-
HyTTec Trophy	111	127	108	108	114	117	123	114
InVigor T 4510	113	113	108	108	101	114	102	108
Monola 515TT	75	-	-	-				81
Pioneer 44T02 TT	-	115	-	99	101	98	102	-
SF Ignite TT	108	-	100	99				111
SF Turbine TT	105	114	96	96	99	104	98	-
Site mean (t/ha)	*2.40*	*1.79*	*2.38*	*2.96*	*2.53*	*1.29*	*1.64*	*2.94*
Lsd (0.05%)	*8*	*13*	*7*	*5*	*10*	*13*	*10*	*11*
Imidazolinone								
Banker CL	97	70	103	99	103	108	99	98
Hyola 575CL	92	84	89	96	90	91	95	86
Pioneer 43Y92 (CL)	-	117	99	-	105	97	103	-
Pioneer 44Y90 (CL)	106	117	100	107	102	93	107	100
Pioneer 45Y91 (CL)	97	86	93	98				92
Saintly CL	99	98	105	100	97	110	102	111
Victory V7002CL	96	111	-	93	97	-	92	117
Site mean (t/ha)	*2.87*	*2.05*	*2.61*	*3.29*	*3.07*	*1.35*	*1.92*	*2.89*
Lsd (0.05%)	*6*	*11*	*6*	*5*	*8*	*13*	*8*	*11*
Conventional								
AV Garnet	No trial	79	No trial	91	No trial	No trial	92	96
Hyola 50		-		101			103	101
Nuseed Diamond		99		101			98	95
Nuseed Quartz		98		107			111	111
Site mean (t/ha)		*2.29*		*3.08*			*1.71*	*3.08*
Lsd (0.05%)		*10*		*5*			*9*	*10*

Variety x Time of Sowing Experiments (Optimised Canola Project)

In 2017 experiments were established at Yeelanna (Lower Eyre Peninsula), Hart (Mid North), and Lameroo (Mallee) aimed at discovering the best match of sowing time with variety in each environment.

Results from the experiment at Yeelanna (Table 2), where canola was established using irrigation on 14 April and 8 May, found that the highest yielding treatments were the quicker maturing varieties Diamond and 44Y90 CL, when sown on 8 May, yielding similarly to the longer season variety, Archer sown on 14 April.

The trials at Hart and Lameroo found that Diamond and 44Y90 CL were again the highest yielding varieties, with Stingray also performing well at Lameroo, when sown on the first sowing date. The first time of sowing in both of these experiments was later (21 and 27 April) than at Yeelanna. There was a consistent yield penalty for delaying sowing beyond the first time of sowing at both Hart and Lameroo.

Table 2: Summary of yields from canola time of sowing x variety experiments conducted at Yeelanna (Lower EP), Hart (Mid North) and Lameroo (Mallee) in 2017

	Yeelanna		**Hart**		**Lameroo**	
Variety/ Sowing Date	14/04/2017**	8/05/2017**	27/04/17	15/05/17	21/04/17	08/05/17
ATR_Stingray	3.28	3.05	2.88	2.53	1.90	1.60
Diamond	NA*	4.04	3.14	2.80	1.82	1.62
ATR_Bonito	3.10	3.45	2.42	2.23	1.62	1.43
44Y90_CL	3.31	3.66	3.51	2.78	1.83	1.88
ATR_Wahoo	3.14	3.18	2.43	1.92	1.64	1.40
Archer	3.68	3.53	2.83	2.44	1.66	1.51
Lsd (var x TOS)	0.60		0.33		0.28	
CV	14.20		14.80		16.20	
PAW @ sowing + GS Rainfall	TOS 1 = 348mm*** TOS2 = 342mm***		295mm		394mm	

* bird damage

** established using dripper hose irrigation

*** including irrigation

Similar to previous years, these experiments concluded that yield for each variety is maximised when sowing time matches an optimal flowering window, where frost, heat and water stress are all minimised.

Optimum start of flowering

Following four years of field experiments and considerable effort to improve simulated modelling in APSIM® the Optimised Canola Profitability project has been able to identify the optimum start of flowering date* for canola so that yield is maximised and so that frost, heat and water stress are all minimised. This information has been used in conjunction with historical meteorological records to produce an optimum start of flowering date (and acceptable range – in days) for a number of South Australian localities (table 3).

Table 3 Optimum start of flowering date for 13 localities in South Australia
(Modelling conducted by Julianne Lilley, CSIRO, Canberra).

Location	Optimum date	Acceptable range (days)
Wudinna	14 Jul	15
Minnipa	15 Jul	22
Kadina	16 Jul	27
Minlaton	17 Jul	38
Yeelanna	18 Jul	35
Loxton	19 Jul	14
Karoonda	19 Jul	23
Bute	20 Jul	37
Lameroo	22 Jul	39
Booleroo	24 Jul	32
Hart	25 Jul	31
Tarlee	26 Jul	31
Spalding	26 Jul	33

*start of flowering is defined as when 50% of plants have one open flower

This information can now be used to extrapolate when a particular canola variety should be sown to maximise yield and minimise environmental stresses (based on historical information). However, this requires an understanding of the development triggers/ phenology for each variety, particularly in early sowing situations. Table 4 provides some of this information based on measurements and observations by the Optimised Canola Profitability project across south eastern Australia over recent years.

Table 4. Proposed 'phenology ratings' of canola varieties compared with commercial 'maturity' ratings

Variety	**Phenology** time from sowing to flowering when sown early	**Maturity** as supplied by breeding companies	**Herbicide tolerance**	**Hybrid or OP** (open pollinated)
Diamond	Fast	early	Conv.	Hybrid
ATR Stingray	Fast	early	TT	OP
Hyola 575CL	Fast	mid to mid-early	Imi	hybrid
43C80 CL	mid-fast	early	Imi	OP
44Y89 CL	mid-fast	early-mid	Imi	hybrid
44Y89 CL	mid-fast	early-mid	Imi	hybrid
44Y90 CL	mid-fast	early-mid	Imi	hybrid
ATR Bonito	mid-fast	early to early-mid	TT	OP
45Y86 CL	mid-fast	mid	Imi	hybrid
44Y87 CL	Mid	early-mid	Imi	hybrid
ATR Gem	Mid	mid-early	TT	OP
Hyola 559TT	Mid	mid	TT	hybrid
45Y88 CL	Mid	mid	Imi	hybrid
Garnet	Mid	mid to mid-early	Conv.	OP
Hyola 577CL	mid-slow	mid	Imi	hybrid
45Y91 CL*	mid-slow	mid	Imi	hybrid
ATR Wahoo	mid-slow	mid-late	TT	OP
Hyola 750TT	mid-slow	mid-late	TT	hybrid
Archer	Slow	mid-late	Imi	hybrid
Victory V7001CL*	Slow	mid-late	Imi	hybrid
Hyola 970CL*	very slow (winter)	winter	Imi	hybrid
SF Edimax CL*	very slow (winter)	winter	Imi	hybrid

22 canola varieties (above) were included in the Optimised Canola Project from 2014-2016. Phenology differences between varieties were a major yield determinant in the project, however phenology did not relate to commercial maturity ratings for early sowing. The project committee is encouraging industry to adopt more accurate phenology terminology as described above to guide sowing date decisions and target the Optimal Start of Flowering period.

Other/newer varieties are available that may also be suited to early sowing, including those indicated above (*).

Conclusion

HyTTec Trophy, InVigor T 4510, Pioneer 43Y92, Pioneer 44Y90 and Nuseed Quartz all performed well in South Australian NVT trials in 2017.

Time of sowing experiments demonstrated benefits from matching sowing date to variety phenology. Optimal start of flowering time provides a target range for flowering to start within to minimise frost/heat/ water stress and maximise yield for a particular environment. Once the development triggers/ phenology for a variety are understood an optimal sowing date can be derived to match the optimal flowering time.

Useful resources

https://grdc.com.au/2018SowingGuideSA

https://www.nvtonline.com.au

GrowNotes™ - GRDC : Southern Canola

https://grdc.com.au/10TipsEarlySownCanola

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SCLEROTINIA IN CANOLA ON LOWER EYRE PENINSULA

Blake Gontar, SARDI Port Lincoln

Key Messages

- Despite a below-average rainfall season, sclerotinia was widespread, being present in all 20 surveyed paddocks across the lower Eyre Peninsula. However, inoculum loads varied between paddocks;
- The major driver of infection appeared to be favourable humid conditions in the crop canopy, at least partly driven by the size of the early canola canopy;
- The incidence of sclerotinia ranged from 0 to 16.8% of surveyed plants infected;
- Severity, measured as the difference in yield between individual plants that were sclerotinia-infected and non-infected, ranged from 0 to 21%;
- The overall impact of sclerotinia (incidence x severity) on crop yields was therefore quite minor, ranging from 0 to 1.7% yield loss;
- In a fungicide trial conducted at Mt Hope in 2017, below average rainfall conditions resulted in no sclerotinia and hence no response to fungicides. Cv. Diamond averaged 1.68 t/Ha;
- While the paddock survey indicates the potential for serious crop loss from sclerotinia should the right conditions occur on LEP, the plot trial shows that applying fungicides may provide no benefit under certain conditions.

Why do the trial?

Sclerotinia stem rot affects canola and most pulses. It is known to affect canola crops in Australia, with significant yield loss recorded in parts of NSW and northern Victoria (Hind et al. 2003; Kirkegaard et al. 2006). Whilst it is commonly seen in South Australia, in particular, in the Lower Eyre Peninsula (LEP), it has rarely been reported as causing a significant yield loss in this region. However, reports from growers and advisors suggest Sclerotinia may be becoming more common and more severe with some growers and advisors taking precautionary action in the form of fungicide applications.

The aim of this research, involving paddock surveys and field plot trials, was to generate baseline incidence and severity data to quantify the extent of the sclerotinia issue. Furthermore, it is hoped that the paddock surveys will indicate the contributing factors of sclerotinia epidemics, to answer the question of why sclerotinia incidence and severity may have increased, and also allow better prediction of outbreaks which would facilitate improved spray application decision-making. Finally, it is hoped that the field trials will quantify any economic benefits of fungicide applications.

How was it done?

Paddock Monitoring & Survey

Initially, six paddocks around the LEP were chosen to locate a monitoring point for detailed crop, weather and disease monitoring. Given the unusual lateness of opening rain for most of the LEP, the six sites were chosen based mostly on their early establishment following localised storms in April/May. The details of monitoring points are shown in Table 1.

Location	Paddock History*	Cultivar	Germinating Rainfall Date (mm)	Sowing Density (kg/Ha)	Est. Density (pl/m2)	GSR	Paddock Yield (t/ha)
Coulta	WLWCWCL	45Y91	27 April (13)	2	20	306	2.86
Edillilie	BLWWCLW	44Y90	28 May (27)	2	47	333	2.0
Kapinnie	BWLWCWP	Diamond	16 May (8)	2	27	277	2.28
Mt Drummond	WWCWCWW	44Y90	27 May (12)	3	36	293	2.5
Mt Hope	WLWCWCW	44Y89	3 July (25)	2.2	22	274	1.45
Wangary	WLWWC	45Y91	24 May (10)	2.5	23	310	2.4

Table 1. Details of monitoring locations on LEP. * Paddock history from most recent year (2016) to least recent record.

For each monitoring point, plant density and crop biomass at flowering onset, was initially recorded. A temperature and relative humidity sensor was installed between crop rows at 50 cm above ground level. Crop height, growth stage/bloom stage and the presence of fungal mycelia (‘white fluffy growth’), apothecia (‘mushrooms’) and lesions were recorded at each weekly visit. At each visit, 20 randomly selected flowers were sampled from within 10 m of the monitoring point and were plated on a PDA growth medium to score the presence of viable sclerotinia spores on petals.

The incidence of sclerotinia was calculated by counting 500 plants within 10 m of the monitoring point, and recording the number of plants with any type of sclerotinia lesion. The severity of this infection was determined by comparing yield from a sample of healthy plants to that of infected plants.

For each of the six paddocks where a monitoring point was located and the incidence and severity of sclerotinia was calculated, a second incidence and severity calculation was then conducted in a randomly selected location within the same paddock (>100m away). Furthermore, 14 additional paddocks were surveyed and the incidence of sclerotinia calculated using the same method described above. Severity of infection was only calculated for the additional paddocks at Wanilla and Wangary, as none of the other additional paddocks had significant infection (>1% incidence).

Weather data was reviewed by considering average RH throughout flowering and peak flowering for each site. It has previously been reported that > 95% RH for a period of at least 48 hours is optimal for sclerotinia disease development. Thus, the total number of hours within each period which exceeded the 48 hours where average RH > 95% and did not go below 80% RH, are reported, as well as the number of these periods within each season.

Plot Trial

A plot trial was established at Mt Hope following opening rains. The trial comprised two varieties (Diamond and Hyola575CL) and five spray treatments (Unsprayed, Early Flowering, Mid Flowering, Late Flowering and Full Control) with a registered fungicide (Prosaro®). The full control treatment received 3 spray applications, at each of the other 3 spray timings (early, mid, late). Seed of both varieties was treated with fluquinconazole (Jockey®) and sown using a standard narrow point/press wheel seeder. A plant density of 45 plants/m2 was targeted for both.

The trial was sown on the 22nd June and was located in a paddock with a history of sclerotinia, near to the Mt Hope monitoring point discussed above. The site was managed for weeds, pests and nutrition as per district practice. A fungicide (Prosaro) application was made at the 3-5 leaf growth stage to assist in controlling blackleg in the vulnerable young crop, but is not expected to have influenced the later development of sclerotinia during reproductive stages.

What Happened?

Paddock Monitoring & Survey

Crop Growth and Weather

Table 2 shows the details of crop growth and development. The crops were all generally germinated within the acceptable window for canola on the LEP, except for Mt Hope, where the combination of low early rainfall and water-repellent soil type resulted in staggered germination and generally delay in the growth the crop as a whole.

Site	Germination	Flowering Initiation	30% Bloom	50 % Bloom	End Flowering	Maturity *
Coulta	27 April	08 Aug	14 Aug	21 Aug	24 Sep	27 Oct
Edillilie	28 May	14 Aug	24 Aug	03 Sep	24 Sep	24 Oct
Kapinnie	16 May	10 Aug	18 Aug	21 Aug	18 Sep	29 Oct
Mt Drummond	27 May	21 Aug	28 Aug	03 Sep	03 Oct	3 Nov
Mt Hope	3 July	28 Aug	03 Sep	18 Sep	10 Oct	14 Nov
Wangary	24 May	18 Aug	24 Aug	03 Sep	03 Oct	5 Nov

Table 2 – Crop growth and development at monitoring sites on the LEP. * Maturity defined as physiological maturity i.e. 'windrowing stage', although not all crops were windrowed.

Rainfall was below average at all sites during the growing season. However, there were a number of distinctly prolonged moist periods at most sites during flowering, resulting in high humidity at various times. Average RH within the crop canopy throughout the flowering ranged from 80.81-96.1% across all sites.

Figure 1 shows the minimum, mean and maximum daily RH for each monitoring site, with the peak flowering period for each site and 'infective periods' indicated on each graph.

It is clear from the weather data that the crop canopy at Edillilie remained moist for long periods throughout flowering and particularly through 'peak' flowering (> 30 % bloom). To a lesser degree, Coulta and Kapinnie also remained quite humid. Wangary appeared to experience two clear periods of very high RH.

When the weather data is reviewed in terms of 'infective' periods as defined above, Kapinnie (4) experienced the greatest number of infective periods, followed by Coulta and Edillilie (3) and Wangary (2). Mt Drummond and Mt Hope did not appear to experience any periods optimal for disease development throughout flowering.

The total number of 'infective' hours experienced at each site varied considerably and did not necessarily reflect the number of periods. Edillilie experienced the greatest combined 'infective' period with a total of 753 hours, followed by Coulta (613), Kapinnie (310) and Wangary (138).

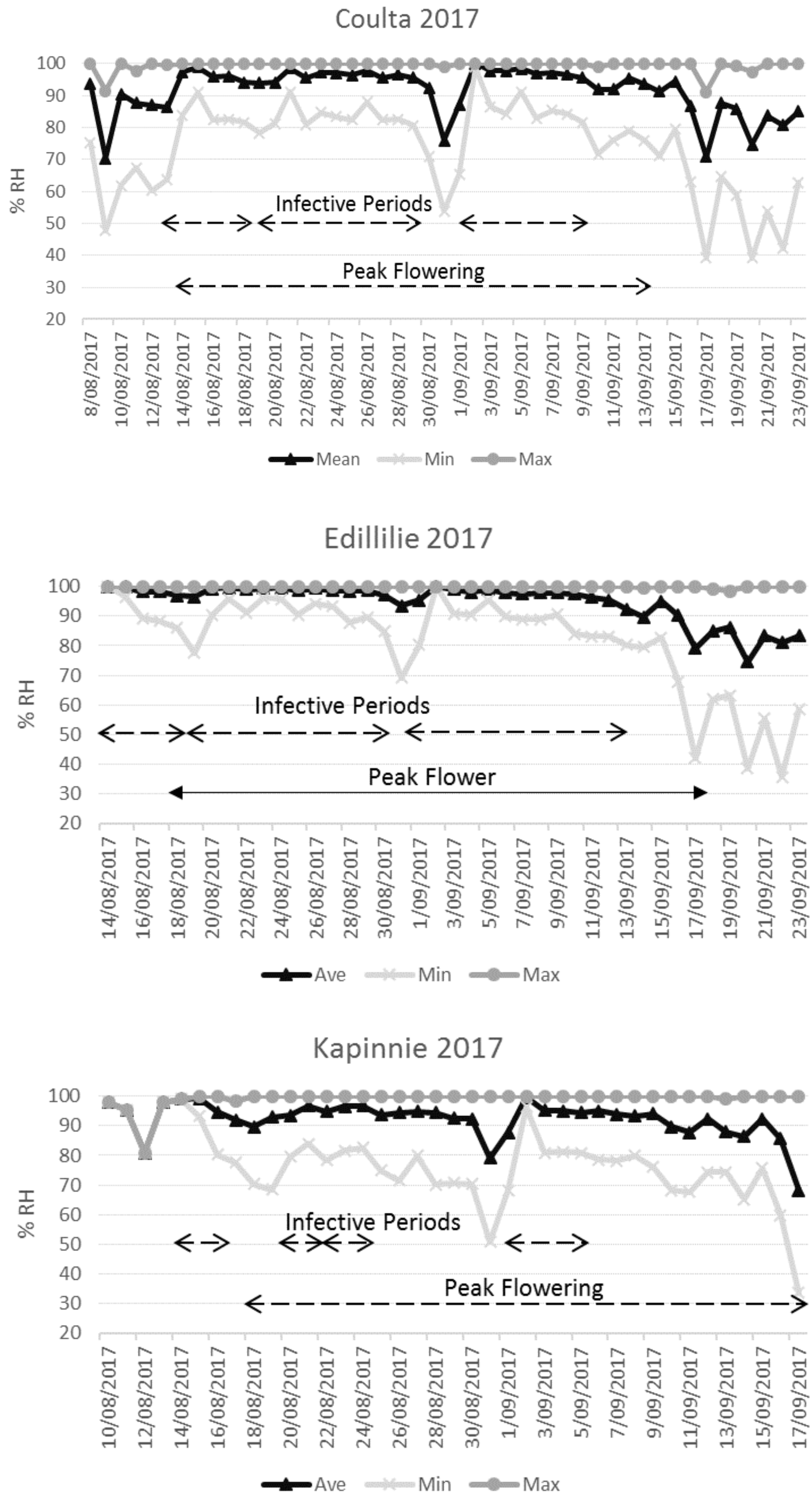
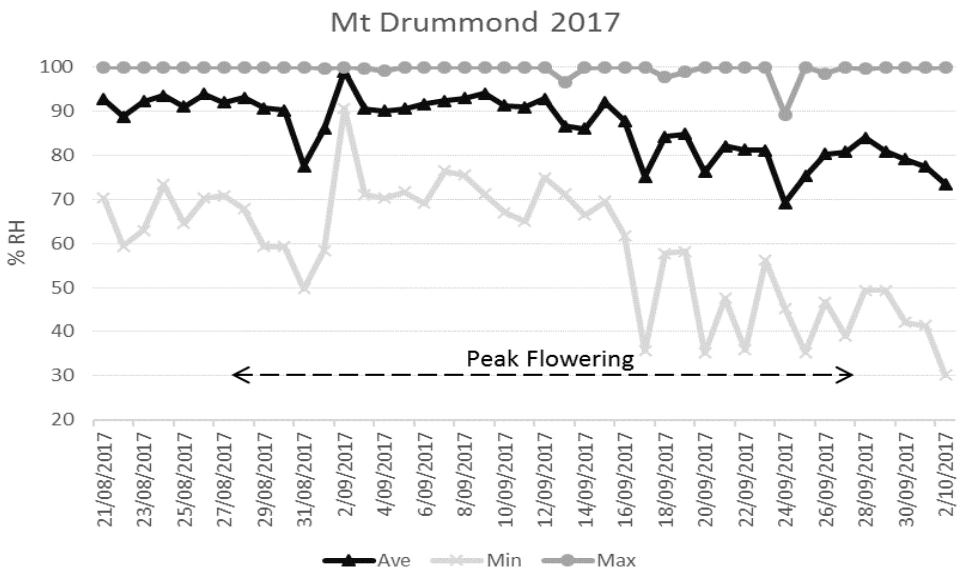
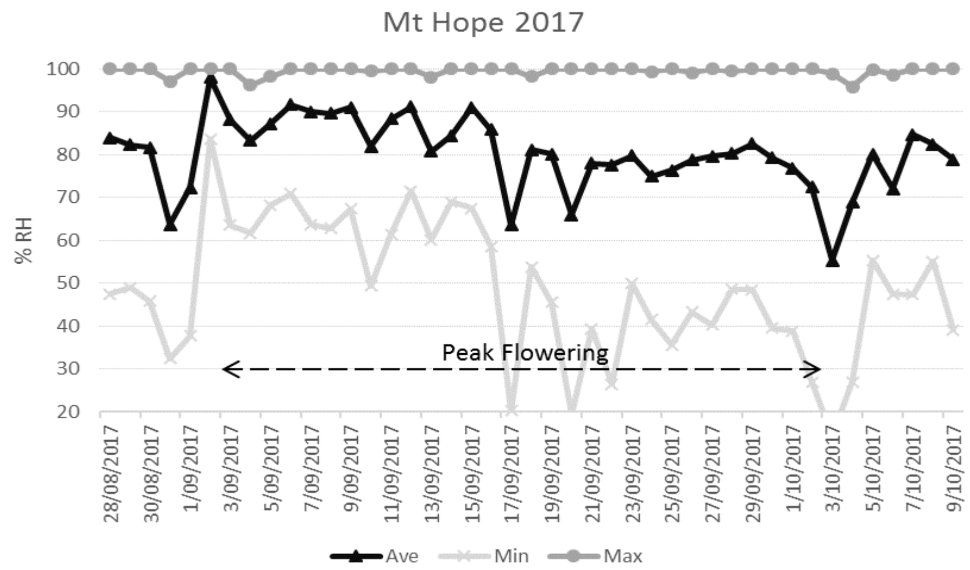
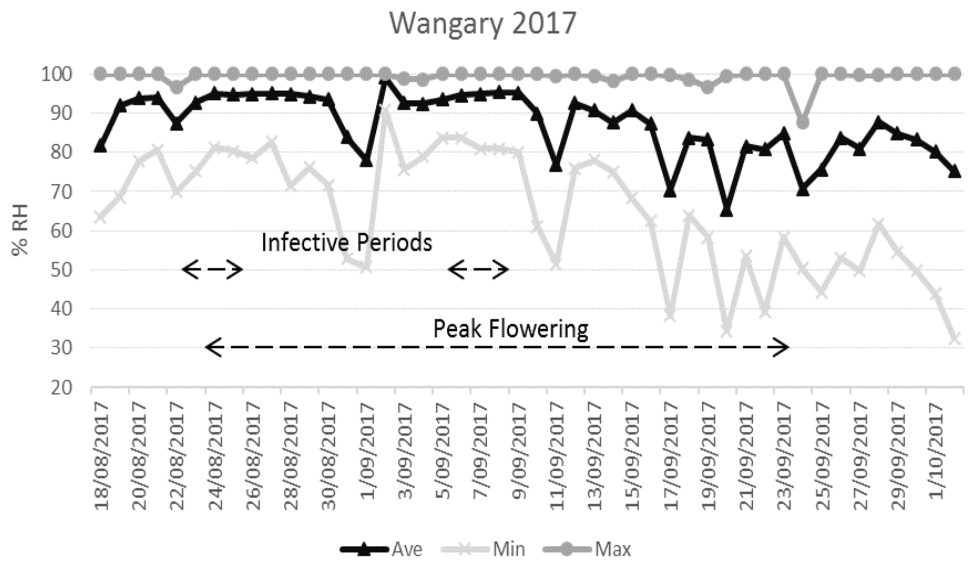


Figure 1 – Relative humidity through canola flowering periods at detailed monitoring sites on the LEP in 2017.


Mt Drummond 2017
% RH
Peak Flowering
Ave
Min
Max


Mt Hope 2017
% RH
Peak Flowering
Ave
Min
Max


Wangary 2017
% RH
Infective Periods
Peak Flowering
Ave
Min
Max

Inoculum

Sclerotinia was present at each of the six main monitoring sites, with at least one lesion present in each crop, and petal samples confirming the presence of spores in each crop. The rotational histories of these paddocks support the likelihood of inoculum build-up, with a susceptible broadleaf crop being grown roughly 2/5 years at each site, for at least the last 20 years (data not shown). Combined with a reduction in tillage and stubble burning reported by all growers (data not shown), the build-up of viable inoculum within 2-3 cm of the soil surface is expected. However, the degree to which petals were infested with spores varied between sites and throughout the season. Table 3 (below) shows the proportion of petals infected at each sampling date for each of the six sites.

	Sampling Date									
Site	**30 Jul**	**7 Aug**	**14 Aug**	**21 Aug**	**28 Aug**	**3 Sep**	**11 Sep**	**18 Sep**	**24 Sep**	**Ave***
Coulta	20	75	90	90	35	30	95	55	0	70
Edillilie	NA	70	40	25	55	40	45	20	0	30
Kapinnie	0	10	0	35	45	0	45	5	0	25
Mt Drummond	NA	NA	0	45	5	0	10	5	0	5
Mt Hope	NA	NA	45	55	25	5	70	10	0	20
Wangary	NA	70	70	80	95	90	100	90	5	75

Table 3 – Petals with sclerotinia spores present as a percentage of total. * Average spore release throughout the 'peak' flowering period (30% bloom onward for 5 weeks).

Mt Drummond appeared to have consistently lower levels of spores released throughout the season, with only one sampling date (28 August) showing moderate levels of spores. Despite low rainfall conditions throughout the season and a significant delay in starting rainfall, there were moderate levels of petal infestation throughout the season at Mt Hope. Heavy spore release occurred relatively early at Coulta, Edillilie and Wangary, whereas Kapinnie appeared slower to start and remained quite variable throughout the season.

Spore release appeared to almost completely reduce by the end of September.

Disease

Disease incidence in the 6 survey paddocks ranged from 0.2% at Mt Hope to 16.8% at Kapinnie. Severity ranged from 5.2% at Coulta to 20.8% Edillilie. Combined, these estimates of incidence and severity gave a total predicted yield loss estimate of between 0.23% at Wangary to 1.72% at Kapinnie. At the second site surveyed from within each of these paddocks, yield loss was very similar, 0.16% at Edillilie to 1.36% at Kapinnie. Sclerotinia incidence was low in all other additional survey paddocks, except one at Wanilla, where incidence was 3.6% and severity 11.1%, giving an estimated yield loss of 0.4%. The incidence and severity, as well as an estimated total yield loss for the survey site is given in Table 4.

Site	Variety	Sclerotinia incidence (%)	Severity (yield difference) (%)	Total Estimated Yield Loss (%)
Coulta (Main)	45Y91	10.2	11.3	1.16
Coulta (2nd)	45Y91	12.2	5.2	0.63
Edillilie (Main)	44Y90	3.2	20.8	0.67
Edillilie (2^{nd})	44Y90	0.8	19.7	0.16
Kapinnie (Main)	Diamond	16.8	10.2	1.72
Kapinnie (2^{nd})	Diamond	13.0	10.4	1.36
Mt Drummond (Main)	44Y90	0.4	NC	<0.5
Mt Drummond (2^{nd})	44Y90	0.0	NC	0
Mt Hope (Main)	44Y89	0.2	NC	<0.5
Mt Hope (2^{nd})	44Y89	1.0	NC	<0.5
Wangary (Main)	45Y91	4.6	4.9	0.23
Wangary (2^{nd})	45Y91	6.6	6.2	0.41
Mt Drummond	44Y90	0.8	NC	<0.5
Kapinnie	Bonito	0.0	NC	0
Mt Hope	Diamond	0.8	NC	<0.5
Wangary	45Y91	1.8	-1.6	<0.5
Edillilie	45Y91	0.0	NC	0
Wanilla	45Y91	0.4	NC	<0.5
Wanilla	Banker	0.0	NC	0
Wanilla	44Y89	3.6	11.1	0.4
Wanilla	44Y89	0.4	NC	<0.5
Yeelanna	NA	0.0	NC	0
Karkoo	NA	0.0	NC	0
Yeelanna	45Y91	0.0	NC	0
Yallunda Flat	NA	0.4	NC	<0.5
Cummins	Quartz	0.0	NC	0

Table 4 – Incidence and severity of sclerotinia in canola crops surveyed on the LEP in 2017.

Plot Trial

No sclerotinia lesions were observed in any treatment, including fungicide timings or variety, of the plot trial. There were no yield differences between fungicide treatments and, whilst there was a substantial yield difference between varieties, this difference clearly does not relate to the interactions between flowering timing and sclerotinia development, but rather to yield potential differences and probably specifically to the varying phenology of the two varieties in response to the short season. Table 5 below shows the evenness of yields within each variety, for all spray timings.

Variety	Spray Timing	Yield	Oil%
Diamond	UTC	1.62	44.5
	Full (all timings)	1.69	45.3
	Early (10% bloom)	1.67	44.0
	Mid (30% bloom)	1.66	44.8
	Late (50% bloom)	1.76	44.8
Hyola 575 CL	UTC	1.01	43.9
	Full (all timings)	1.01	43.2
	Early (10% bloom)	0.94	43.6
	Mid (30% bloom)	0.98	43.8
	Late (50% bloom)	0.98	43.8

Table 5 – Yields and oil content of fungicide x variety treatments at Mt Hope in 2017.

What does this mean?

Paddock Monitoring & Survey

Sclerotinia is a widespread disease on LEP, with virtually every paddock monitored showing some signs of sclerotinia inoculum. Furthermore, there is real potential for damage given the incidence of infected plants within certain paddocks, under relatively dry, unfavourable conditions. However, despite the unexpectedly high incidence in some paddocks, yield loss was highly variable, and, at worst, only 1.7% in a reasonably high yielding crop. Application of a registered fungicide at label rate would not prove economical under this sclerotinia disease burden.

Explaining incidence and severity appears complex based on the data presented above. At Mt Drummond, the significantly lower inoculum levels, combined with no favourable periods conducive to infection quite adequately explained the lack of sclerotinia disease. Similarly, the lack of adequate conditions, despite the higher inoculum levels, appeared to limit disease at Mt Hope. Whilst all other sites had overlap of spore release, flowering and humid conditions, they varied greatly in their response. Edillilie experienced extremely wet conditions during flowering, with significant levels of inoculum, however disease expression did not occur to the extent that it did at Kapinnie, which experienced fewer favourable humid hours, similar spore release and yet far greater disease incidence and severity. Similarly, Coulta and Wangary appeared to be less suitable for sclerotinia than at Edillilie, yet both experienced equal or greater disease burden. From the data collected to date, incidence appears to be somewhat explained by inoculum load (petal testing). The exception to this was at Kapinnie, where a lower inoculum load still resulted in high infection rate and relatively high disease severity, however this may have been due to other factors, such as cultivar. Severity appears to be somewhat related to the total number of infective hours i.e. once an infection occurs, greater periods of high humidity may control the degree to which the infection progresses and, hence, how much yield is lost in that plant.

This work will continue in 2018 and it is expected that further data points from a range of seasons/inoculum levels/crops will give a clearer picture of the nature of sclerotinia on LEP and hopefully lead to greater predictability and more certain decision-making around fungicide application.

Plot Trial

The plot trial clearly illustrates two key points. Firstly, for sclerotinia to develop, there must be coincidence between spore release, prolonged wet conditions and the presence of senescing (dying/falling) flowers. The petals collected from the grower’s crop surrounding the plot trial as part of the paddock survey showed that sclerotinia spores were present in this paddock and a small number of infected plants were found in the grower’s crop. However, this crop was dry sown and germinated earlier than the plot trial and, thus, there were flowers senescing earlier in the season. It is likely that some of these petals contained spores and were able to lodge against the canola stems during a period humid enough earlier in the season for minor sclerotinia lesions to develop. However, in the plot trial, where spore release likely occurred when plots were still at vegetative or bolting stages, it is likely that any spores released did not contact suitable senescing material to begin the infection process. It is also possible that spore release did occur as late as flowering stages in the plot trial but that the dry conditions at this time did not allow for further infection of stems.

Secondly, the complete lack of response to fungicide is notable. Although it should be expected that no fungicide application would have an effect on sclerotinia given the conditions were not suitable for it to develop, it might have been expected that there would be some associated benefit from the control of other diseases, including upper canopy infection (UCI) blackleg, given this certainly was present in the trial and blackleg appears to be less dependent on extended wet conditions. However, in this trial, despite the presence of UCI blackleg disease and sclerotinia inoculum, there was absolutely no gain from spraying a fungicide. 2017 was an atypical season and more data needs to be collected before management conclusions can be made from this research.

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Location:

Mt Hope (field trial)

Rainfall:

Av. Annual: 400 mm

Av. GSR: 325 mm

2017 Total: 390 mm

2017 GSR: 274 mm

Yield:

Potential: 1.7 t/ha (B)

Actual: 1.68 t/ha

Paddock History:

2017: Canola

2016: Lupin

2015: Wheat

Soil Type:

Red chromosol

Plot Size:

2 m x 10 m x 3 reps

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IMPROVING EYESPOT DISEASE PREDICTION AND REFINING MANAGEMENT STRATEGIES BASED ON RISK

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Key Messages

- In a late break, low rainfall season at Yeelanna, under low-moderate disease levels, there was no yield response to fungicide application at any timing;
- Whilst variety choice did influence yield, this appeared to be unrelated to eyespot or any other disease, but rather related to phenology and season;
- Whilst some eyespot infection was recorded, there did not appear to be any effect of cultivar or fungicide application on disease incidence or severity;
- It is likely that total inoculum in the soil/stubble was reduced in all plots, due to the weather conditions alone and not influenced by either variety or fungicide treatments.

Why do the trial?

Eyespot disease can have devastating effects on the yield of wheat under the right conditions. Growers on the Lower Eyre Peninsula (LEP) are likely to have seen these effects in recent years, or at least heard about them. Yield losses in the order of 20-30% are common, resulting from both direct grain fill reduction as well as losses associated with harvesting difficulty.

Eyespot can be difficult to manage. Symptoms only appear long after infection has occurred and, by that point, fungicides are no longer effective. Thus, management decision-making is pre-emptive and based on risk. Management options include sowing cereals less often, choosing a more resistant cereal cultivar, sowing of eyespot-affected paddocks last in the normal sowing program, and application of a fungicide during early growth stages.

This research program is aimed at evaluating the benefit of various management strategies within cereal phases under varying eyespot inoculum levels and seasonal conditions, particularly in wheat-on-wheat situations, so that eyespot management remains flexible and fungicide use is limited to situations where a return is likely.

How was it done?

A trial was established at Yeelanna. The site was chosen based on a previous eyespot problem and the likelihood that the grower would plant consecutive cereal crops in 2017 and 2018, allowing a 2-year wheat-on-wheat trial to be established. The initial Predicta B soil test showed a low level of eyespot inoculum. Further testing of soil disease inoculum levels (eyespot only) was undertaken for every plot to identity variation across the trial site.

The trial was sown using a standard knife point/press wheel plot seeder, with two cultivars of varying susceptibility, Mace (S) and Trojan (MS) on 27 June, ahead of a forecast rain event on 3

July (30 mm). All seed was coated with a fungicide to assist in control of rusts. Herbicides and fertilisers used throughout the trial reflected district practice.

Plots received a fungicide treatment at either GS25 (25 August), GS31 (11 September) or GS 39 (3 October). There were also control plots for each variety, where no fungicide was applied. As yet, no fungicides are registered for the control of eyespot in wheat, however a fungicide registered for control of other diseases in wheat was used at maximum label rate.

Disease incidence and severity was calculated by visually inspecting plants from samples taken from 10 cm of row in 8 locations across each plot on 16 November, with a 0-4 scoring scale for each plant used to calculate a disease index for that plot. The trial was harvested on the 11th December and plot weights were recorded and grain samples retained for analysis.

What Happened?

Starting disease inoculum at the trial site varied greatly between plots, ranging from 0 to 2.6 log10kDNA copies/g soil. Figure 1 shows the trial site layout and inoculum level.

Figure 1. Starting inoculum at Yeelanna in 2017 (log10kDNA copies/g soil), where 0.3-1.5 is considered low risk, 1.5-3.1 moderate and >3.1 high.

Range \ Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
4	0.62	1.8	0	0	0	0	0.42	0	0	0	0	1.04	0	0	0.47	0
3	0	0.64	0	0	0.61	0.9	0	1.42	0	1.36	0	0	0	0	0	0
2	0	2.6	2.05	0	2.03	1.24	0	0	1.01	0	0	0	0	1.22	0	0
1	0	0	0	1.46	0.4	0	0	0	0	2.23	0	0	0.53	1.09	0	0.46

Growing season rainfall was below average with just 204 mm from April to October. However, with the late break, the growing season at the trial site, measured from seeding to harvest, was just 161 days (23 weeks) compared to a common LEP growing season of 28 weeks.

All plots had at least some eyespot present, but incidence was generally low, ranging from 1–13% stem infection. Severity was extremely low, ranging across all plots from 0.01 to 0.18 (out of a possible 4). However, disease incidence and severity were not affected by either fungicide or variety, nor the starting inoculum present in the plot.

Yield was not affected by fungicide timing and no fungicide treatment was any higher yielding than the untreated control for either Mace or Trojan. Cultivar did significantly affect yield (P =

0.0004), with Mace yielding 2.94 t/Ha and Trojan 2.82 t/Ha across all fungicide treatments. There was no relationship between starting inoculum and disease incidence or yield.

What does this mean?

For eyespot, risk is related to two factors; the inoculum level present in the paddock, since eyespot is predominantly rain-splashed from stubble already present in the paddock and, the weather conditions in any given season. Higher levels of inoculum in a paddock make infection more likely – this can now be tested as part of the Predicta B disease DNA soil test, but is also likely to be indicated by a recent eyespot problem in that paddock. Because of the disease's need for rain-splash to spread spores, as well as its slow growing nature, early sown crops which experience substantial or multiple rainfall events from early tillering to early stem elongation are likely to incur yield penalties if untreated where inoculum is present. Late-sown crops or crops which do not experience heavy and prolonged rainfall through this period, may not see yield effects, even though some infection may still occur (which would influence risk for the following year).

The starting inoculum levels, shown in Figure 1, highlight an important point. Eyespot inoculum was highly variable between plots at a trial scale. At a paddock scale this variability is also normally visible. The implications of this variability is that a PredictaB test conducted in part of a paddock may not represent the problem over the whole paddock. Likewise, a quick perimeter check of a paddock may not identify an eyespot problem throughout the paddock. Identifying the extent of inoculum presence is critical to making management decisions in following years and there is clearly the need to thoroughly assess the whole paddock based on the spatially-variable nature of this disease.

It is quite clear from this trial that the combination of low-moderate levels of starting inoculum and a late break/below average rainfall year is not conducive to eyespot disease development and does not justify fungicide application or the selection of a wheat cultivar of lower disease susceptibility. Whilst the low rainfall is likely to have directly reduced infection (fewer rain-splash events), it is also likely that the late break and low rainfall, which resulted in low crop biomass and thus low canopy humidity throughout peak spore release, reduced eyespot infection. Eyespot generally requires extended wet/humid conditions in early growth stages to successfully infect the host. Where there was infection, the severity scores of these infections were low. This is likely due to the short growing season, as eyespot is considered to be a slow-growing disease which generally needs a long growing season to have substantial yield impacts.

This trial highlights the cost-benefit of knowing the eyespot risk for each paddock, in each season, before making management decisions. Under the low-inoculum, late break conditions of 2017, choosing a variety of higher resistance status, Trojan, resulted in a yield reduction of 0.12 t/Ha, compared with the less eyespot-resistant Mace. This equates to a loss of $30/Ha (@ $250/t). Furthermore, application of a prophylactic fungicide would cost between $16.50 and

$31/Ha (depending on product and including contract spraying costs of $10/Ha). Overall, management for eyespot in a low risk scenario could reduce profit by $46.50/Ha.

Furthermore, the treatments did not appear to affect disease incidence and severity and, thus, may not have had any residual benefit on inoculum levels for the following year. This will be further tested ahead of the second cereal phase in this trial, however it appears that there would be little benefit of extensive management to successive wheat crops in a paddock where starting inoculum is low and seasonal conditions are unconducive to eyespot.

This trial will continue in 2018, with wheat plots sown directly over 2017 plots (i.e. wheat on wheat). Further assessment of disease inoculum will be undertaken in the established plots to determine whether 2017 treatments had any effects on inoculum build-up (or decline). In 2018, we plan to evaluate the effects of 2017 management decisions on both Trojan and Mace (possibly replaced with Scepter). A second trial site will also be established to restart the 2-year trial under different conditions.

Acknowledgments
This research program is funded by GRDC (Project DAS00167). Thank you to Margaret Evans (SARDI, Waite) for assistance with trial planning and management. Thank you to Helena Oakey (SAGI, Uni of Adelaide) for assistance with statistical design and analysis. Thank you to Ian Proctor for providing the trial site at Yeelanna for this research.

Location:
Yeelanna
Rainfall:
Av. Annual: 425 mm
Av. GSR: 325 mm
2017 Total: 360 mm
2017 GSR: 204 mm
Yield:
Potential: 3 t/ha (B)
Actual: 2.94 t/ha
Paddock history:
2017: Wheat
2016: Canola
2015: Wheat
Soil type:
Red chromosol
Plot size:
2 m x 10 m x 4 reps

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BAITING ROUND SNAILS PRIOR TO EGG LAYING IN ACCORDANCE TO ENVIRONMENTAL CONDITIONS ON LOWER EYRE PENINSULA, 2017

Jacob Giles, SARDI Port Lincoln

Jacob Giles[1] and Michael Nash[2]
[1]SARDI, Port Lincoln, [2]formerly SARDI, Waite

Key messages

- Baiting can be successful during warmer months if snails are active and feeding.
- Relative humidity >90% triggers snail activity.
- Periods of activity are not linked just to rainfall but also dew which can be forecast to some extent.
- Snail activity around rainfall events is dependent on significance of rainfall event as well as temperatures pre and post event.
- Do not cut bait rates as increase in bait number = increase in incidence.
- Decrease potential alternative food source and refuge through summer weed management.

Introduction

Previous SARDI work, including at Coulta (Gontar 2016), established critical points regarding the effective baiting of snails prior to egg laying. Firstly, if you plan on spreading bait at seeding, it is highly likely that egg laying has already taken place and snail issues will continue into the season. Figure 1 outlines this as the size of a snail's albumen gland reflects its level of preparedness leading up to egg laying (14 April). It is clear that control prior to egg laying is the most effective way of limiting population growth. It was also well established that cultural methods of control such as rolling were highly effective and not to be disregarded.

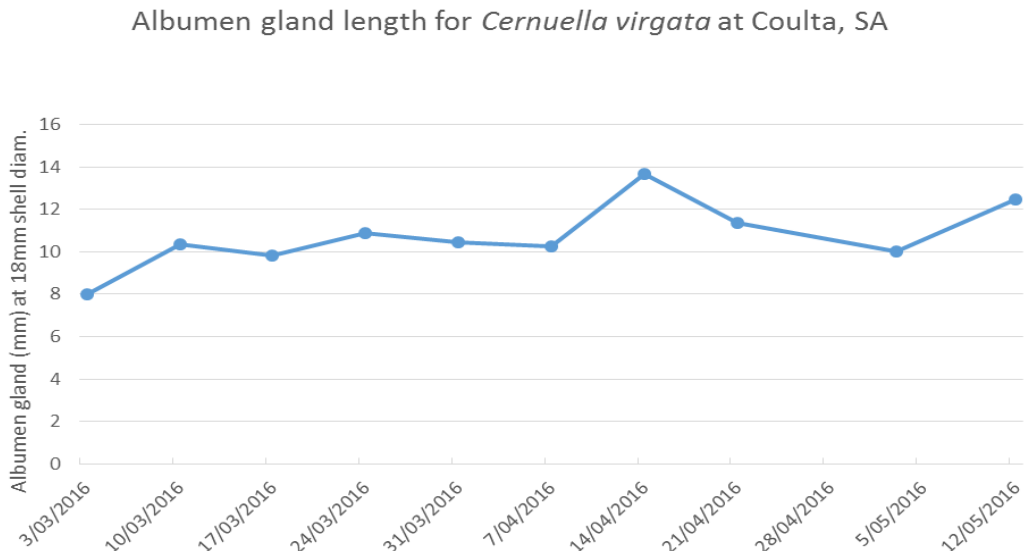

Figure 1. Albumen gland size variation over time at Coulta in 2016 (Gontar, Nash 2016)

Methods

A Brinno TLC100 time lapse camera and HOBOware Pro data logger were assembled in the paddock alongside the trial site. Pestmaster bait (15 g/kg metaldehyde, 2.5mm diameter) was placed under the camera every 7-10 days to enable the constant monitoring of feeding activity. Two baiting treatments at 7.5 kg/ha took place, one in February and one in March. Each treatment saw two 50 m strips baited, with 30 quadrat counts to assess the snail density in each strip. Counts were split into ten quadrat counts at each of the three marked positions. Pre-treatment counts took place 1-2 days prior to baiting followed by post-treatment seven days after bait application. Live samples were also taken in two paddocks, with gland dissections performed.

Results

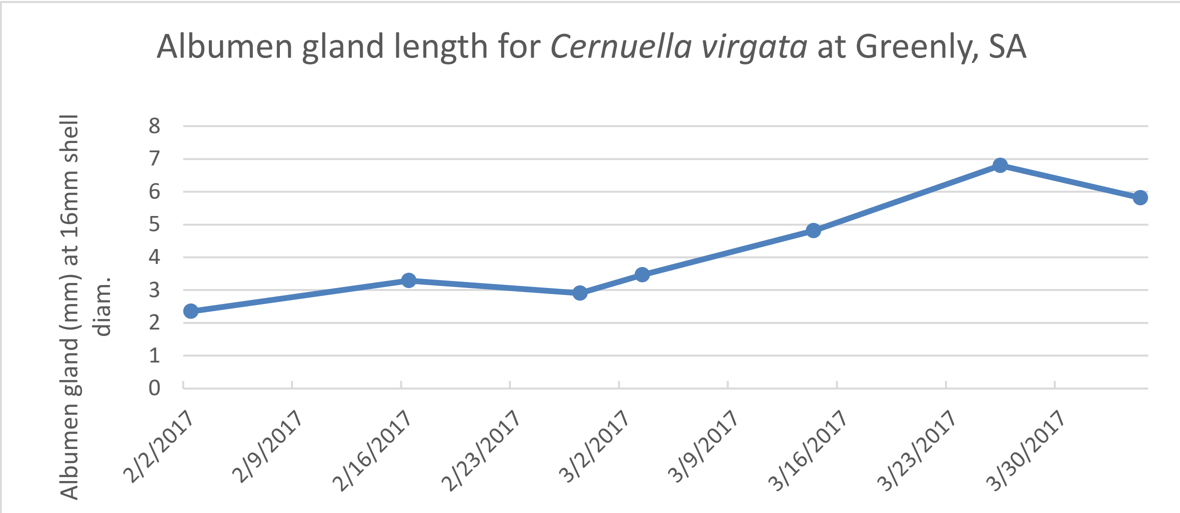

Figure 2. Albumen gland size variation over time in canola stubble at Greenly in 2017

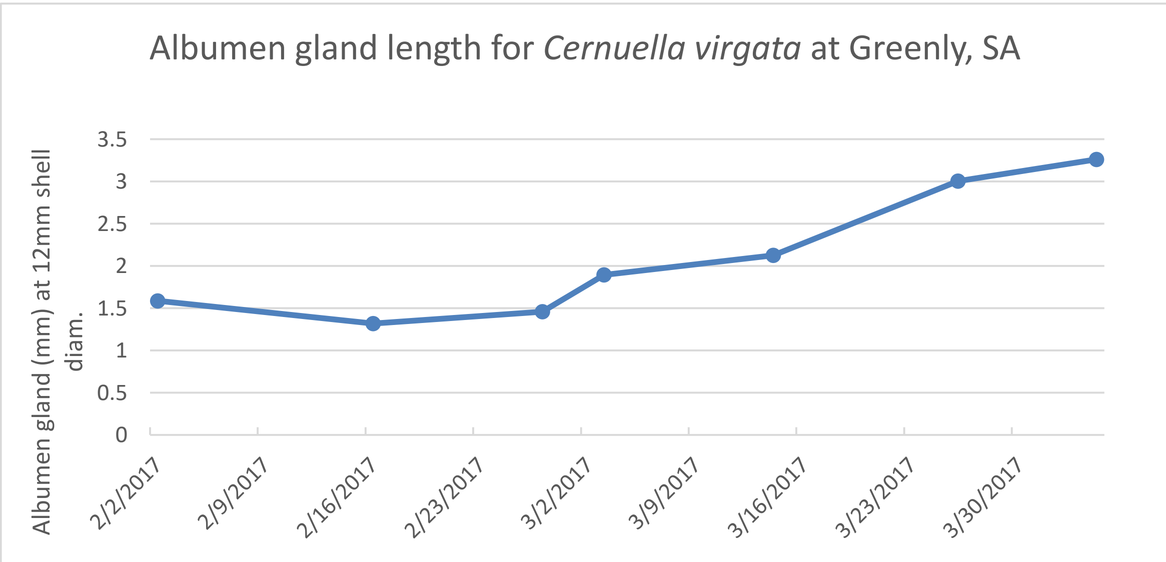

Figure 3. Albumen gland size variation over time in wheat stubble at Greenly in 2017

Figures 2 and 3 demonstrate a steady increase in albumen gland size from early March. Such trends could be indicative of an increase in opportunistic feeding and hydration to allow gland size increase, however at this stage such conclusions are anecdotal.

Table 1. Snail population counts before and after bait treatment on 6 February 2017. Bait efficacy is the decrease in population accounted for by baiting.

Baiting treatment							**Average**
Monitoring point	1.1	1.2	1.3	2.1	2.2	2.3	
Snails/m^2 before	40	68	64	27	37	46	47
Snails/m^2 after	25	39	39	24	28	35	32
Pop^n change (%)	-38	-43	-39	-11	-24	-24	-30
Bait efficacy (%)	27	31	29	08	18	18	22

Table 2. Snail population counts before and after bait treatment on 6 March 2017. Bait efficacy is the decrease in population accounted for by baiting.

Baiting treatment							**Average**
Monitoring point	1.1	1.2	1.3	2.1	2.2	2.3	
Snails/m^2 before	25	37	33	29	22	27	29
Snails/m^2 after	3	12	10	5	7	1	6
Pop^n change (%)	-88	-68	-70	-83	-68	-96	-79
Bait efficacy (%)	62	48	49	59	48	68	56

Table 1 demonstrates the poor result produced by baiting over warmer months through a period that did not facilitate snail activity. During the week post baiting only two hours of significant snail movement were observed. Such a period is seen when conditions are dry, which is usually linked to hot, windy weather with a lack of rainfall. Baiting during such a period is ineffective. Table 2 shows greater bait efficacy (56%) as a result of 15 hours of significant activity during ideal conditions linked mainly to dew events (only two hours due to rainfall at the end of this period). This clearly shows baiting of snails as an effective means of snail control in early autumn.

Discussion

Cultural methods of snail control such as cabling and rolling can be a highly effective method of snail control (Gontar, Nash 2016). Such methods are well known to provide the best control on hot days when the chances of desiccation of snails is greater.

Monitoring and research has now shown that snails respond to short-term weather change rather than calendar-based seasonal change. This provides growers with an opportunity to bait during periods of high activity prior to egg laying. High levels of activity are seen as a ground inversion (dew) or rainfall event results in >90% relative humidity (RH), and coincides with low daytime temperatures. Dew is driven by moisture near the soil surface from recent rainfall events, as well as ground inversion which is common on clear nights going into/during autumn. A combination of surface soil moisture, low wind speed and day time temperatures below 27–30 °C will greatly increase the chance of a ground inversion or dew. Daytime temperatures over 30°C will severely hamper snail activity. The more favourable conditions are, the greater the length of time snails will remain active each night. A heavy dew will facilitate around eight hours of activity in a night. BOM current weather observations, while not perfectly accurate, are a very good guide of periods when RH>90%.

Baiting efficacy is further increased if ground cover and alternative food availability is decreased (Baker, 2015). The autumn period also correlates with a greater snail mortality when baits are consumed however there is still some un-accounted for variability (Brodie, 2017). Snails have been observed to move without feeding. This will clearly decrease baiting efficacy and must be taken into account.

Conclusion

Cultural methods play an integral role in snail control over the summer months. With increasing knowledge and a level of predictability in the weather, baiting is another means by which snails can be effectively controlled prior to egg laying. However, if conditions do not facilitate snail activity and summer weeds are present baiting efficacy will be compromised.

Acknowledgement

This work was conducted on behalf of LEADA under the GRDC-funded Stubble Initiative (LEA00002).

Thank you to the Parker family for providing a site for trial work, maintaining the site and baiting where required. Many thanks to Helen Brodie for her technical assistance and providing data.

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Baker, G. 2015, 'Stubble retention: A barrier to snail management'.

Brodie, H. 2017 'Integrated approach best for snail control', Nov-Dec 2017, GRDC Groundcover

BOM Current weather observations: http://www.bom.gov.au/sa/observations/saall.shtml#WC

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THE EFFECT OF INCREASED SOWING DENSITY ON YIELD WHEN SOWING LATE AND IS INFLUENCE ON YIELD DETERMINING FACTORS

Jacob Giles, SARDI Port Lincoln

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Key messages

- There was no significant response to sowing density in 2017.
- A significant yield response was seen for time of sowing (TOS) and variety.
- There was no significant nitrogen (N) response across the trial.
- There was a significant yield response to N for Scepter in TOS1, (0.25 t/ha).
- Yield was driven by grain number /m^2 .

Introduction

The trial contained 36 treatments. Three varieties, two times of sowing, 2 N treatments at 3 different sowing densities. Sowing densities were 80, 160 and 240 kg/ha. Each treatment was replicated 3 times. Scepter, Emu Rock and Trojan were sown at time of sowing (TOS) 1, dry which emerged 11th July. TOS 2 was sown into a moist seedbed and emerged August 3rd. All treatments received 100kg DAP at sowing (treated with Impact), while high nitrogen treatments received 46 units of N at TOS 1 Zadoks GS31, prior to rainfall.

Results

A significant yield increase was seen as a result of both time of sowing and variety (P<0.001). While this would be expected, yield differences between TOS 1 and 2 ranged from 0.61 – 0.7 t/ha. Figure 1 shows that in both TOS 1 and 2 Scepter yielded considerably higher than Emu Rock (0.41, 0.32 t/ha) and Trojan (0.29, 0.28 t/ha).

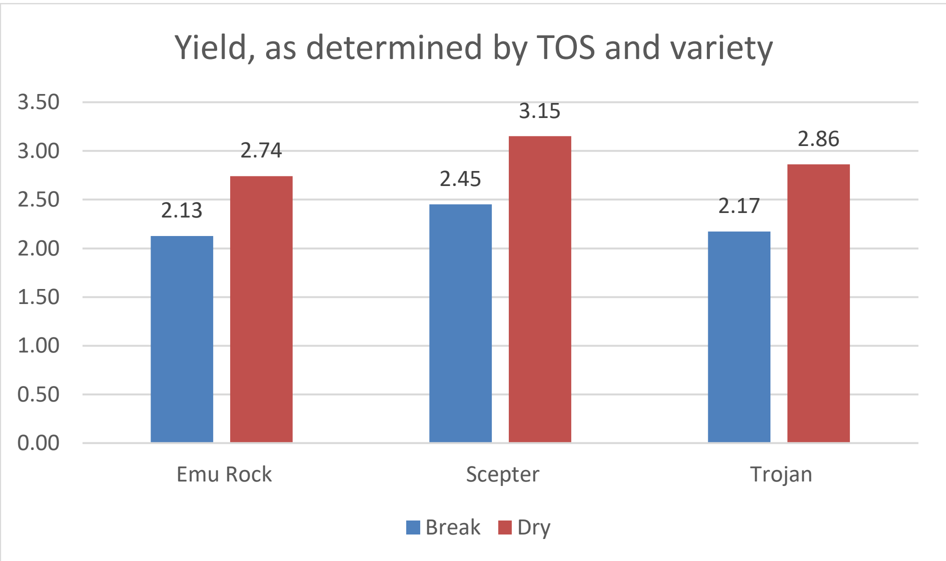

Figure 1: Yield response as a result of two times of sowing at Ungarra in 2017. TOS 1 emerged 12th July, TOS 2 emerged 3rd August.

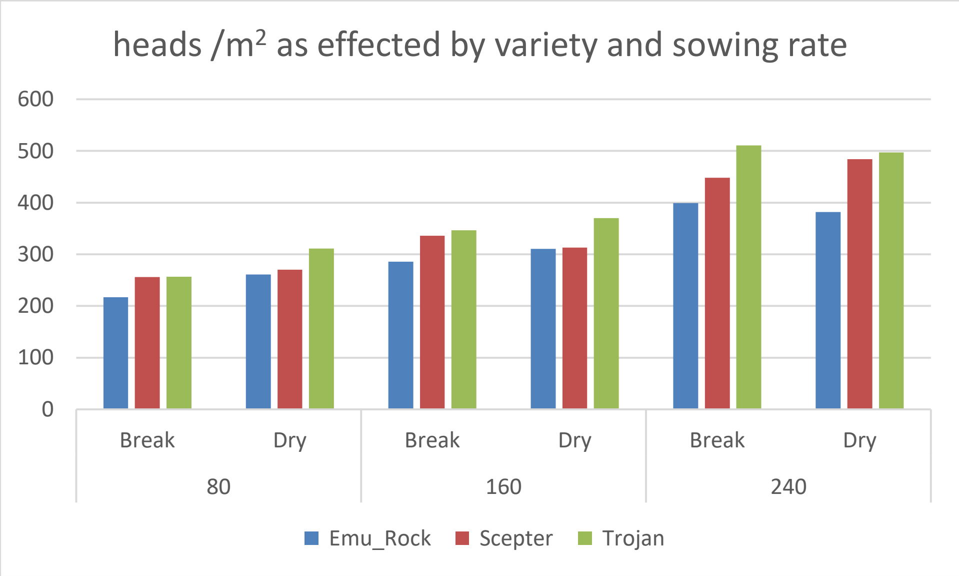

Figure 2: Heads /m^2 as determined by variety and sowing rate. No significant differences were seen between TOS but rather variety and sowing rate.

Figure 2 displays the lack of response of heads per square metre to TOS. This indicates that the yield difference between TOS 1 and TOS 2 is not driven by head number per square metre. An increase of sowing rate resulted in an increase of heads per square metre as sowing rate increases, (which could be expected). Table 1 shows plants produced more heads per plant when sowing rates were at 80 kg/ha. This percentage did not vary hugely when sowing rates were increased from 160 to 240 kg/ha (0-0.1 tillers/plant) (Table 1).

Table 1: Heads per square metre as a result of three different sowing rates for each variety at Ungarra, 2017

Variety	kg/ha	Plants m^2	Heads m^2	Tillers/ plant
Emu Rock	80	138	239	1.7
	160	254	298	1.2
	240	365	391	1.1
Scepter	80	164	263	1.6
	160	298	325	1.1
	240	418	466	1.1
Trojan	80	168	285	1.7
	160	320	358	1.1
	240	463	504	1.1

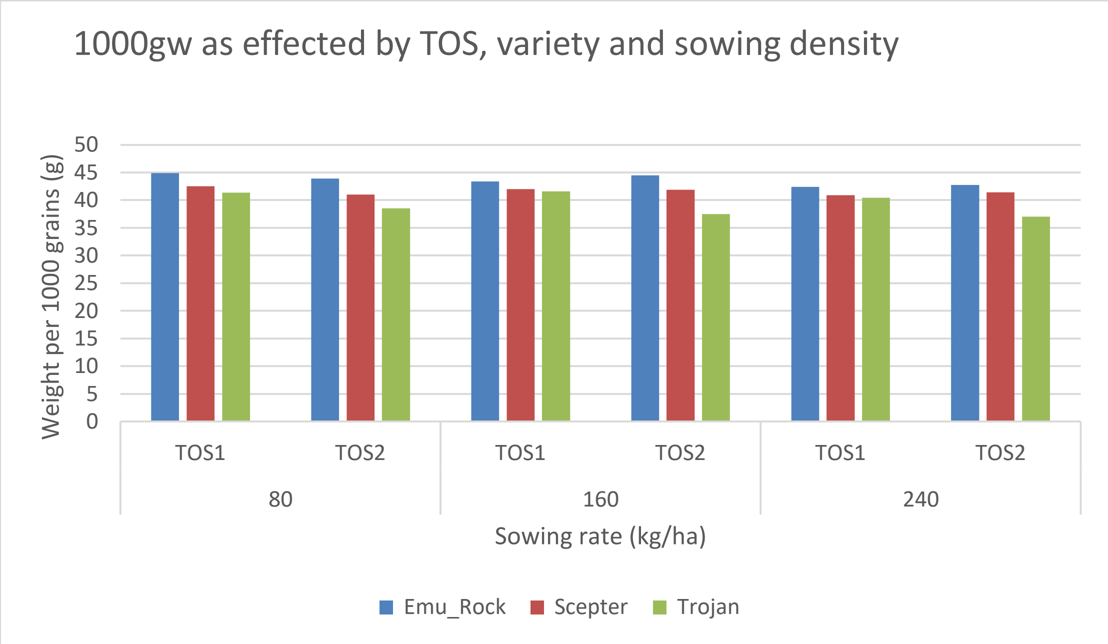

Figure 3: Displaying the effect of TOS, variety and sowing rate on 1000gw.

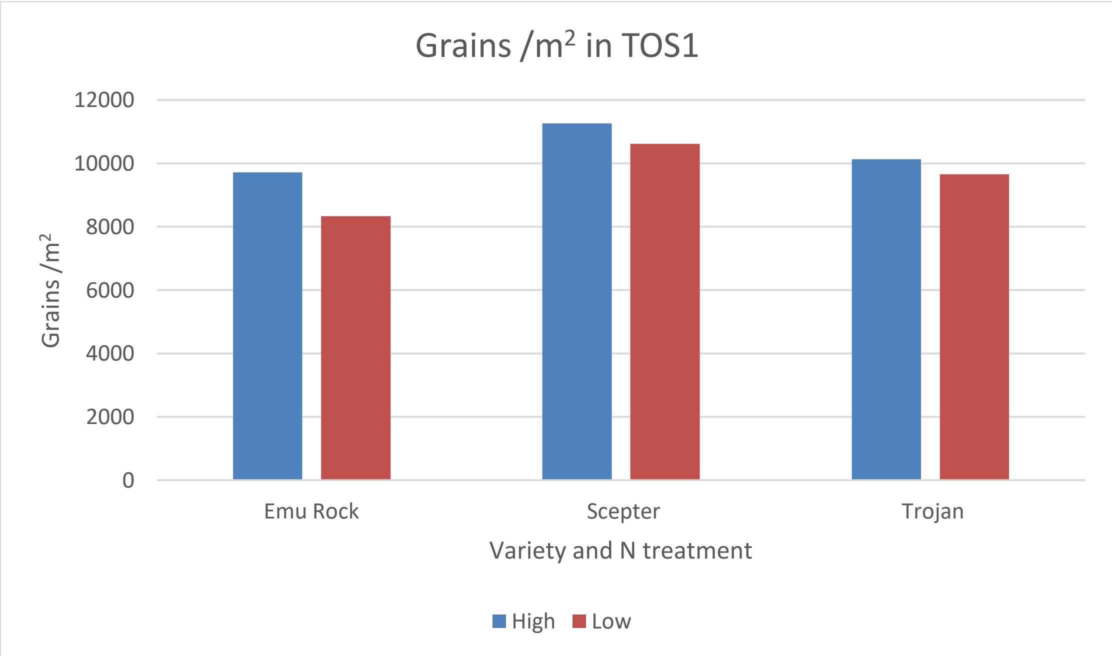

Figure 4: Differences seen between varieties in TOS 1 as measured by grains /m^2

There was no significant interaction between TOS and 1000gw across all varieties. While Trojan saw a consistent decrease in 1000gw from TOS1 to TOS2, both Scepter and Emu Rock did not (Figure 3). If yield is a result of (grain number*grain weight) per area, and grain weight differences are even across treatments, it displays that grain number is the main driver of yield. This is shown in Figure 4 where Scepter yielded highest followed by Trojan then Emu Rock.

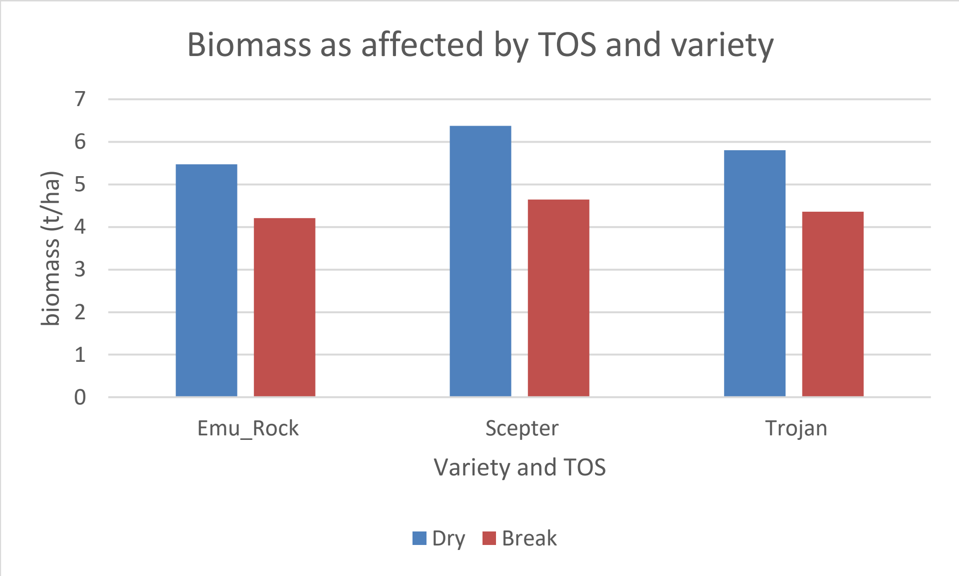

Figure 5: Biomass as determined by TOS and variety, Ungarra 2017

Biomass trends fit similarly to that of grains /m^2. TOS 1 biomass was consistently higher than TOS 2 with Scepter having the highest biomass followed by Trojan and Emu Rock.

Scepter yielded significantly higher ($P<0.001$) than Emu Rock and Trojan across both times of sowing. It can be seen in Figure 4 that Scepter is able to maintain a much higher number of grains /m^2. Table 2 displays the variation between yield determining factors within Scepter, TOS1 as a treatment and its resulting yield. It can be seen that despite variable sowing rates and resultant head counts, yield is relatively consistent across TOS 1.

Table 2: Scepter TOS 2, high N, yield variates and factors.

Scepter – an overview of TOS1. What drove the highest yields?									
Nitrogen treatment	sowing rate (kg/ha)	TOS	plants /m^2	heads /m^2	kernels /m^2	g/ 1000 seeds	biomass (t/ha)	yield (t/ha)	Protein (%)
High	80	1	176	280	11276	42.15	6.4	3.37	9.9
High	160	1	297	333	10953	41.37	6.1	3.02	9.6
High	240	1	376	428	11546	39.55	7.5	3.43	10.3

Discussion

The most significant factor in the trial was TOS. Sowing at higher sowing rates did not significantly increase yield, despite increase in number of heads /m^2.

Where yield is determined by grain number and grain weight per area, grain weight remained relatively equal between TOS, indicating that yield was driven by a greater number of grains

/m^2. This is also displayed by the significantly higher grain number produced by Scepter, also showing superior yield in both times of sowing.

Where grain number drives yield and the number of heads /m^2 is sufficient to reach full yield potential, it can be assumed that either pre-determined grain number was less in TOS2, or grain abortion occurred towards the later stages of development. However, grain quality was high. Screenings were low and grain weights were stable. No frosts or major heat events occurred during the critical stages of development. This further pushes the point that the yield penalty seen in TOS2 was a result of the earlier developmental stages being too brief and plants being under developed prior to Zadoks GS30, (end of tillering), resulting in a lower grain number and hence yield.

The trial also demonstrated the ability of Scepter as a variety to perform under a range of circumstances. Despite huge variance in establishment rates and therefore heads /m^2 and two times of sowing it was able to maintain a consistently high yield with sound grain quality parameters. This displays a high level of plasticity in this variety, and explains its ability to maintain high yields across a wide range of environments in the low to medium rainfall zone in South Australia.

Conclusion

No yield benefit was seen from sowing at a higher density across the trial. Time of sowing and varietal choice were of the most importance. Yield was driven by grain number /m^2 for variety and assumedly TOS. Low grain numbers in TOS 2 were driven by the shorter vegetative period prior to Zadoks GS 30.

Acknowledgements

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PRE-EMERGENT HERBICIDES IN A DRY SOWN SCENARIO

Jacob Giles, SARDI Port Lincoln

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Background

The season of 2017 began in many parts of the LEP with little to no rainfall. Despite this, many paddocks were sown early (i.e. April) to maximise yield potential and allow growers to complete their sowing program within the optimal window of sowing (April to June).

Dry sowing has the capacity to increase yields where agronomically suitable varieties are sown, increasing the length of the growing season to maximise WUE and helping avoid adverse conditions (i.e. exposure to heat-stress) from crop flowering to grain fill.

Today's no-till farming systems are heavily reliant on herbicides to provide effective weed control in order to maintain yields. However, widespread resistance to many of the grass selective herbicides has now placed greater importance on pre-emergent herbicides. Many of the pre-emergent herbicides require sufficient rainfall (>10 mm) for soil incorporation and activation. The amount of rainfall required however varies depending on the herbicide and its properties (i.e.; binding co-efficient, solubility, volatility). These properties will also influence the persistence of the herbicide and how quickly it breaks down (usually microbial degradation) and becomes ineffective.

Here we report results from trials investigating the relative performance of several pre-emergent herbicides applied under dry sowing conditions on ryegrass control in wheat (Ungarra) and canola (Yeelanna).

Materials and Methods

Chemicals Used (active, commercial name, group, rate/ha)

Ungarra (Wheat)

1. tri-allate (Avadex Xtra) Group J (1.6 L ha^{-1})
2. pyroxasulfone (Sakura®) Group K (118g ha^{-1})
3. trifluralin (Treflan) Group D (2 L ha^{-1})
4. prosulfocarb + S-metolachlor (Boxer Gold®) J + K (1.5 and 2.5 L ha^{-1})
5. prosulfocarb (Countdown®) Group J (3 L^{-1})

Yeelanna (Canola)

1. metazachlor (Butisan®) Group K (1.5 and 1.8 L ha^{-1})
2. trifluralin (Treflan) Group D (2 L ha^{-1})
3. tri-allate (Avadex Xtra) Group J (2 L ha^{-1})
4. propyzamide (Rustler®) Group D (1 L ha^{-1})
5. napropamide + clomazone (Altiplano®) Group K + Q (3 kg ha^{-1})

Method

At Ungarra, ARG (Domesticated: Diamond T) was sown at 9kg ha^{-1} to achieve a sowing rate of 250 seeds/m^{-2} with the seeder boot raised to achieve a uniform spread of seed prior to sowing. Pre-emergent herbicides were applied at a water rate of 100 L ha^{-1} using a handboom (coarse droplet nozzles) and incorporated by sowing (IBS) within a few hours of application. Spray conditions were ideal, with minimal stubble interception observed. Mace wheat was sown at 110 kg ha^{-1} on the 12th of May. On the 30th of June, prosulfocarb was applied post sowing pre-emergent (PSPE) ahead of a forecast front. The first significant rainfall event (15 mm) occurred on the 3-5th of June, 6 weeks after the herbicides were applied and IBS. The crop emerged on the 14th of July with ryegrass assessments undertaken 20 days later.

At Yeelanna, ryegrass assessments were undertaken on a background population. Herbicide treatments were applied at a water rate of 100 L ha^{-1} using a handboom (coarse droplet nozzles) and IBS within a few hours of application. Hybrid canola Pioneer 44Y90CL was sown at 2.5 kg ha^{-1} on the 15th of June under dry conditions. Stubble interception was minimal to none. Rainfall required for herbicide activation was not received until 18-20 days after application. The crop emerged on the 11th of July.

Results

Ungarra

Table 1: Effect of different pre-emergent herbicides and their tank mixtures on ryegrass control in wheat at Ungarra, 2017. Mean values in columns with different letters are significantly different (P = 0.05).

Treatment	ryegrass m^{-2}	% control	spikes m^{-2}	% control	cost ($ ha^{-1})
Sakura® +Trifluralin	7^{a}	93	1^{a}	99.5	50.17
Sakura® + Avadex Xtra + Trifluralin	8^{a}	93	5^{a}	97	65.2
Sakura® + Avadex Xtra	12^{ab}	89	13^{a}	92	55.13
Sakura®	18^{ab}	84	8^{a}	88	40.09
Boxer Gold® (2.5L ha^{-1})	18^{ab}	83	42^{a}	75	39.25
Boxer Gold® + Avadex Xtra	19^{ab}	82	40^{a}	76	54.29
Avadex Xtra + Trifluralin	29^{abc}	73	33^{a}	80	25.12
Trifluralin	38^{abc}	65	44^{a}	74	10.08
Boxer Gold® (1.5L ha^{-1})	47^{abc}	56	42^{a}	75	23.55
Avadex Xtra	51^{bc}	52	109^{a}	35	15.04
Prosulfocarb PSPE	64^{c}	40	85^{ab}	49	34.5
Nil (untreated)	107^{d}	0	168^{ab}	0	0

At Ungarra, all herbicide treatments provided significant (P<0.001) control of ryegrass (Table 1). Sakura® + trifluralin and Sakura®+ trifluralin + Avadex Xtra performed the best providing 93% control. PSPE prosulfocarb was ineffective providing only 40% control.

Both Boxer Gold® and Sakura® provided equivalent early control (83%), and showed excellent stability given the delay (40 days after sowing) in rainfall required for herbicide activation. Extended residual control with Sakura® and its tank mixture with trifluralin and trifluralin + Avadex resulted in the greatest reduction (95-99.5%) in ryegrass seed set relative to the nil (Table 1). Sakura® is known for its moderate persistence and the benefit of its extended residual control was obvious given the dry conditions experienced last season. Avadex Xtra in combination with Sakura® or Boxer Gold® did not improve efficacy to the same degree as trifluralin. However, many ryegrass populations across the lower EP have developed resistance to trifluralin, and these results may have been somewhat different had a field population been evaluated (i.e. poor control with trifluralin).

Yeelanna Canola (Pioneer 44Y90CL)

Table 2: Effect of different pre-emergent herbicides and their tank mixtures on ryegrass control in canola at Yeelanna, 2017. Mean values in columns with different letters are significantly different (P = 0.05).

Treatment	ryegrass/m^{-2}	% control	spikes/m^{-2}	seed set control (%)	cost ($/ha)
propyzamide (1L ha^{-1}) + Butisan® (1.8L ha^{-1})	4^{a}	83	4^{a}	93	64.25
propyzamide (1L ha^{-1})	5^{a}	77	14^{a}	79	22.85
Butisan® (1.8L ha^{-1})	5^{a}	77	16^{a}	77	41.4
Altiplano® (3kg ha^{-1})	6^{a}	74	17^{a}	75	NA
Butisan® (1.5L ha^{-1})	7^{a}	71	22^{a}	67	34.5
trifluralin (2L ha^{-1}) + Avadex Xtra (3L ha^{-1})	17^{b}	26	63^{b}	6	38.30
Nil (untreated)	23^{b}	0	67^{b}	0	0

Despite the low ryegrass numbers (<25 plants m^{-2}) at Yeelanna, significant (P=0.05) differences in ryegrass control were evident between herbicide treatments (Table 2). All treatments with the exception of trifluralin + Avadex reduced ryegrass numbers and seed set. Trifluralin resistance in ryegrass is widespread across the lower EP and was most likely responsible for the poor control. Tank mix of propyzamide and Butisan® reduced seed set by 93% compared to the nil. A more robust rate of Butisan® (1.8L/ha) provided equivalent ryegrass control to propyzamide (77%). Altiplano® a new herbicide to be released was also effective, and like propyzamide and Butisan provides an option for ryegrass control in all canola production systems (i.e. OP, TT and Clearfield®).

Conclusions

At both sites, Avadex and trifluralin were the least effective options against ryegrass (<65% control) in both wheat (Ungarra) and canola (Yeelanna). Poor results with these herbicides were the result either of herbicide resistance, dry conditions or combination of both. In contrast effective control was observed for Sakura®, Sakura® + trifluralin, and Sakura® +

trifluralin + Avadex in wheat, and propyzamide, Butisan® and Altiplano® in canola. Although several new pre-emergent herbicides are entering the market, be mindful to rotate herbicide groups within and between crops as well as utilising an integrated weed management plan to prevent herbicide resistance development.

Acknowledgements

We would like to acknowledge Jamie Phillis and Ian Proctor for providing trial sites for this research and GRDC for funding the project. Also thanks to Chris Preston and Sam Kleemann for their assistance with the trial.

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HARVEST WEED SEED CONTROL – WHAT WE HAVE LEARNED

Michael Walsh, University of Sydney

Introduction

Australian growers developed harvest weed seed control (HWSC) systems in response to widespread occurrence of herbicide-resistant weed populations. With loss herbicides due to resistance alternative weed control practices are needed to maintain highly productive reduced tillage and stubble retention. Continuing innovation HWSC systems along with research and development efforts over the last two decades has established the efficacy of HWSC systems and driven the widespread adoption of these systems. As the use of HWSC systems continues to grow so does the development of current and new systems. HWSC is now an established method of weed control that being routinely used by Australian growers.

Long-term impact of HWSC

The monitoring of annual ryegrass populations in 25 fields over 17 years in the northern region of WA has demonstrated the potential of HWSC to reduce and maintain weed populations at very low densities (Figure 1). In conjunction with herbicides, HWSC was used on average third year in 12 fields (plus treatment) and rarely (once every ten years) in the remaining 13 fields (minus HWSC). In all fields the initially very high (>50 plants m^{-2}) populations present at the commencement of this study in 2001 were reduced to more moderate levels (1-10 plants m^{-2}) by 2008. From 2008 onwards, annual ryegrass populations in the plus HWSC treatment have consistently been <1.0 plant m^{-2} while for the minus HWSC treatment average plant densities have consistently been 5-10 plants m^{-2} (Walsh *et al.*, 2013). Based on estimated seed production of 200 seed per annual ryegrass populations present in wheat crops at maturity(Walsh *et al.*, 2017), considerable reductions in seedbank inputs result from the routine use of HWSC treatments. Estimated seedbank inputs for the minus HWSC treatment from 2008 onwards were approximately 1,000 - 2,000 seed m^{-2} compared to < 100 seed m^{-2} for the plus HWSC treatment over this period (Figure 1b). These results clearly highlight the potential to drive weed populations to very low levels by including HWSC in weed management programs.

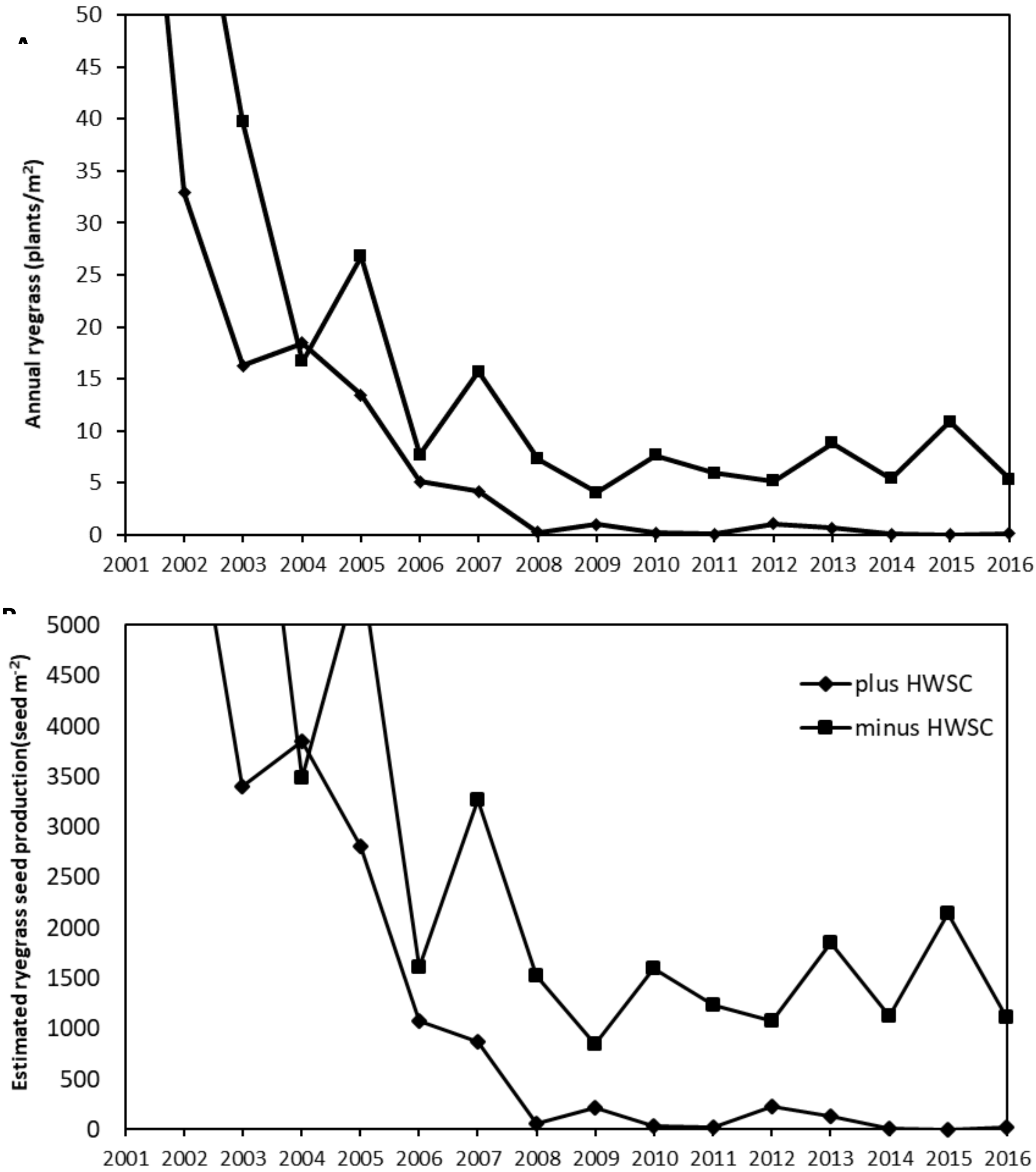

Figure 1. (a) Influence of long-term herbicide alone or herbicide plus HWSC weed-management programs on average annual ryegrass population densities and (b) predicted seedbank

Grower adoption

This survey established that 43% of Australian growers are now routinely using HWSC to target weed seed production during grain harvest. The adoption of narrow windrow burning (30%) was considerably greater than the other currently available techniques of chaff tramlining (7%), chaff carts (3%), bale direct system (3%) and the HSD (<1%). When growers were asked about their future use of these systems 82% indicated that they would be using some form of HWSC within five years. Grower preferences for future HWSC use were primarily for either narrow windrow burning (42%) or the HSD (29%).

Impact mill testing

There has be strong demand for the development of HWSC systems that controls weed seeds during grain harvest without the need for follow-up operations. In 2005 the development began on the Harrington Seed Destructor (HSD), a trailer mounted cage mill, with chaff and straw transfer systems, and a diesel motor as a power source. Although the HSD had proven weed seed destruction efficacy there was grower preference for a harvester integrated system. Subsequently, the iHSD and seed terminator have been developed and commercially released. Extensive testing of the iHSD has proven its seed destruction efficacy on a range of weed species (Table 1).

Table 1. Individual seed weight and percent seed destruction of 11 weed species of Australian. Figures in brackets are the standard errors for the mean of eight replicates.

Weed species	Seed weight (mg/seed)	Seed kill (%)
Annual ryegrass (*Lolium rigidum*)	2.8	96 (0.9)
Wild oats (*Avena* spp.)	26.8	99 (0.1)
Wild radish (*Raphanus raphanistrum*)	5.2	99 (0.1)
Barley grass (*Hordeum vulgare*)	10.0	99 (0.1)
Brome grass (*Bromus* spp.)	15.7	98 (1.0)
Barnyard grass (*Echinochloa* spp.)	2.2	99 (0.8)
Indian hedge mustard (*Sysmbrium orientale*)	0.20	99 (0.4)
Fleabane (*Conyza bonariensis*)	0.047	99 (0.2)
Windmill Grass (*Chloris truncata*)	0.28	97 (0.4)
Sowthistle (*Sonchus oleraceus*)	0.33	99 (0.5)
Feathertop Rhodes Grass (*Chloris virgata*)	0.33	98 (0.3)

Chaff lining and chaff tramlining

The confinement of the chaff material into narrow (20-30cm) rows on dedicated wheel tracks (Chaff tramlining) or between stubble rows (chaff lining) during harvest was developed in the mid-2000s. Chaff rows are established by a chute attached on the rear of the combine that concentrate chaff material into narrow rows. Typically, two rows, one on each wheel track, are established in a chaff tramlining system while a single row is formed in a chaff lining approach. This approach relies on the placement of the weed seed bearing chaff material into an inhospitable environment that prevents weed seed germination and emergence. The concentration of chaff material can have a “mulch effect” on weed seeds where a combination of physical and chemical influences prevents the germination and emergence of the contained weed seed. The placement of chaff material on tramlines has the added advantage of reducing the amount of dust, that created by vehicle movement during summer spraying, interferes with herbicide efficacy.

Chaff grazing

Chaff material is a valuable source of livestock feed and was the original reason for the development of chaff carts in Canada (Olfert *et al.*, 1991). This material typically includes some small and shrivelled grain as well as weed seed resulting in protein contents of between 10 - 15% (Roberts and Devenish, 2001). Chaff material concentrated in lines (chaff lining) may be directly grazed, whereas chaff piles resulting from the use of chaff carts can be grazed or collected for use in lot-feeding. The direct grazing of concentrated chaff or lot-feeding of this material reduces the amount of livestock movement across fields, maximizing the benefits of retaining stubble (Roberts and Devenish, 2001). Recent studies have shown that sheep grazing of fields containing chaff piles had a 2 to 4 kg weight advantage compared to those grazing fields without chaff piles (E. Riggall unpublished data). The grazing action of livestock reduces the amount of chaff material, allowing seeding machinery to easily pass through them without the need for burning (Roberts and Devenish, 2001). While some seed present in the chaff heaps will remain viable after being consumed by livestock, several studies have shown that only a small proportion of grass seeds (< 10%) remain viable after passing through the gut of sheep and cattle (Lehrer and Tisdale, 1956; Schoenbaum *et al.*, 2009; Simao Neto *et al.*, 1987; Stanton *et al.*, 2002).

Conclusion

HWSC systems have evolved considerably since they were first introduced about 30 years ago. These systems will continue to be altered and adapted to fit production systems as these also change. As the adoption of HWSC systems continues to grow there will be the increasing demand for more refined systems that are easier to use and have minimal impact on harvest efficiency as well as maintaining weed control efficacy. Estimates are that HWSC will grow from 42% in 2014 to 82% adoption by 2019. Thus, there will be strong demand for a range of HWSC systems in the future.

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SOIL MOISTURE PROBE NETWORK – USING SOIL WATER INFORMATION TO MAKE BETTER DECISIONS ON EYRE PENINSULA

Andrew Ware, SARDI Pt Lincoln

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Key messages

- A network of soil moisture probes and weather stations has been established across Eyre Peninsula.
- The 'live' data can be viewed by visiting the https://eparf.com.au/ website and then clicking on the yellow Soil Moisture Probe Network icon in the top right hand side and logging on using the user name: EPARF and password: EPARF.

Why do the trial?

Water is the principal limiting factor in rain-fed cropping systems in South Australia. The research that French and Schultz (1984) conducted linked growing season rainfall to grain production, providing growers and advisors with a target yield potential. However, this had deficiencies in that it didn't account for out of season rainfall and treated the water holding capacity of all soils equally.

A better understanding of the how plant available water content varies with changes to soil type and how valuable out of season rainfall can be to cropping systems in different environments improves the French Schultz model by allowing growers to define better define target yields, but also make informed in-season decisions based on the information they receive.

Being able to monitor soil moisture in real time by using technology such as soil moisture probes connected to the mobile phone network allows growers and advisors access to improved soil water information, allowing them to make more informed decisions.

In 2016 SAGIT and EPARF provided funding to create and monitor a network of new and existing soil moisture probes across Eyre Peninsula, with the aim assisting growers and advisors to interpret the data produced by the moisture probes and link the soil water information to yield potential so that improved crop decisions can be made.

How was it done?

A network of a network of 32 soil moisture probes across Eyre Peninsula has been created by linking new and existing (EPNRM and LEADA funded) soil moisture probes found across Eyre Peninsula and providing access to the data via the EPARF website (Figure 1).

Figure 1. Locations of the soil moisture probes on Eyre Peninsula.

In addition, weather stations capable of logging temperature, humidity and wind speed have also been installed at ten soil moisture probe sites funded through contributions by EPARF and AgFarm. This data can also be accessed by logging into the soil moisture probe network via the EPARF website.

Soil testing for soil chemistry and soil moisture was conducted at 29 of the sites in late March 2017. In 2017, 15 of the sites were planted to wheat, seven to pasture, four to pulse crops, three to barley and two to canola. Soil moisture testing and hand harvest samples were conducted at 26 sites in early November, at crop maturity. The sites that weren't tested at this time were not mature and rainfall shortly after meant that soil testing for moisture at these sites was futile.

Eight sites were characterized for drained upper limit, crop lower limit and bulk density in 2017 and Yield Prophet® was also run at eight sites (Lock, Cleve, Elliston, Kimba, Ungarra, Warramboo, Pinkawillinie and Karkoo). Small trials were established at five sites (Pinkawillinie, Warramboo, Ungarra, Karkoo and Rudall), where additional nitrogen was applied in replicated plots adjacent to soil moisture probes.

What happened?

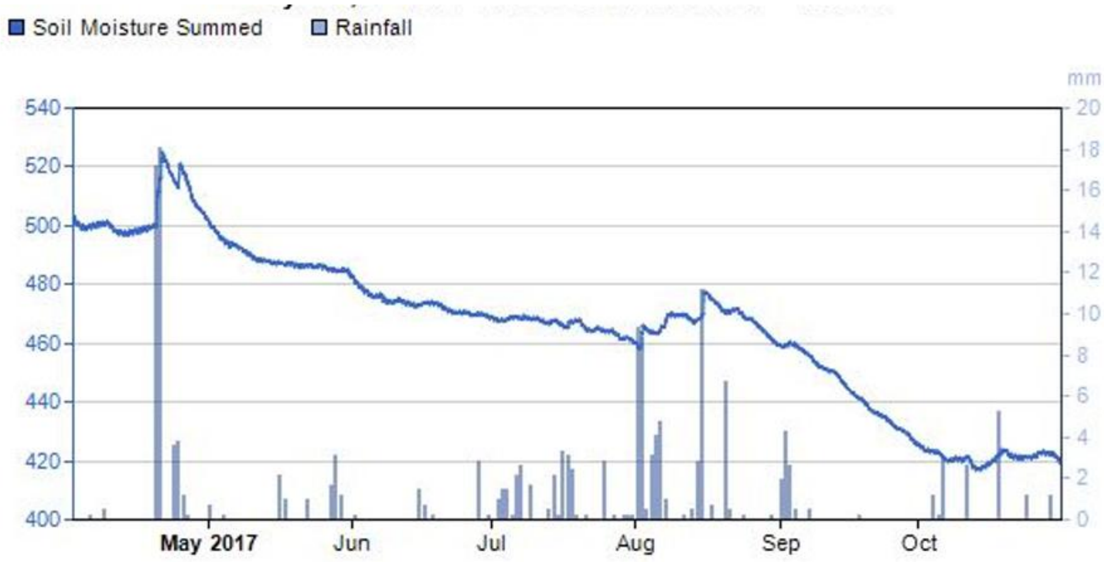

Figure 2. Summed soil moisture chart showing total soil moisture in the soil profile (line) and rainfall (columns) during the 2017 growing season (April-October) at a site that was planted to wheat in 2017.

Figure 2 demonstrates a soil moisture probe site that was planted to wheat in early May 2017, following a break to the season in late April. The figure shows how soil moisture started from a high point through being able to retain moisture from summer rainfall events, and then gradually declines as soil moisture is used throughout the growing season.

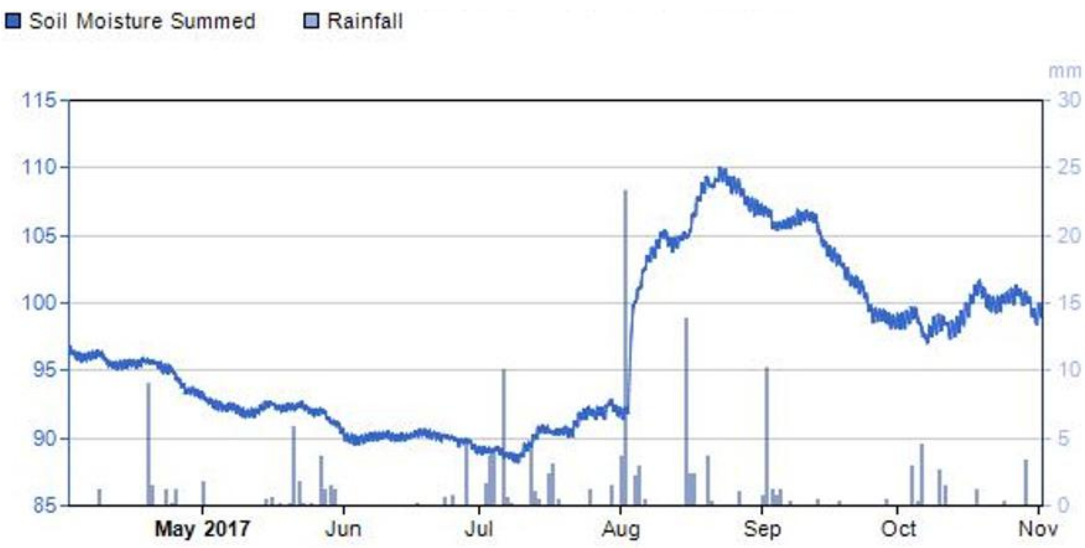

Figure 3. Summed soil moisture chart showing total soil moisture in the soil profile (line) and rainfall (columns) during the 2017 growing season (April-October) at a site that was a regenerated pasture in 2017.

Figure 3 demonstrates a soil moisture probe site that was pasture in 2017. The figure shows how soil moisture started from a low point after summer weeds were allowed to survive and use most of the out of season rainfall, and then how soil moisture was accumulated through the growing season, ending up in with more soil moisture at the end of the season compared to the start. This may indicate that the poor growth that pastures were able to achieve in 2017 may have a role in conserving moisture for following wheat crops or also have the potential to be better used to grow more fodder to feed livestock in the pasture phase.

What does this mean?

The 2017 growing season was challenging for many growers on Eyre Peninsula, but having improved knowledge of soil water information will allow a better understanding of yield potentials during the growing season and help tailor inputs such as in-season nitrogen applications and assist in grain marketing decisions.

Interpretation of the information the soil moisture probes are providing will need at least another season to be fully realised. The extra season will help determine the 'bucket size' or soil water holding capacity at each site. Then a quick view of the soil moisture probe output through the EPARF website at any time during the season will allow growers to determine how full the bucket is.

Acknowledgements

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OPTIMISING INOCULATION OF PULSE CROPS

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Take home messages

- Peat slurry inoculants applied to seed perform consistently well when sown into moist soil; other formulations can also provide good nodulation, but outcomes are dependent on the carrier and sowing conditions.
- Good nodulation can be achieved when dry sowing beans and lupins if inoculation rate is increased. Even doubling the rate of inoculation significantly improves nodulation.
- Standard inoculation practices are unlikely to deliver satisfactory nodulation where extended dry conditions are combined with other stresses such as low pH.

Background

Pulse and pasture legumes can provide an abundant, inexpensive and sustainable source of nitrogen (N) for Australian cropping systems. Cereal yields are consistently greater following legumes due to these N inputs, and other benefits including disease and weed breaks, and improvements to soil structure and biological function.

Not all pulses in Australian farming systems are well nodulated and fix optimal N. N fixation is dependent on the availability and number of suitable root nodule bacteria (rhizobia) (Drew et al. 2012, Denton et al. 2013). When suitable rhizobia are unlikely to be present in sufficient numbers then they must be provided at sowing in the form of a commercial inoculant product.

Sowing pulse crops early in the season into dry soils can offer significant growth advantages in short-season environments. However, rhizobia are sensitive to desiccation and the consequences of dry sowing on rhizobia survival in different inoculant formulations are poorly understood. There have been few well designed, objectively measured studies in south-east Australia to understand the extent to which dry sowing affects the nodulation, nitrogen fixation and grain yield in pulses.

Work is presented from SAGIT funded trials in 2017 which aim to optimise guidelines for inoculation when dry sowing. Impacts of different inoculant formulations and other stresses on nodulation at sowing, such as soil acidity and seed applied pesticides are also considered.

When is inoculation of pulse crops necessary?

Inoculation provides one of the most cost effective ways to improve legume performance where the legume (or another from the same inoculation group) has not previously been grown and/or where conditions are detrimental to the survival of rhizobia in the soil.

Chickpea and lupin are typically responsive to inoculation in the GRDC southern region because they have been less widely grown and their rhizobial requirement is more specific than for some other legume species. The first time they are grown, nodulation can often be improved by increasing the rate of inoculation.

Pea, bean, lentil and vetch are nodulated by the same species of rhizobia and have been widely grown and survive reasonably well in neutral/alkaline soils, so many South Australian soils support adequate populations of rhizobia for these legumes. Nonetheless, inoculation of these legumes is still necessary where;

(i) they have not previously been grown.
(ii) where they have not been grown in the past five years or if nodulation of the previous crop was not satisfactory.
(iii) if they are grown on acidic soils (pH_{CaCl2} <6.0) because the pea/bean rhizobia from previous crops may not persist at a high enough number for optimal nodulation.

The general relationship between soil pH and the number of rhizobia that nodulate pea/bean/lentil in soil shown in Figure 1. It illustrates that rhizobial number declines below pH_{Ca} 6.0 to about 100 rhizobia per g soil, where there is a moderate to high chance of response to inoculation.

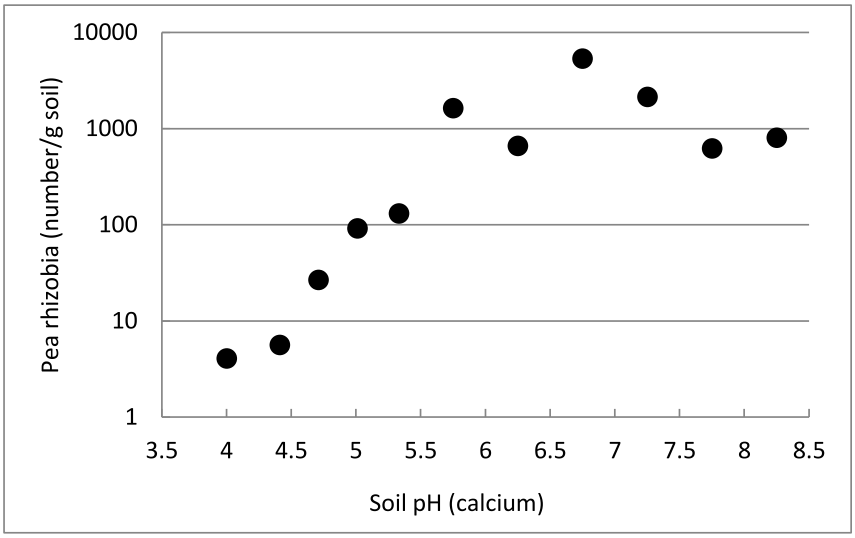

Figure 1. Relationship between soil pH (0 – 10 cm, 0.01 M $CaCl_2$) and the number of pea nodulating rhizobia persisting in the soil. Modified from Drew et al. (2012).

The lower limit of $pH_{(Ca)}$ for reliable nodulation with the commercial strains of faba bean and field pea rhizobia is about pH 5. Below this level nodulation on acid soils can be improved by increased inoculation rate. Liming to increase soil pH and increased rates of inoculation should be considered where soil $pH_{(Ca)}$ is below 5.0. Efforts are also underway to select new strains of rhizobia with improved acidity tolerance (discussed below). Several strains shown promise in the field on faba and broad bean. They are being more widely tested to develop a case for commercial release.

Inoculation when dry sowing

Extension publications state that; sowing peat slurry inoculated seed into dry soil is not generally not recommended where a legume crop is sown for the first time, since under some conditions the applied rhizobia may not survive at adequate numbers to provide satisfactory nodulation. Furthermore, if there are no suitable background rhizobia the nodulation and performance of the crop will be compromised (Drew et al. 2014). It is less of a concern where a legume has been used frequently and the soil is favourable to rhizobial survival; here the risk of nodulation failure resulting from dry sowing is negligible.

Despite the potential impacts of dry sowing on nodulation, it is common practice. The three main granular rhizobia inoculant products available in Australia are all recommended by the manufacturers for use when dry sowing. There are anecdotal reports of success, but there has been little recent independent research to compare their performance against peat applied to seed or understand the limits of their efficacy. Field trials (funded by SAGIT) were conducted at two sites in 2017 assessing a range of formulations at different rates and in combination (including peat on seed); these treatments push the boundaries of current recommendations, with the aim of providing better guidelines for growers around dry sowing.

Samira faba beans at Wanilla

The trial was sown on a sandy soil of pH_{CaCl2} 4.3 at Wanilla on Eyre Peninsula (Co-operator: Andrew Green, sown by SARDI Port Lincoln pulse agronomy group).

Uninoculated (Nil) control treatments were compared to 6 commercial Group F (strain WSM1455) inoculant treatments. All inoculants were applied at the recommended commercial rates with the exception of treatment 3 which combined BASF peat with New Edge Freeze dried inoculant to deliver a higher rate of rhizobia cells on seed (4 x recommended rate; 4RR). Peat slurry was applied on seed within 24 hours of sowing and granular products were sown in furrow with seed. It should be noted that only granular products are recommended for dry sowing by manufacturers.

Plots were sown on either the 28th April (TOS1) at 10cm depth and remained dry for approximately 4 weeks, or on 16th June (TOS2) and remained dry for 2 weeks (Figure 3).

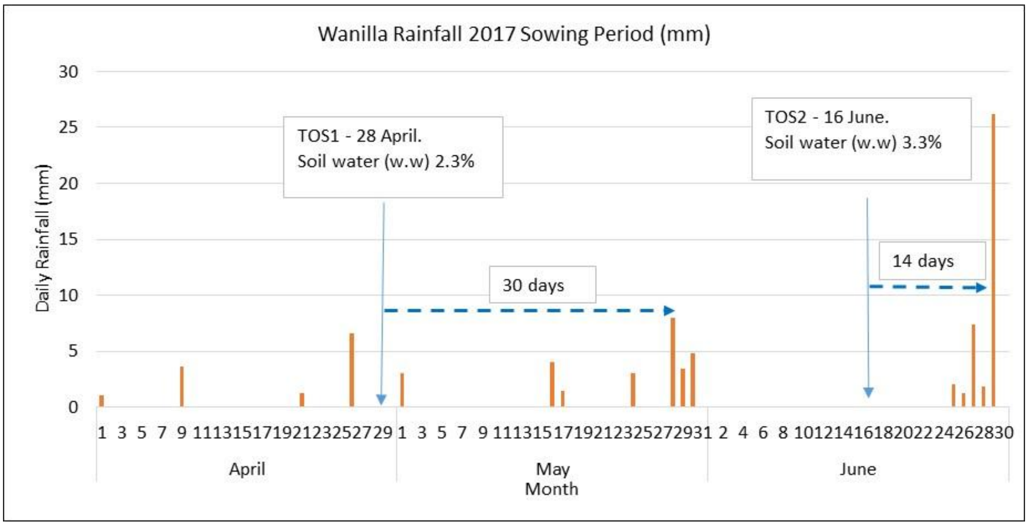

Figure 3. Rainfall and sowing times for Wanilla Bean trials 2017.

The site was responsive to inoculation. Under these harsh (dry, acidic) conditions all inoculants improved the nodulation of faba bean relative to no inoculation (Figure 4), but there were large differences between inoculation treatments. Novozymes granules provided the best nodulation at both sowing times, and surpassed the nodulation provided by peat slurry inoculation on seed at that site (Peat) (Figure 4). Notably, the Novozymes granule also delivered the highest number of rhizobia per seed in this trial. Number of rhizobia delivered by the different inoculants was well correlated to their performance.

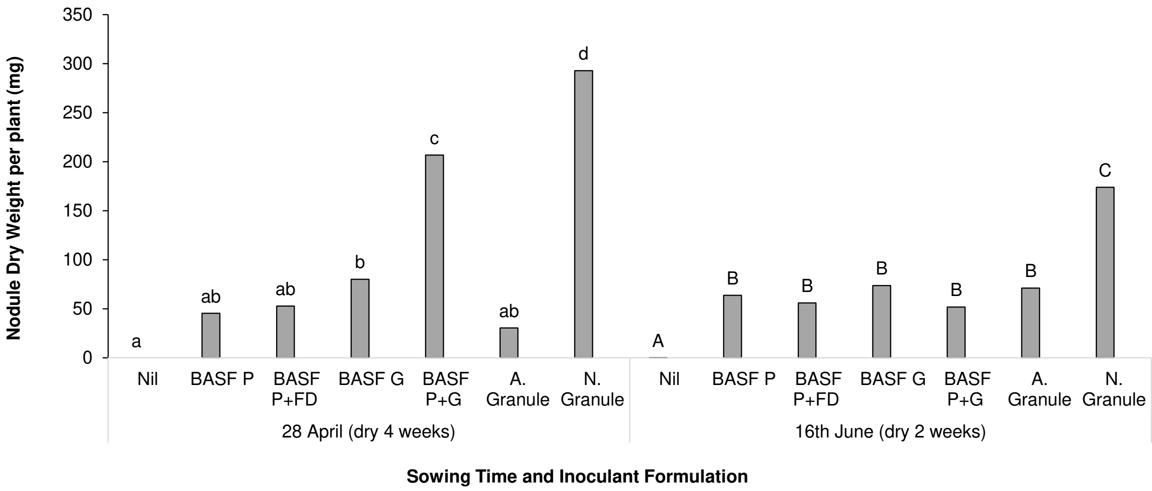

Figure 4. Impact of dry sowing time (28th April – 4 weeks, 16th June- 2 weeks) and inoculant formulation on nodulation of faba bean. Letters which are different indicate significance at P<0.05.

Nodulation was measured approximately 10 weeks after plant emergence. Letters which are different within a sowing time indicate significance at P<0.05. All inoculants are group F; peat slurry on seed (Peat) and BASF granules (B. Granule) were supplied by BASF and applied separately or in combination, Freeze dried inoculant (Freeze dried) was supplied by New Edge

Microbials (applied with the Peat treatment), Alosca granules (A. Granule) were sourced from Landmark, and Novozymes (N. Granule) were supplied by Novozymes.

Despite a very dry finish at Wanilla which limited faba bean grain yields, all inoculants improved yields for the early sown treatments (Table 1). Novozyme granules increased yield at both sowing times (TOS2 data not shown), relative to peat slurry inoculation (Table 1). Notably the combination of peat slurry on seed and granules (BASF) also resulted in improved nodulation and yields when sown early. Late sown treatments produced less than half the yield of early sown treatments due to decreased growing degree days.

Table 1. Grain yields (t/ha) of Samira faba bean at Wanilla, SA in response to different inoculation treatments when sown into dry soil.

Inoculation Treatments	**Sowing Time 28 April (Dry 4 weeks)**
Nil (Uninoculated)	0.13
BASF Peat	0.30
BASF Peat + New Edge FD	0.30
BASF Granules	0.39
BASF Peat + Granules	0.49
Alosca Granules	0.33
Novozymes Granule (Tag-team)	0.57
l.s.d.	*0.06*

Impact of inoculation rate and rhizobia strain

In a second trial at Wanilla, also dry sown on April 28th, we compared the commercial Gr F rhizobium strain WSM1455, and two strains with putative acid tolerance (SRDI954 and SRDI969). All were grown up in sterile peats at SARDI and applied at one of three rates to seed (0.5, 1.0 or 2.0 times the recommended rate) within 24 hours of sowing. The 0.5 rate was chosen to reflect that in practice inoculation is not always optimal and sometimes reduced rates are used to improve coating and flow of seed through machinery.

At the recommended inoculation rate (& half rate) the current commercial bean strain, WSM1455, was unable to nodulate faba bean at this site (pH 4.3) (Figure 5). In comparison the two strains with putative acid tolerance were able to nodulate bean at all three application rates. Yield directly reflected nodulation of bean (data not shown).

This finding is significant because it is in acid soils (no background rhizobia) where dry sowing is likely to have the biggest impact on nodulation and N fixation. Practically, in the future it may be possible to use the better strains in the most effective formulations. In the interim, increasing the rate of inoculant applied will likely improve nodulation outcomes.

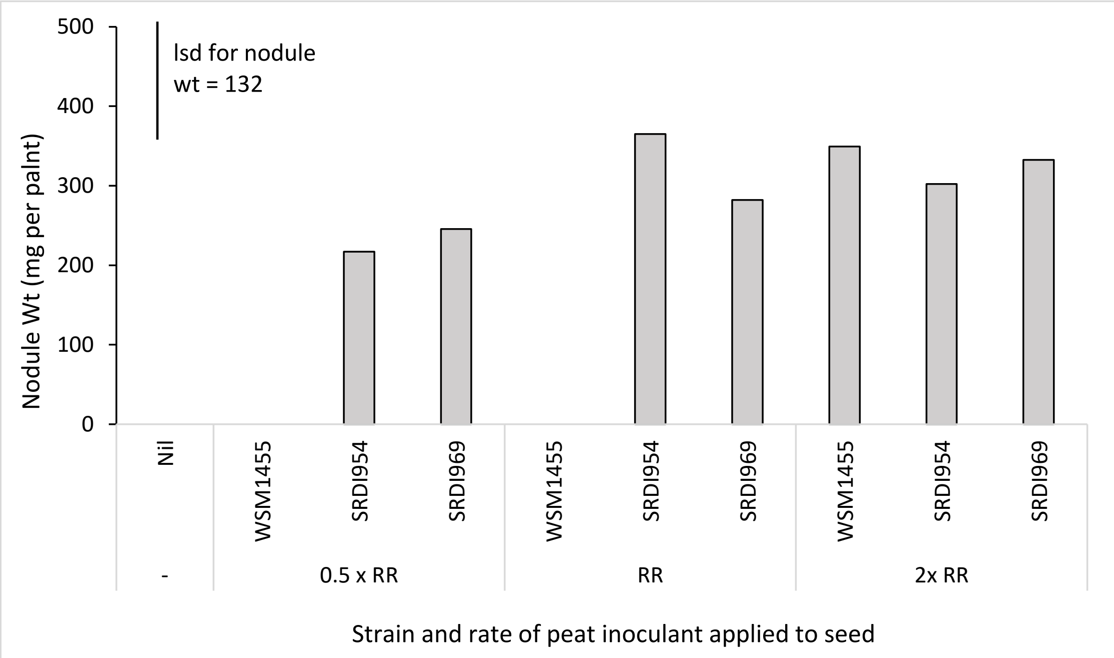

Figure 5. Effect of inoculation rate and rhizobia strain on nodule weight of Samira faba bean at Wanilla, Eyre Peninsula SA in 2017. Treatments were; uninoculated (nil) control, the commercial Gr F rhizobium strain WSM1455, and two strains with putative acid tolerance (SRDI954 and SRDI969) applied at one of three rates to seed (0.5, 1.0 or 2.0 times the recommended rate (RR)).

Barlock lupins at Farrell Flat

The trial was sown on a loamy soil of pH_{Ca} 5.1 at Farrell Flat in the mid north (Co-operator: Craig Jaeschke, sown by SARDI pulse agronomy group at Clare).

This trial consisted of six treatments, one uninoculated (Nil) control and 5 commercial Group G (strain WU425) inoculant treatments. All inoculants were applied at the recommended commercial rates, as noted above only the granule formulation was recommended for dry sowing.

Treatments were sown on either the 13th April (TOS1) at 3cm depth and were in dry soil for approximately 7 days or on the 28th April (TOS2) into moist soil (Figure 6).

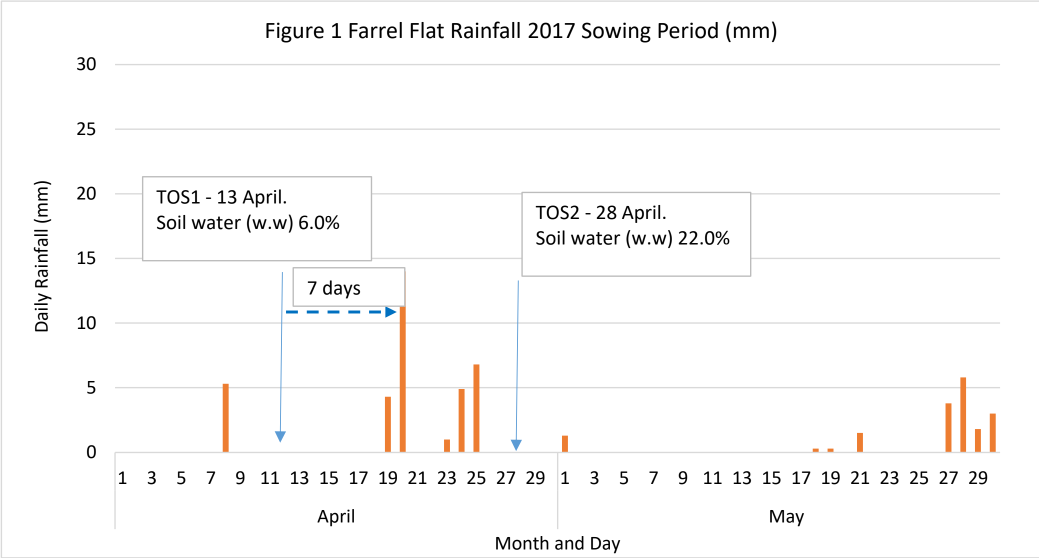

Figure 6. Rainfall and sowing times for Farrell Flat trial 2017.

In this trial, peat slurry treatments performed significantly better than the standard rate of granules. This may reflect the shorter period which rhizobia were exposed to dry sowing conditions, as well as the fact that lupin rhizobia are tolerant of acidic soils. Furthermore, peat slurry in combination with freeze-dried inoculant enhanced nodulation lupins sown late into moist soil (Figure 7).

Inoculation with any formulation improved grain yield of lupin at both sowing times at Farrell Flat, SA (Table 3). When dry sown, peat slurry inoculation on seed produced the highest grain yield (2.9 t per ha). Grain yields were generally lower when the crop was sown after the break and grain yield was not significantly affected by inoculant formulation (Table 2).

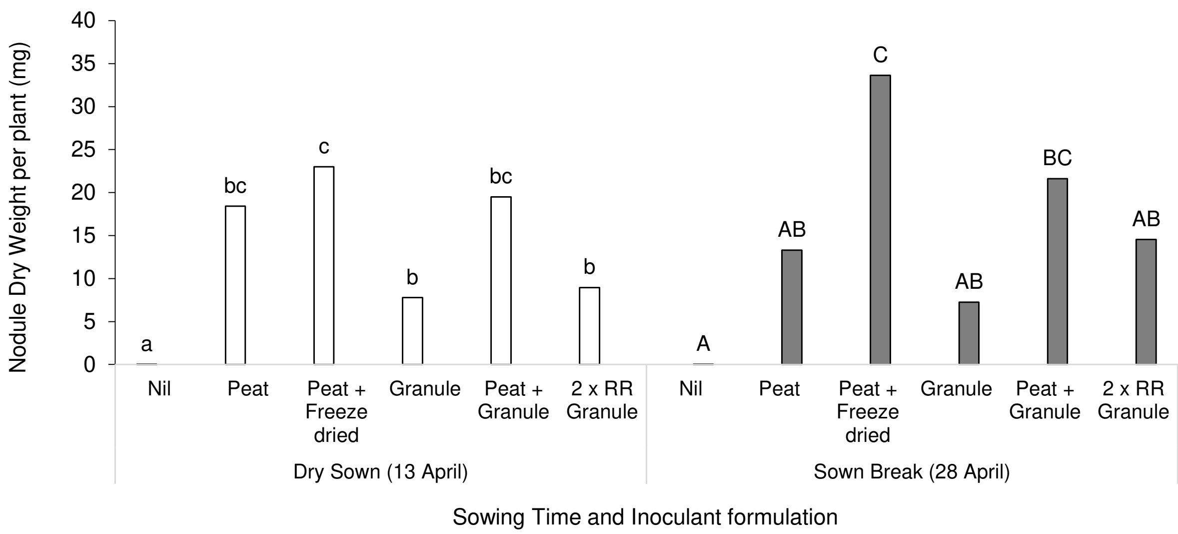

Figure 7. Impact of sowing into dry (13th April – 7 days dry) or moist (28th April) soil and inoculant formulation on nodulation of lupin. Nodule weight per plant was measured approximately 10 weeks after plant emergence. Letters which are different within a sowing time indicate significance at P<0.05.

All inoculant was group G Lupin. Peat slurry on seed (Peat) and granule inoculants were supplied by BASF and New Edge Microbials supplied (Freeze dried inoculant). Granules were supplied at the standard rate and 2 times the recommended rate (2 x RR Granule).

Table 2. Grain yields (t/ha) of narrow-leaf lupin at Farrell Flat, SA in response to different inoculation treatments sown either prior to the break or following breaking rains.

Inoculation Treatments	**Sowing Time**	
	Dry Sown (13 April)	**Sown Break (28 April)**
Nil (Uninoculated)	1.64	1.86
BASF Peat	2.90	2.46
BASF Peat + New Edge FD	2.67	2.33
BASF Granules	2.48	2.35
BASF Peat + Granules	2.50	2.40
BASF Granules 2 x RR	2.46	2.35
l.s.d.	**0.34**	

Nitrogen fixation data from the 2017 trials is pending, however we can conclude from the results so far that:

- When dry sowing peat inoculant applied at recommended rate is unlikely to optimise nodulation. The extent of this deficiency was greater at the drier site (Wanilla).
- Good nodulation can be achieved when dry sowing beans and lupins if inoculation rate is increased, doubling the rate of inoculation significantly improves nodulation.
- For granules applied alone, only Novozymes granules for bean increased nodulation, compared to peat applied at recommended rate.
- Combining the peat and freeze dried inoculant increased nodulation of lupin sown into moist soil.

Work is continuing to understand more about how rhizobia survive and nodulate under a range of dry sowing conditions, so that improved recommendations can be provided. Our results to date indicate that to optimise nodulation when dry sowing, rhizobia need to be applied in high numbers which can be achieved by increasing the rate of inoculant applied.

Useful resources

Inoculating Legumes: A Practical Guide
http://www.grdc.com.au/Resources/Bookshop/2015/07/Inoculating-Legumes
www.ua.edu.au/legume-inoculation

References

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Drew E, Herridge DF, Ballard RA, O'Hara GW, Deaker R, Denton MD, Yates RJ, Gemell G, Hartley E, Phillips L, Seymour N. (2014). Inoculating legumes: a practical guide. Grains Research and Development Corporation.

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TRIAL RESULTS 2017

Andrew Ware, SARDI Port Lincoln

Eyre Peninsula barley variety yield performance - 2017 and long term (2013-2017) expressed as t/ha and % of site average yield

Variety	Mid and Lower Eyre Peninsula									
	2017 (as % site average)			Long term yield brackets (2013-2017)						
	Wanilla	Wharminda	Cummins	No. Trials	1.5	3.5	4	4.5	5	6.5
Alestar	96	73	91	12	82	94	97	98	100	106
Bottler	104	88	95	3	81	-	100	-	102	-
Commander	80	138	101	14	115	100	100	102	102	95
Compass	106	131	106	14	144	119	109	110	105	95
Fathom	107	127	99	14	110	110	109	106	102	99
Fleet	102	125	99	14	119	103	102	103	100	93
Flinders	105	100	97	14	86	94	96	94	96	101
Grange	113	69	103	14	87	97	99	98	101	104
Hindmarsh	90	132	109	14	124	116	108	106	104	100
Keel	88	106	88	14	123	108	103	102	96	92
La Trobe	102	134	106	14	122	116	109	107	106	101
Maltstar	94	64	97	12	75	92	96	100	99	107
Oxford	98	61	103	14	64	87	96	96	100	107
RGT Planet	104	84	111	6	75	-	110	112	112	122
Rosalind	116	117	109	12	112	121	116	113	112	111
Scope	92	120	88	14	105	98	98	97	97	96
Spartacus CL	101	129	104	12	128	118	111	108	107	100
Topstart	95	67	96	12	69	88	96	97	101	107
Westminster	92	74	90	14	69	83	90	90	95	102
Site av. yield (t/ha)	**3.87**	**1.25**	**4.73**		**1.26**	**3.29**	**3.76**	**4.34**	**4.73**	**6.49**
LSD % (P=0.05)	*15*	*17*	*8*	No Trials	1	2	4	3	3	1
Sowing date	02-Jun-17	10-Jul-17	20-Jun-17							
Soil type	LS	LS	L							
J-M/A-O rain (mm)	63/ 298	60/ 205	88/ 234							
pH (water)	5.7	6.4	8.3							
Previous crop	Lupin	g/f pasture	Canola							
Site stresses										

Abbreviations

Soil type: S=sand, L=loam

gf=grass free

d= droughted

Data source: NVT & SARDI/GRDC (long term data based on weighted analysis of sites, 2013- 2017)

Data analysis by GRDC funded National Statistics Group

Eyre Peninsula wheat variety yield performance - 2017 and long term (2013-2017) expressed as t/ha and % of site average yield

Variety	Mid and Lower Eyre Peninsula										
	2017 (as % site average)			Long term yield brackets (2013-2017)							
	Cummins	**Rudall**	**Wanilla**	**No Trials**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5.5**	**6**
Axe	94	88	95	15	97	82	93	94	94	86	90
Beckom	110	105	110	15	109	116	109	111	107	109	108
Chief CL Plus	92	99	100	8	107		109	101	102	-	98
Cobalt	-	-	-		-	-	-	-	-	-	-
Corack	104	102	115	15	109	109	112	108	109	105	101
Cosmick	100	100	107	15	105	109	105	108	105	107	107
Cutlass	107	103	112	9	101	-	98	98	100	-	104
DS Darwin	94	85	87	14	94	-	95	96	98	98	98
DS Pascal	81	82	76	5	84	-	82	91	-	-	100
Emu Rock	87	96	98	15	104	99	103	107	102	98	99
Estoc	97	99	94	15	98	96	96	96	98	98	100
Gladius	77	99	85	15	97	90	94	96	96	94	97
Grenade CL Plus	87	100	76	15	97	87	93	96	95	91	95
Hatchet CL Plus	88	97	88	15	96	84	93	97	94	89	92
Kord CL Plus	83	100	87	15	97	86	92	92	94	89	93
LRPB Arrow	102	98	100	9	107	-	110	109	107	-	106
LRPB Cobra	102	81	95	15	97	109	104	108	106	111	108
LRPB Havoc	115	94	112	5	108	-	113	110	-	-	100
LRPB Scout	101	100	96	15	97	99	98	105	102	105	106
LRPB Trojan	97	95	104	15	101	111	105	105	109	113	111
Mace	111	114	96	15	108	109	110	107	106	104	101
Scepter	122	118	110	9	116	-	116	114	112	-	108
Shield	101	104	98	15	104	99	98	102	96	94	97
Tenfour	-	-	-	-	-	-	-	-	-	-	-
Wyalkatchem	97	98	101	15	104	108	106	104	102	103	101
Yitpi	83	95	95	14	94		90	89	92	93	96
Site av. yield (t/ha)	**3.11**	**2.42**	**3.28**		**2.37**	**2.53**	**3.21**	**3.92**	**4.19**	**5.36**	**5.83**
LSD % (P=0.05)	*7*	*6*	*6*	No Trials	2	1	4	2	4	1	1
Date sown	20-Jun-17	19-Jun-17	02-Jun-17								
Soil type	L	LSL	LS								
J-M/A-O rain (mm)	88/234	91/190	63/298								
pH (water)	8.3	8.7	5.7								
Previous crop	Canola	Faba Beans	Lupin								
Site stresses											

Abbreviations

Soil type: S=sand, L=loam

gf=grass free

Data source: NVT & SARDI/GRDC (long term data based on weighted analysis of sites, 2013-2017)

Data analysis by GRDC funded National Statistics Group

Lower Eyre Peninsula lupin variety trial yield performance 2017 and long term (2012-2017) average across sites (as a % of site mean).

Variety	LOWER EYRE PENINSULA				
	2017	2013-2017			
	Ungarra	Trial	Yield Bracket (t/ha)		
		#	1.5	2	2.5
Jenabillup	1.01	8	102	99	103
Jindalee	0.98	8	87	85	85
Mandelup	1.13	8	103	99	96
PBA Barlock	1.01	8	96	102	105
PBA Bateman	-	3	-	114	115
PBA Gunyidi	1.10	8	97	107	107
PBA Jurien	1.17	7	99	106	107
PBA Leeman	-	2	-	96	93
Wonga	1.04	8	91	92	95
Site mean yield (t/ha)	1.11		*1.11*	*1.76*	2.32
% LSD (P=0.05)	*16*				
Date sown	10/7				
Soil type	S				
Rainfall (mm) J-M/A-O	65/243				
pH (H_2O)	5.8				
Previous crop	Wheat				
Site stress factors	de				

Soil type S = Sand, C = clay, L = loam

Site Stress Factors de = pre flowering moisture stress

Data source: GRDC, PBA & NVT (long term data based on weighted analysis of sites and courtesy National Statistics Program)

Eyre Peninsula field pea variety trial yield performance 2017 (as % of site mean) and long term (2013-2017) average across sites (as % of site mean)

Variety	Lower Eyre Peninsula						
	2017		2013-2017				
	Murdinga	Yeelanna	Trial #	Yield Bracket (t/ha) 1.5	2	2.5	3
Kaspa	93	94	10	91	92	86	100
Parafield	74	82	8	74	83	88	107
PBA Butler	106	102	10	112	104	115	113
PBA Gunyah	102	103	10	96	97	91	111
PBA Oura	113	98	10	101	103	110	111
PBA Pearl	110	99	10	113	109	127	110
PBA Percy	84	103	10	97	100	107	133
PBA Twilight	-	-	6	88	94	84	-
PBA Wharton	88	113	10	91	96	96	112
Site mean yield (t/ha)	1.47	1.89		1.39	1.74	2.27	2.70
% LSD (P=0.05)	*14*	*8*					
Date sown	06/07	06/07					
Soil type	SL	SL					
Previous crop	Barley	Wheat					
Rainfall (mm) J-M/A-O	56/165	59/227					
pH (H_2O)	8.7	7.7					
Site stress factors	de	de					

Soil type	S = sand, L = loam
Site Stress Factors	de = pre flowering moisture stress

Data source: GRDC, PBA & NVT (long term data based on weighted analysis of sites and courtesy National Statistics Program)

Lower Eyre Peninsula lentil variety trial yield performance 2017 and long term (2012-2017) average across sites (as a % of site mean)

Variety	LOWER EYRE PENINSULA			
	2017	2013-2017		
	Yeelanna	Trial	Yield Bracket (t/ha)	
		#	1.5	2.5
Nipper	95	5	89	97
Nugget	101	5	96	101
PBA Ace		4	96	100
PBA Blitz	77	5	94	88
PBA Bolt	106	5	101	98
PBA Flash	110	5	106	105
PBA Hurricane XT	99	5	98	100
PBA Jumbo		3	95	97
PBA Jumbo 2	106	5	104	102
Site mean yield (t/ha)	2.15		*1.16*	2.24
% LSD (P=0.05)	*18*			
Date sown	6/7			
Soil type	CL			
Rainfall (mm) J-M/A-O	59/227			
pH (H_2O)	7.7			
Previous crop	Wheat			
Site stress factors	de			

Soil type	C = clay, L = loam
Site Stress Factors	de = pre flowering moisture stress

Data source: GRDC, PBA & NVT (long term data based on weighted analysis of sites and courtesy National Statistics Program)

PULSE CHECK GROUPS PREPARE FOR THE 2018 GROWING SEASON

Across the Southern Region twelve pulse check discussion groups are preparing to meet and discuss pre-sowing topics relating to pulse production in their regions. These meetings are a part of the Southern Pulse Extension Project, delivered by a consortium of organisations involved in the pulse industry across GRDC's Southern region to provide a collaborative opportunity to increase the knowledge of growers and advisers on sustainable pulse production.

With the first pulse check meetings prior to harvest engaging almost 200 growers and advisors, regionally specific discussions are proving a popular way for locals to collaboratively increase their knowledge and skills. The pre-sowing discussion will provide an opportunity for local growers and advisors interested in pulse production to discuss practical aspects of getting their crops in the ground.

The pre-sowing meeting will focus on providing information and discussion around a number of topics, including:

- 2017 harvest Debrief – yields, quality, harvesting issues
- Markets & marketing
- Impact of 30% Indian tariff
- Paddock Selection 2018
- Herbicide strategies
- Inoculants & seed dressings
- Nutrition
- Sowing time, rates & depth

LEADA are facilitating a Lower EP Pulse Check Discussion group and are currently planning the date and location for the pre-sowing discussion, to be held in early March. Interested growers and advisors are encouraged to contact George Pedler at george@georgepedlerag.com.au or on 0427 876 043 for more information.

Growers and advisors are also encouraged to engage in the discussion group on an ongoing basis, with Pulse Check groups focused on continually developing regional capacity in the pulse industry and feeding grower and advisor knowledge and priorities back into GRDC and the broader pulse industry.

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COPPER MANAGEMENT FOR THE FUTURE

George Pedler, George Pedler Ag

The project aims to explore different management strategies to overcome copper deficiency in cereals. The project will compare the effectiveness of copper sulphate and copper chelate applied either as liquids banded at seeding or as a foliar spray. The project will also evaluate the effect of different timings of application of the foliar sprays and their efficiency.

Head sterility was scored at maturity and no differences were found

Neither trial had yields that were statistically higher than the Nil treatment – so there was no positive measured effect of applying copper to either site.

LEADA believe that the short growing season and lower nitrogen inputs for the year were contributing factors to this.

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Cockaleechie Site
Co-operator: Jim and Jenna Holman, Cockleechie

Sowing Date: 18 May 2017 Dry - emergence date approx 11 July 2017
Copper Spray Application 1 (GS21): 14 August 2017
Copper Spray Application 2 (GS31): 14 September 2017
Copper Spray Application 3 (GS 41): 21 September 2017
Copper Spray Application 4 (GS49): 26 September 2017
Copper Spray Application 5 (Flowering): 3 October 2017

Trial Management:

- 80kg/ha Mace
- 80kg/ha 18:20 + impact
- Minnipa seeder
- 2m centres
- Soil dry, reasonably friable
- Sowing treatments of copper sulphate and chelate applied through fluid system.

Herbicide:

- 118gms/l Sakura
- 1.8 l/ha Axadex Xtra
- 2l/ha Roundup.

In crop:
20th July – Sprayed for broadleaf with Bromoxynil @ 1.4L/ha
21st August – Nitrogen Application, granular urea at 100kg/ha prior to showers

Harvest Grain Sample Testing – Summary of 4 replicates taken as grain samples at harvest

Tissue Tests	**Cu (mg/kg)**
Nil	3.80
Seeding_Sulphate_2kg	3.75
Seeding_AminoAcidChelate_2l	3.76
GS21_Sulphate_250g	3.87
GS21_AminoAcidChelate_4l	3.61
lsd (5%)	ns

Cockaleechie – 2017 Grain Yield and NDVI results

Treatment	Yield (t(/ha)	NDVI 1	NDVI 2
Flowering_AminoAcidChelate_2l	2.68	0.38	0.65
Flowering_AminoAcidChelate_4l	2.62	0.34	0.63
Flowering_Sulphate_125g	2.64	0.32	0.56
Flowering_Sulphate_250g	2.66	0.36	0.59
GS21_AminoAcidChelate_1l	2.66	0.36	0.59
GS21_AminoAcidChelate_2l	2.70	0.35	0.57
GS21_AminoAcidChelate_2l+GS31_Ammino Acid Chelate@2L	2.92	0.32	0.58
GS21_AminoAcidChelate_2l+GS41_Ammino Acid Chelate@2L	2.80	0.34	0.58
GS21_AminoAcidChelate_2l+GS49_Amino Acid Chelate@2L	2.45	0.36	0.60
GS21_AminoAcidChelate_4l	2.51	0.33	0.56
GS21_Sulphate_125g	2.80	0.35	0.57
GS21_Sulphate_125g+GS31_Sulphate@125g	2.48	0.35	0.60
GS21_Sulphate_125g+GS41_Sulphate@125gm	2.80	0.34	0.62
GS21_Sulphate_125g+GS49_Sulphate@125	2.60	0.37	0.62
GS21_Sulphate_250g	2.87	0.36	0.62
GS31_AminoAcidChelate_1l	2.30	0.39	0.62
GS31_AminoAcidChelate_2l	2.60	0.37	0.60
GS31_AminoAcidChelate_2l+GS49_	2.82	0.35	0.59
GS31_AminoAcidChelate_4l	2.93	0.38	0.62
GS31_Sulphate_125g	2.65	0.36	0.59
GS31_Sulphate_125g+GS41_Sulpha	2.91	0.35	0.61
GS31_Sulphate_125g+GS49_Sulpha	2.82	0.35	0.59
GS31_Sulphate_250g	2.78	0.36	0.61
GS41_AminoAcidChelate_1l	2.80	0.33	0.58
GS41_AminoAcidChelate_2l	2.74	0.36	0.60
GS41_AminoAcidChelate_4l	2.31	0.36	0.58
GS41_Sulphate_125g	2.44	0.36	0.59
GS41_Sulphate_250g	2.48	0.38	0.62
GS49_AminoAcidChelate_1l	2.88	0.34	0.59
GS49_AminoAcidChelate_2l	2.79	0.35	0.61
GS49_AminoAcidChelate_4l	2.36	0.38	0.62
GS49_Sulphate_125g	2.40	0.35	0.57
GS49_Sulphate_250g	2.79	0.35	0.58
Nil	2.77	0.36	0.59
Seeding_AminoAcidChelate_1l	2.98	0.36	0.63
Seeding_AminoAcidChelate_1l+GS31 Amino Acid Chelate @ 2l/ha	2.88	0.38	0.64
Seeding_AminoAcidChelate_1l+GS41 Amino Acid Chelate 2l/ha	2.72	0.36	0.61
Seeding_AminoAcidChelate_1l+GS49 Amino Acid Chelate @ 2l/ha	2.62	0.37	0.60
Seeding_AminoAcidChelate_2l	2.81	0.37	0.63
Seeding_Sulphate_1+GS21 Sulphate@125	2.79	0.38	0.64
Seeding_Sulphate_1+GS41 Sulphate 125	2.76	0.39	0.60
Seeding_Sulphate_1kg	2.47	0.40	0.62
Seeding_Sulphate_1kg+GS49_Sulphate@125g	3.11	0.38	0.64
Seeding_Sulphate_2kg	2.78	0.37	0.58
LSD (5%)	0.41	0.05	0.05
CV	10.70	9.6	6.4

Highest yielding treatments not significantly different from Nil treatment

Strawberry Hill Site
Co-operator: Shane Nelligan, Warrunda

Sowing Date:	18 May 2017 Dry - emergence date approx 20 June-17
Copper Spray Application 1 (GS21):	26 July 2017
Copper Spray Application 2 (GS31):	14 August 2017
Copper Spray Application 3 (GS 41):	24 August 2017
Copper Spray Application 4 (GS49):	15 September 2017
Copper Spray Application 5 (Flowering):	21 September 2017

Trial Management:
- 80kg/ha Mace
- 80kg/ha 18:20 + impact
- Minnipa seeder
- 2m centres
- Soil dry, reasonably friable
- Sowing treatments of copper sulphate and chelate applied through fluid system.

Herbicide:
- 118gms/l Sakura
- 1.8 l/ha Axadex Xtra
- 2l/ha Roundup.

In crop:
20th July – Sprayed for broadleaf with Bromoxynil @ 1.4L/ha
21st August – Nitrogen Application, granular urea at 100kg/ha prior to showers

Harvest Grain Sample Testing – Summary of 4 replicates taken as grain samples at harvest

Tissue Tests	**Cu (mg/kg)**
Nil	4.10
Seeding_Sulphate_2kg	5.57
Seeding_AminoAcidChelate_2l	4.82
GS21_Sulphate_250g	4.94
GS21_AminoAcidChelate_4l	4.69
lsd (5%)	ns

Strawberry Hill – 2017 Grain Yield and NDVI results

Treatment	Yield (t(/ha)	NDVI 1	NDVI 2
Flowering_AminoAcidChelate_2l	2.33	0.60	0.53
Flowering_AminoAcidChelate_4l	2.27	0.57	0.51
Flowering_Sulphate_125g	2.28	0.58	0.53
Flowering_Sulphate_250g	2.24	0.58	0.53
GS21_AminoAcidChelate_1l	2.37	0.59	0.58
GS21_AminoAcidChelate_2l	2.14	0.58	0.52
GS21_AminoAcidChelate_2l+GS31_Ammino Acid Chelate@2L	2.39	0.60	0.52
GS21_AminoAcidChelate_2l+GS41_Ammino Acid Chelate@2L	2.33	0.58	0.53
GS21_AminoAcidChelate_2l+GS49_Amino Acid Chelate@2L	2.25	0.58	0.53
GS21_AminoAcidChelate_4l	2.37	0.58	0.51
GS21_Sulphate_125g	2.34	0.58	0.51
GS21_Sulphate_125g+GS31_Sulphate@125g	2.36	0.58	0.51
GS21_Sulphate_125g+GS41_Sulphate@125gm	2.24	0.58	0.55
GS21_Sulphate_125g+GS49_Sulphate@125	2.28	0.59	0.53
GS21_Sulphate_250g	2.31	0.57	0.49
GS31_AminoAcidChelate_1l	2.03	0.57	0.49
GS31_AminoAcidChelate_2l	2.21	0.54	0.47
GS31_AminoAcidChelate_2l+GS49_	2.22	0.60	0.51
GS31_AminoAcidChelate_4l	2.40	0.57	0.49
GS31_Sulphate_125g	2.51	0.58	0.53
GS31_Sulphate_125g+GS41_Sulpha	2.33	0.57	0.52
GS31_Sulphate_125g+GS49_Sulpha	2.36	0.57	0.41
GS31_Sulphate_250g	2.31	0.58	0.51
GS41_AminoAcidChelate_1l	2.12	0.57	0.52
GS41_AminoAcidChelate_2l	2.22	0.56	0.52
GS41_AminoAcidChelate_4l	1.85	0.55	0.44
GS41_Sulphate_125g	2.55	0.61	0.53
GS41_Sulphate_250g	2.30	0.58	0.49
GS49_AminoAcidChelate_1l	2.07	0.58	0.53
GS49_AminoAcidChelate_2l	2.31	0.60	0.54
GS49_AminoAcidChelate_4l	2.26	0.58	0.53
GS49_Sulphate_125g	2.11	0.56	0.48
GS49_Sulphate_250g	2.19	0.58	0.51
Nil	2.27	0.59	0.53
Seeding_AminoAcidChelate_1l	2.28	0.60	0.53
Seeding_AminoAcidChelate_1l+GS31 Amino Acid Chelate @ 2l/ha	2.06	0.59	0.52
Seeding_AminoAcidChelate_1l+GS41 Amino Acid Chelate 2l/ha	1.96	0.56	0.46
Seeding_AminoAcidChelate_1l+GS49 Amino Acid Chelate @ 2l/ha	2.13	0.56	0.48
Seeding_AminoAcidChelate_2l	2.08	0.56	0.51
Seeding_Sulphate_1+GS21 Sulphate@125	2.47	0.58	0.52
Seeding_Sulphate_1+GS41 Sulphate 125	2.31	0.55	0.50
Seeding_Sulphate_1kg	2.12	0.57	0.50
Seeding_Sulphate_1kg+GS49_Sulphate@125g	2.25	0.60	0.53
Seeding_Sulphate_2kg	2.30	0.58	0.51
LSD (5%)	0.41	0.04	0.07
CV	13.10	5.3	9.6

Highest yielding treatment not significantly different from Nil.

NOTES

NOTES