GRAINS RESEARCH UPDATE

BOOSTING PROFITABILITY – RESILIENT SOLUTIONS

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

Maitland

Thursday 14 February
9.00am to 2.00pm
Central Yorke Football Club,
5 Rogers Terrace, Maitland

#GRDCUpdates

Maitland GRDC Grains Research Update
convened by ORM Pty Ltd.

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Contents

SOUTHERN/WESTERN REGION*

PREDICTA® B

KNOW BEFORE YOU SOW

*CENTRAL NSW, SOUTHERN NSW, VICTORIA, TASMANIA, SOUTH AUSTRALIA, WESTERN AUSTRALIA

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Potential high-risk paddocks:

- Bare patches, uneven growth, white heads in previous crop
- Paddocks with unexplained poor yield from the previous year
- High frequency of root lesion nematode-susceptible crops, such as chickpeas
- Intolerant cereal varieties grown on stored moisture
- Newly purchased or leased land
- Cereals on cereals
- Cereal following grassy pastures
- Durum crops (crown rot)

There are PREDICTA® B tests for most of the soil-borne diseases of cereals and some pulse crops:

- Crown rot (cereals)
- Rhizoctonia root rot
- Take-all (including oat strain)
- Root lesion nematodes
- Cereal cyst nematode
- Stem nematode
- Blackspot (field peas)
- Yellow leaf spot
- Common root rot
- Pythium clade f
- Charcoal rot
- Ascochyta blight of chickpea
- White grain disorder
- Sclerotinia stem rot

Government of South Australia
Primary Industries and Regions SA

SARDI
South Australian Research and Development Institute

GRDC
Grains Research & Development Corporation

CONTACT:
Russell Burns
russell.burns@sa.gov.au
0401 122 115

Program

9:00 am	**Welcome**	***ORM***
9:05 am	**GRDC welcome and update**	***GRDC***
9:15 am	**Australian agvet chemical review program in perspective**	***Gordon Cumming,*** *GRDC*
9:50 am	**Root lesion nematodes in pulses**	***Katherine Linsell,*** *SARDI*
10.15 am	**Grain and pulse storage – looking at the options for maintaining quality in storage**	***Ben White,*** *GRDC Grain Storage Extension Team*
10.50 am	***Morning tea***	
11:20 am	**Snail research – optimising control**	***Helen Brodie,*** *SARDI*
11.55 am	**Rapid assessment of crop N – in field assessment of a hand-held near infra-red tool**	***Michael Zerner,*** *Landmark Pfitzner & Kleinig*
12:30 pm	**Impact of chaff lining on the seed persistence and emergence of weeds**	***Annie Ruttledge,*** *QLD Dept Ag and Fisheries*
1.05 pm	***Close and evaluation***	***ORM***
1.10 pm	***Lunch***	

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GROWING RESULTS FOR YOU

Who are we?

Yorke Peninsula Alkaline Soils Group (YPASG) was formed in 1999 by a group of farmers with an interest in tackling snail management and control in the local area.

We have evolved a lot since then, both in research and size, and now have around 150 members. Our focus is still on initiating and directing research with the aim of developing robust, sustainable and profitable farming systems. We provide motivation and support required to best match the rapid rate of change and encourage sharing of information and resources tailored to local farmers and local growing and soil conditions.

YPASG aims to utilise community/ land holder driven research to disseminate information and promote adoption of successful, sustainable technologies and practices. Our group is run by a committee of volunteers who coordinate regular workshops, crop walks, field days and events to encourage an inclusive community including business, students, women, and landholders.

Since inception, YPASG has managed over 100 projects, funded by industry stakeholders including NRM, Australian Government, CSIRO, University of South Australia, Livestock industry funds, Caring for our Country and South Australian Grains Industry Trust.

We have strong industry links and a panel of qualified agronomists and associated experts to draw upon for technical expertise. With all projects, a strong methodology is in place and communication and collaboration ensure strong work relationships. Methods and processes are defined to develop and deliver successful project outcomes for the benefit of our members and the greater agricultural community.

MEMBERSHIPS

Membership to YPASG offers great value and, in most cases, is tax deductible.

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We are grateful to our six corporate sponsors whose support helps us continue our work for local farmers.

Not a member? Please consider joining us.

Membership is an annual fee of $99. Please contact us for details.

YPASG OFFICE
61 – 63 Main Street
Minlaton SA 5575
Ph: 08 88532241
E: projects@alkalinesoils.com.au
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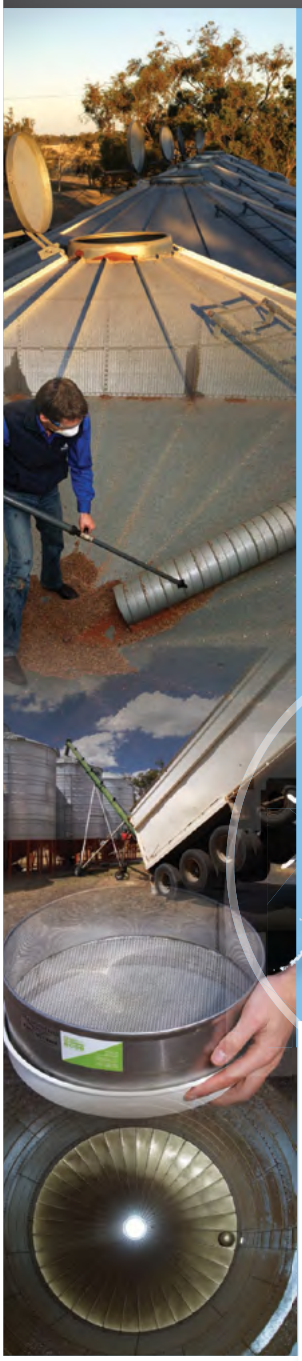

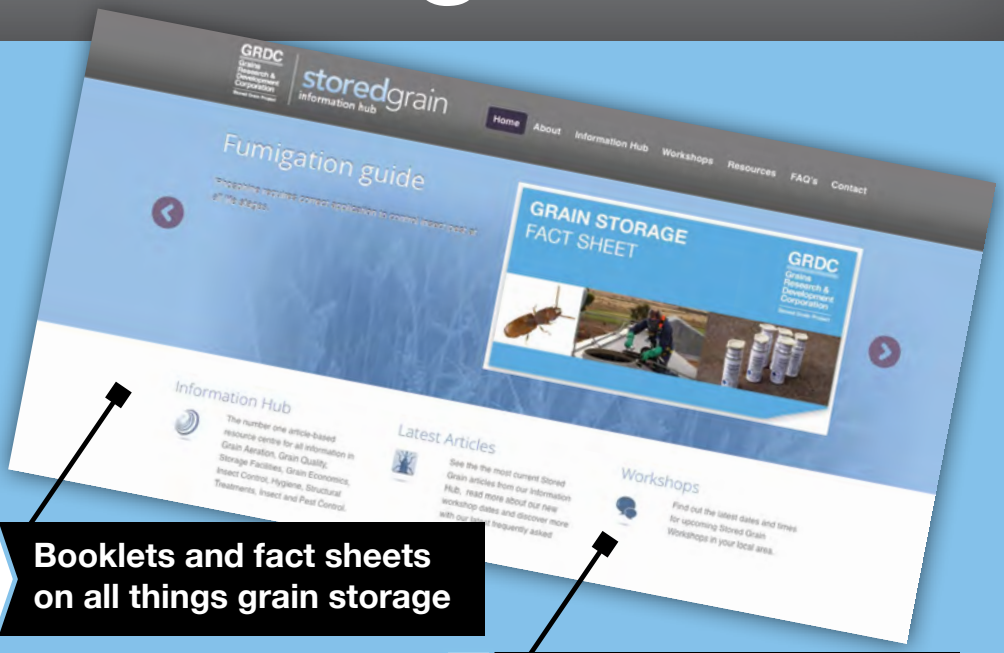

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Australian agvet chemical review program in perspective

Gordon Cumming.

Grains Research and Development Corporation (GRDC).

Keywords

- crop protection, agvet, chemicals, APVMA, regulations, review, reconsideration.

Take home messages

- The Australian agvet regulatory system is a scientific, evidence-based risk assessment process which is highly recognised internationally.
- Agvet chemicals are nominated for review based on key criteria of concern including human health (toxicology and occupational health and safety), environment, residues and trade, target crop safety and efficacy.
- The greatest direct influence that grain growers can have on retaining their access to agvet chemicals is to only use chemicals for their registered or permitted use and closely adhering to all label directions for use.
- Maintenance of access to agricultural chemicals for broadacre use is reliant on growers showing strong stewardship in following label directions for use.

Background

The Australian Pesticides and Veterinary Medicines Authority (APVMA) is the Australian Government regulator of agricultural and veterinary (agvet) chemical products. It is responsible for the regulation of agvet chemicals into the Australian market place and needs to be satisfied that the intended use does not harm the health and safety of people, animals and crops, the environment, and trade. It does this through:

- Evidence-based evaluation and approval of active constituents and the registration of agvet chemical products.
- The review of certain agvet chemicals of concern to ensure that they continue to meet contemporary scientific standards.

For an agvet chemical product to legally be manufactured, imported, supplied or sold in Australia, it must be registered by the APVMA. The registration process involves scientifically evaluating the safety and efficacy (effectiveness) of a product in order to protect the health and safety of people, animals, plants and the environment.

The APVMA looks to new data, information and science when considering the ongoing safety of a registered product, the full range of risks and how human exposure can be minimised through instructions for use and safety directions.

The assessment determines whether the agvet product, when used in accordance with the label or permit directions for use, would have a harmful effect on human health, occupational health and safety, the environment or trade.

The APVMA's approach to chemical risk assessment

All products registered for use in Australia have been through a robust chemical risk assessment process and are safe when used as per the label instructions.

As Australia's agvet chemical regulator, it is the role of the APVMA to consider all relevant scientific material when determining the likely impacts on human health and worker safety including long term and short-term exposure to users and residues in food before registering a product.

It is the role of the regulator to determine whether products used according to label instructions could result in a level of exposure that poses an unacceptable risk.

Consistent with regulators in other countries, the APVMA uses a risk-based, weight-of-evidence assessment, which considers the full range of risks, including studies of cancer risks, and how human exposure can be minimised through instructions for use and safety directions.

Chemical risk assessment = hazard assessment + exposure assessment

Hazard assessment: Is an assessment of the data related to the intrinsic toxicity potential of an active constituent and/or formulated product.

Exposure assessment: Is an assessment of the likely exposure of humans and environmental organisms that takes into account how the chemical product is to be used, the type and formulation of the product, and the crops or animals to be treated.

Australian Chemical Review Program

The APVMA considers a wide range of scientific data submitted by registrants in support of an application to approve an active constituent or to register a product containing that active constituent. The Chemical Review Program reconsiders the registration of agvet chemicals in cases where credible new scientific information has been generated after a product has been registered that suggests the existence of previously unknown risks to human health, worker safety, the environment, trade and/or product performance has been identified.

If this happens, the APVMA can initiate a reconsideration process (commonly called a chemical review) to assess the identified risk(s) and determine whether changes are needed to ensure that the product can continue to be used safely and effectively.

Chemical reconsiderations are managed under the auspices of the APVMA's Chemical Review Program, which was established in 1995.

The APVMA may undertake a reconsideration to scientifically reassess the risks and determine whether regulatory changes are necessary. Depending on the review's findings, active constituents and the products containing them might:

- be confirmed as safe and appropriate for the registered use(s).
- be restricted in use, by making label amendments to limit the situations in which product(s) may be used, or;
- have its registration suspended pending specific action or cancelled or be withdrawn voluntarily from the market by the registrant(s).

The reconsideration process incorporates legislative, administrative and scientific elements that contribute to the final decision to affirm, vary, suspend or cancel a registration. As a result, reconsiderations can be complex, have high resource requirements and long timeframes.

Prior to 2014, chemical reconsiderations were not time limited—the timeframe of individual reviews was determined by the scope and specific details of the review. For this reason, the time that it has taken to complete individual reviews has been highly variable, ranging from less than six months for the most straightforward label review to more than 10 years for some of the more technically complex and large reviews. The average time taken to complete a review has been just over three years.

From 1 July 2014, chemical reviews will be completed within a prescribed timeframe — under current legislation, a reconsideration must be completed within a maximum of 57 months.

Listing of agricultural chemical reviews

Over the more than 20 years that the Chemical Review Program has been in place, a total of 63 reviews have been completed, with 13 chemicals currently under active review. An additional 19 chemicals have been identified for review prioritisation (Table 1).

Of the 13 chemicals currently under review, eight have broadacre grains registrations as highlighted in Table 1.

Of the 63 completed chemical reviews, 10 had broadacre grains registrations and are listed in Table 2 with a brief description of the regulatory decisions which resulted in:

- Registrations cancelled of two products (endosulfan and fenthion).

- Label amendments/variations of four products (atrazine, dimethoate, diuron, omethoate).
- No changes to broadacre cropping use patterns of four products (bifenthrin, bromoxynil, carbendazim, glyphosate).

A full description of the review status details and regulatory decision(s) for all current and completed chemical reviews is available on the APVMA website.

Listing of chemical reviews: https://apvma.gov.au/chemicals-and-products/chemical-review/listing

Prioritisation of chemicals nominated for review

Agvet chemicals nominated for review by the APVMA are given an order of priority according to the level of concern that led to the nomination.

The APVMA and its external advisory agencies use a scoring process to prioritise nominated chemicals for review, based on key criteria of concern including human health (toxicology and occupational health and safety), environment, residues and trade, target crop safety and efficacy. The priority for each chemical nomination is determined by assessing it against each of the criteria and evaluating the outcomes.

Human health (toxicology and occupational health and safety)

Chemicals that are nominated for review are assessed for their effect on human health against the following criteria:

- Special concerns
  - o demonstrated or potential adverse effects in humans.
- Acute and chronic risk.
- Scheduling of the chemical.
- Exposure to the chemical from food.
- Regulatory action taken overseas (for example, Canada, the European Union, the United Kingdom, the United States of America).
- Hazardous substances.
- Other toxicity (health hazard).
- Industrial exposure in Australia.
- Form of concentrated chemical (includes formulated products).
- Exposure to working strength chemical (mixing, loading or application).
- Frequency of application.
- Post-application exposure (handling of treated crops and animals).
- Toxicity.
- User exposure.

Environment

Chemicals that are nominated for review are assessed for their effect on the environment against the following criteria:

- Environmental exposure
  - o form and method of application.
  - o volume of use (kilograms per annum).
  - o scale of use (hectares per annum).
  - o persistence (soil or aquatic half-life).
  - o bioaccumulation potential.
  - o mobility or leaching potential.
- Environmental toxicity.
- Aquatic toxicity.
- Terrestrial bird or mammalian toxicity.
- Terrestrial plant toxicity.
- Other non-target organisms.
- Sensitivity of receiving environment.
- Demonstrated adverse effects.
- Regulatory action taken overseas on environmental grounds (for example, the US Environmental Protection Agency, the Canadian Pest Management Regulatory Agency or the European Union).

Residues and trade

Chemicals that are nominated for review are assessed for their impact on residues and trade against the following criteria:

- Absence of maximum residue limits (MRLs).
- Reported incidents of residue violations.
- Reported incidents of adverse effects on trade.
- Compatibility with other countries' MRLs.
- International regulatory action.
- Residues resulting from use according to the label and the appropriateness of existing directions (for example, hydroponics versus field use).

Note: Dietary exposure is considered under human health.

Target crop safety

Chemicals that are nominated for review are assessed for their effect on target crop safety against the following criteria:

- Reported incidents of phytotoxicity and adverse interactions with target crops.
- Reported incidents of adverse effects to treated target animals.

Efficacy

Chemicals that are nominated for review are assessed for their efficacy against the following criterion:

- Lack of efficacy (confirmed report(s) of serious incident(s) of chemical failure; substantial incidents of chemical failure).

Chemicals nominated for reconsideration

Identifying and nominating chemicals for review is an ongoing process. The APVMA regularly assesses chemicals nominated for review to ensure the highest risks are being targeted based on up-to-date scientifically based information.

The reconsideration process is initiated when new scientific information raises concerns relating to the safety or effectiveness of the chemical.

The formal legislative process commences when the APVMA decides it is necessary to undertake a reconsideration and issues a legal notice to holders placing their approvals and registrations under review.

The APVMA follows a consultative process with the public, industry and federal and state government agencies to seek input on prioritising chemicals, or types of chemicals, that have been identified for review.

Currently, five chemicals have now been prioritised for detailed scoping prior to commencement of reconsideration. The remainder are to be prioritised for reconsideration after the first five have commenced the reconsideration process.

Currently there 13 chemicals or types of chemicals under review and 19 chemicals the APVMA had identified for future review. Five of these are currently being scoped prior to commencement of the review process.

More information on the chemicals under review, nominated and prioritised for reconsideration is available from: https://apvma.gov.au/node/10876

Table 1. Current chemicals with reviews in progress, those that have be prioritised (1 to 5) for future reviews and those that have been identified for review but not yet prioritised.

Current reviews in progress	Prioritised		Yet to be prioritised
	Priority	Chemical	Chemical
2,4-D[1 2 3 *]	1	Dithiocarbamates [1 2 *]	Acephate [1 2]
Chlorpyrifos [1 3 *]	2	Second generation anti-coagulant rodenticides [1 2 3]	Amitrole [1 2 *]
Diazinon [1 2 3]	3	Cyanazine and Simazine [2 3 *]	Carbofuran [1 2 3 *]
Diquat [1 2 3 *]	4	Phorate [1 3]	Chlorothalonil [1 2 3 *]
Fenitriothion [1 2 3 *]	5	Metal phosphides (only those used for grain treatment) [1 2 *]	Dicofol [1 2 3]
Fipronil [1 2 3 *]			Fenutatin Oxide [1 2 3]
Maldison [1 2]			Hexazinone [3 *]
Methidathion [1 2]			Levamisole [1 2]
Methiocarb [1 2 3 *]			Methomyl [1 2 3]
Molinate [1 2 3]			Permethrin [1 2 *]
Neomycin [1]			Picloram [2 3 *]
Paraquat [2 3 *]			Propargite [1 3]
Procymidone [1 2 *]			Triazole fungicides [1 2 *]
			Trichlorfon [1]

Reason for reconsideration

[1] Public health: Includes a consideration of mammalian toxicology and the risk to people from exposure to residues in food.

[2] Worker safety: Includes a consideration of mammalian toxicology and the risk to people using chemical products, re-entering treated areas and handling treated materials.

[3] Environmental safety: Includes a consideration of ecotoxicology, environmental fate and the risk to organisms from exposure to chemicals in the environment during use and remaining in the environment after use.

** Registered use in broadacre grain cropping.*

Table 2. Agvet chemicals with broadacre grains registrations for which reviews are completed with a brief description of the regulatory decision.

Chemical	Regulatory decision
Atrazine	Label variation.
	Specifically, these changes were to further reduce the risk of atrazine entering waterways, update the information on withholding periods and additional information on weed resistance reporting.
Bifenthrin	Related only to those products containing bifenthrin at 80g/L or 100g/L for which a 500mL pack size had been approved.
	Registration cancellation of 500mL packs with active concentration greater than 80g/L.
Bromoxynil	Changes to withholding period for grazing and cutting for stock food.
Carbendazim	Removal of horticultural and ornamental crops from label.
	Revised safety directions and added birth defects warning statement and male infertility in laboratory animals' statement.
	Re-entry intervals added to label instructions.
Dimethoate	Cancellation of home garden products.
	Restriction of pastures, fodder and oilseed uses to early crop emergence stages only.
Diuron	Label variations to remove or amend those uses where risk from runoff cannot be managed.
	Removal of some horticultural crops and non-agricultural situations.
Endosulfan	All registrations cancelled 11 October 2010.
Fenthion	All registrations cancelled 15 October 2015.
Glyphosate	In May 1997, following the review, the APVMA introduced additional restrictions on the use of glyphosate in or around waterways to limit the potential risks to the aquatic environment.
Omethoate	Removed all use patterns on food producing crops.
	Removed all use patterns for the use of omethoate on crops fed to food producing animals.
	Use restricted to bare earth barrier spray outside of crop.

The cost of registration, reconsideration and its impact on chemical availability

The number of research-based companies involved in the discovery of new chemistries has been declining. In part this is due to the increasing costs of the discovery and development of new pesticides. The average cost to bring a new active ingredient to market from 2010-2014 was an estimated US$286 million – approximately US$134 million more than in 1995.

It is harder and harder to find new active ingredients, despite the fact that chemical companies are screening more molecules than ever before. Only one in 160,000 active ingredients discovered today will pass the rigorous testing requirements to become a registered pest management product.

The additional costs associated with product defence, when a chemical goes through the reconsideration process, can be extremely high if additional data is required to meet current regulatory scientific requirements/standards. A registrant investment decision takes into consideration these additional costs. For older, generic products such expenditure may never be recovered from the market place.

Conclusion

The greatest direct influence that grain growers can have on retaining access to agvet chemicals is to ensure that there are no adverse experiences. This can be achieved by using chemicals for their registered use and closely adhering to all label directions for use including application timing, rates, spray drift mitigation statements and withholding periods.

Failure to do so can result in exceeding of MRLs in commodities, the potential for environmental damage and human health risks. These outcomes then put additional regulatory focus on those agvet chemicals, adding to the body of evidence that may then result in a negative review for the grains industry, leading to further use restriction or cancellation of registrations.

Maintenance of access to agricultural chemicals for broadacre use is reliant on growers showing strong stewardship in following label directions and supporting registrants who invest in new use patterns, both with new actives and old off patent (generic actives).

Useful resources

Australian Pesticides and Veterinary Medicine Authority (APVMA): https://apvma.gov.au/

APVMA: Chemical Review: https://apvma.gov.au/

Contact details

Gordon Cumming
Grains Research and Development Corporation (GRDC)
0428 637 642
gordon.cumming@grdc.com.au

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Notes

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Spray Application GrowNotes™ Manual – go to: https://grdc.com.au/Resources/GrowNotes-technical Also go to https://grdc.com.au/Resources/GrowNotes and check out the latest versions of the Regional Agronomy Crop GrowNotes™ titles.

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South Australian cereal root disease update 2019

Katherine Linsell[1], Joshua Fanning[2], Tara Garrad[1], Jon Baker[2], Marg Evans[1], Isabel Munoz Santa[3], Grant Hollaway[2] and Alan McKay[1].

[1]SARDI; [2]Agriculture Victoria, Horsham; [3]University of Adelaide.

GRDC project codes: DAV00144, DAV00128, DAV00123, DAN00175, DAS1802-011BLX

Keywords

- rhizoctonia, crown rot, root lesion nematode, cereal cyst nematode, PREDICTA® B.

Take home messages

- Drought in 2018 and low summer rainfall are likely to increase the risk of rhizoctonia root rot and crown rot in 2019. Identify paddocks at risk prior to sowing using PREDICTA® B to implement strategies to minimise yield loss.
- Cereal cyst nematode (CCN) levels have increased in SA with detections in 24% of paddocks tested in 2018, compared to 1% in Victoria. Monitor numbers in paddocks sown with susceptible cereals.
- Adding stubble to PREDICTA® B samples improves crown rot risk assessment; crown rot and root lesion nematode (RLN) PREDICTA® B yield loss risk categories were updated and testing for sclerotinia stem rot was added to PREDICTA® B for 2019. PREDICTA® B manual (version 10.2) is available for download (https://rootdisease.aweb.net.au/).
- Consult current cereal and pulse disease guides for the latest RLN resistance ratings as there is variation between crops and crop varieties for resistance to RLN species.

Background

The severity of soilborne disease is significantly affected by seasonal conditions in both the preceding crop that produced the inoculum and, in the crop, exposed to the inoculum.

The 2018 season was characterised by below average rainfall in autumn to mid-winter, reasonable rainfall in August, followed by low rainfall during spring. These conditions favour:

- Build-up of *Rhizoctonia solani* AG8, the cause of rhizoctonia root rot.
- Production of whiteheads caused by crown rot.
- Reduced breakdown of cereal stubble in break crops.
- Root damage caused by root lesion nematodes

Losses from crown rot and RLN were recently estimated to be $125 million and $16 million per/year, respectively.

Managing cereal soilborne diseases in 2019

It is advised that the disease risk profile of paddocks is determined using PREDICTA®B testing well ahead of sowing in 2019. PREDICTA®B is a DNA-based soil testing service which enables identification of pathogens posing the greatest threat to crops. For further information on PREDICTA®B, head to http://pir.sa.gov.au/research/services/molecular_diagnostics/predicta_b

Rhizoctonia

Inoculum levels of *Rhizoctonia* are likely to be a concern in 2019 as dry conditions favour a build-up of the pathogen. Forty-four percent of paddocks in SA that were tested in 2018 using PREDICTA®B had medium to high risk levels of Rhizoctonia prior to sowing (Table 1) and with the dry 2018 season, inoculum level is likely to have increased during the year. The impact on crops during 2019 will be greatest if the summer remains dry, the season breaks late and temperatures drop quickly after

sowing. In areas where good summer rainfall occurs, *Rhizoctonia* levels will be lower. The impact of the pathogen will be reduced if the season breaks early and crops establish in warm soil. Rhizoctonia is most damaging when root growth is restricted either by cold soils, compaction layers or lack of moisture. Crops that establish well can still be affected in mid-winter when soil temperatures drop below 10°C when *Rhizoctonia* can attack the crown roots causing uneven growth and reduced tiller number, rather than classic bare patch symptoms.

In paddocks with *Rhizoctonia* present at high levels, control summer weeds and autumn green bridge and consider rotating to a non-cereal crop. If cereals are to be grown, wheat is more tolerant than barley and early sowing in the seeding window with banding of nitrogen (N) below the seed can facilitate rapid root growth in the soil profile. Ensure good crop nutrition, with particular attention to trace elements, and increase seeding rates to reduce impact of lost tillers from *Rhizoctonia* damage to crown roots. If growing cereals in 2019, a PREDICTA® B test can be used to identify paddocks at risk.

Consider fungicides to protect the roots. Rainfall is needed to move fungicides into the root zone as roots outside the fungicide zone are not protected. Seed treatments tend to protect the seminal roots, whereas liquid streaming Uniform® above and below the seed can protect crown and seminal roots and tends to produce larger yield responses in above average rainfall seasons.

Crown rot

Crown rot has become the most important soilborne disease affecting cereal crops nationally — 38% of SA grower samples tested in 2018 by PREDICTA®B had medium to high risk levels of crown rot prior to sowing (Table 1). The dry finish to the season in 2018 favoured whitehead development in wheat and high inoculum in infected plants. Where there is a medium to high crown rot risk, it is best to avoid growing durum or bread wheat. Yield loss in barley will be lower, but inoculum levels will increase. Generally, a two-year break from cereals is required to reduce medium/high levels to a low inoculum level. However, the dry season of 2018 will have slowed the breakdown of stubble and a three-year break may be required. A PREDICTA® B soil test prior to sowing can identify at risk paddocks — make sure one piece of stubble, from 15 locations, each 5cm long and from the base of the plant, is added to that sample

Cereal cyst nematode

Cereal cyst nematode was the most important soilborne disease in SA and Victoria. However, it is generally under control, following two decades of using resistant varieties. Over the past five years, numbers have been slowly increasing in SA, but not in Victoria. In 2016, CCN was detected in 15% of paddocks tested in SA, increasing to 24% in 2018 (Table 1). While only 5% of paddocks had a medium to high risk (Table 1), the detection of CCN should be noted due to its ability to rapidly increase. PREDICTA®B can be used to monitor CCN levels in paddocks sown to susceptible cereals. Use of resistant varieties or non-host crops is recommended in paddocks where CCN is detected.

Root lesion nematode

Pratylenchus neglectus levels before sowing in 2018 were at medium to high levels in 18% of paddocks tested in SA (Table 1). This was 11% greater than in 2016 due to the exceptional conditions during 2017. The dry conditions in 2018 are expected to reduce *P. neglectus* multiplication and potentially reduce the risk to crops sown in 2019. To keep RLN densities below yield limiting thresholds, grow varieties/crops with a moderately resistant-moderately susceptible (MRMS) or better resistance rating. If susceptible varieties are grown, rotate with resistant crops/varieties.

Table 1. Summary Southern Region PREDICTA® B results showing percentage of samples returning medium/high disease risk (non-bracketed) and total percentage of samples returning positive detection of inoculum (bracketed) from 2016-2018.

Region	Year	Samples	CCN	Crown rot	Rhizoctonia	*P. neglectus*	*P. thornei*
Vic	2016	85	0% (2%)	53% (75%)	31% (40%)	5% (87%)	1% (45%)
	2017	98	0% (4%)	37% (67%)	38% (51%)	8% (84%)	2% (38%)
	2018	90	0% (1%)	51% (82%)	21% (29%)	8% (82%)	2% (46%)
	2019						
SA	2016	66	0% (15%)	39% (76%)	58% (77%)	3% (89%)	0% (32%)
	2017	58	3% (22%)	28% (64%)	29% (52%)	7% (86%)	2% (26%)
	2018	77	5% (24%)	38% (78%)	44% (79%)	18% (95%)	0% (34%)

(X%) Total percentage of samples infected.

P. neglectus yield responses

In 2018, 60% of varieties in a *P. neglectus* tolerance trial located at Pinery, SA, had significant yield losses ranging from 8% to 15% (Figure 1). The trial was established in 2017 to produce paired plots of low (5 *P. neglectus*/g soil) and high (80 P. neglectus/g soil) to be over sown in 2018. Low growing season rainfall limited yield potential. The trial established well on 30mm of rainfall prior to sowing (11 May), followed up with 45mm rainfall in June, while the rest of the season received only 100 mm, most in August.

Emu Rock$^{\Phi}$, Razor CL Plus$^{\Phi}$ and Corack$^{\Phi}$ had the largest losses with 12.1%, 12.6% and 14.6%, respectively, equating to about 0.2t/ha. Scepter$^{\Phi}$, DBA Spes$^{\Phi}$, Spartacus CL$^{\Phi}$, Hindmarsh and Chief CL Plus$^{\Phi}$ had yield losses of 8%.

Severe seminal root damage was observed on a majority of varieties in the spring (Figure 2) in the high treatments. Plants in these plots appeared to rely on the crown roots to finish the season.

A review of losses caused by *P. neglectus* estimated significant yield losses occurred in 30% of seasons in the Southern Region. Preliminary studies indicate seasons with good early/mid-season rainfall, followed by low rainfall and high evapo-transpiration in spring, are most conducive to yield loss. However, there are significant genotype x environment (GxE)

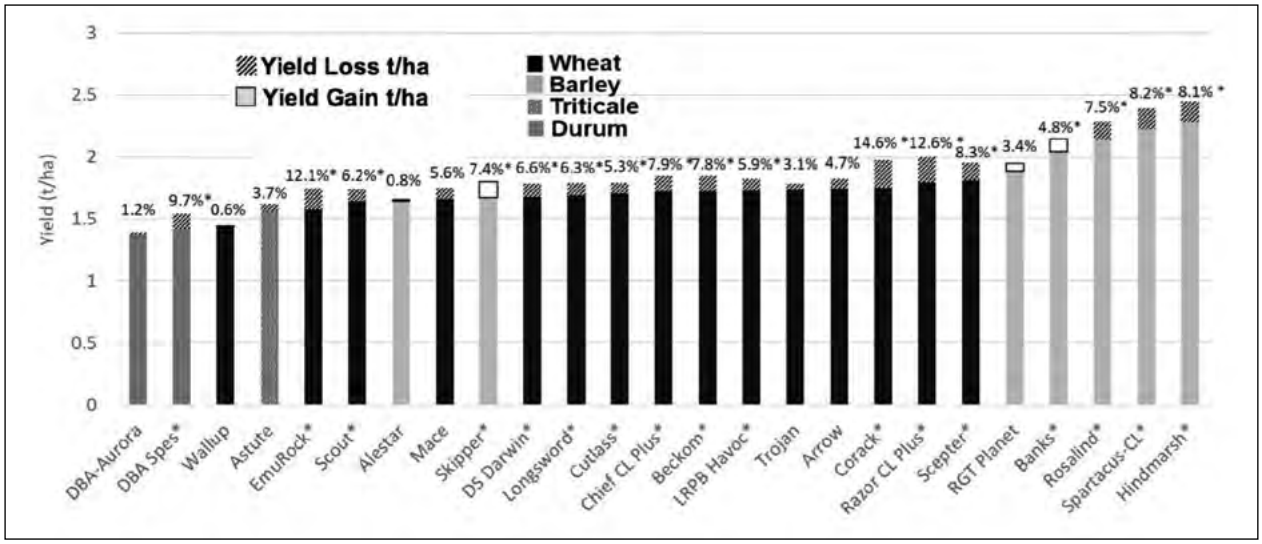

Figure 1. Yield responses of cereal varieties to *P. neglectus* in 2018 at Pinery, SA. * Yield responses significant at p=0.05

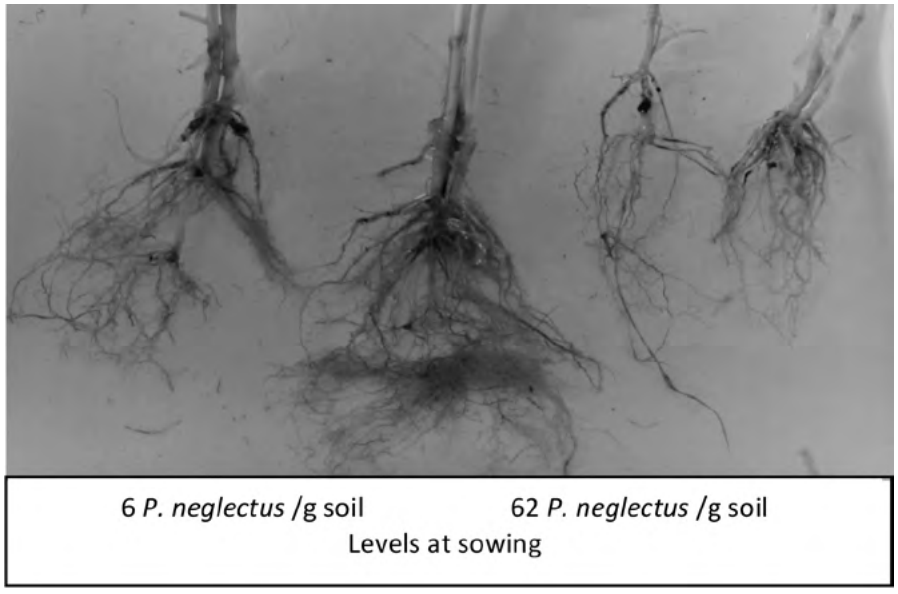

Figure 2. Root damage on Corack$^{\Phi}$ wheat at 21 weeks from sowing.

Table 2. Southern Region PREDICTA® B RLN yield loss risk categories.

RLN level	P. thornei/g soil	P. neglectus/g soil	% Yield loss
BDL	<0.1	<0.1	0
Low	0.1 - <15	0.1 - <25	0 – 5
Medium	15 - <60	25 - <100	5 – 20
High	≥60	≥100	20 – 40

interactions that result in different groups of varieties producing yield responses in different seasons. Therefore, growers should grow the best adapted varieties and use resistant varieties/crops when practical to control high populations.

Root lesion nematode yield loss categories

Following the review of yield loss data collected nationally from 51 field trials (2011-2015), the PREDICTA®B RLN medium to high risk threshold for the Southern Region was increased from 60 to 100 nematodes/g soil (Table 2).

Resistance to RLN in cereals and pulses

It is important to know which RLN species are present, as each species has a different host range.

For *P. neglectus*, triticale is the most resistant cereal crop followed by barley and durum. Wheat is the most susceptible crop, with useful variation in 'resistance' between varieties. The more resistant wheat varieties, Mace$^{\phi}$ and Trojan$^{\phi}$, rated MS. It is important to note that in good seasons all varieties will increase nematode densities except the triticale varieties.

For *P. thornei*, durum, barley and triticale are more resistant than bread wheat (Figure 3b). Wheat varieties vary in susceptibility of *P. thornei,* so it is important to consult a Cereal Variety Disease Guide or NVT Online.

The relative resistance classifications for cereal, pulse and oilseed varieties are summarised in

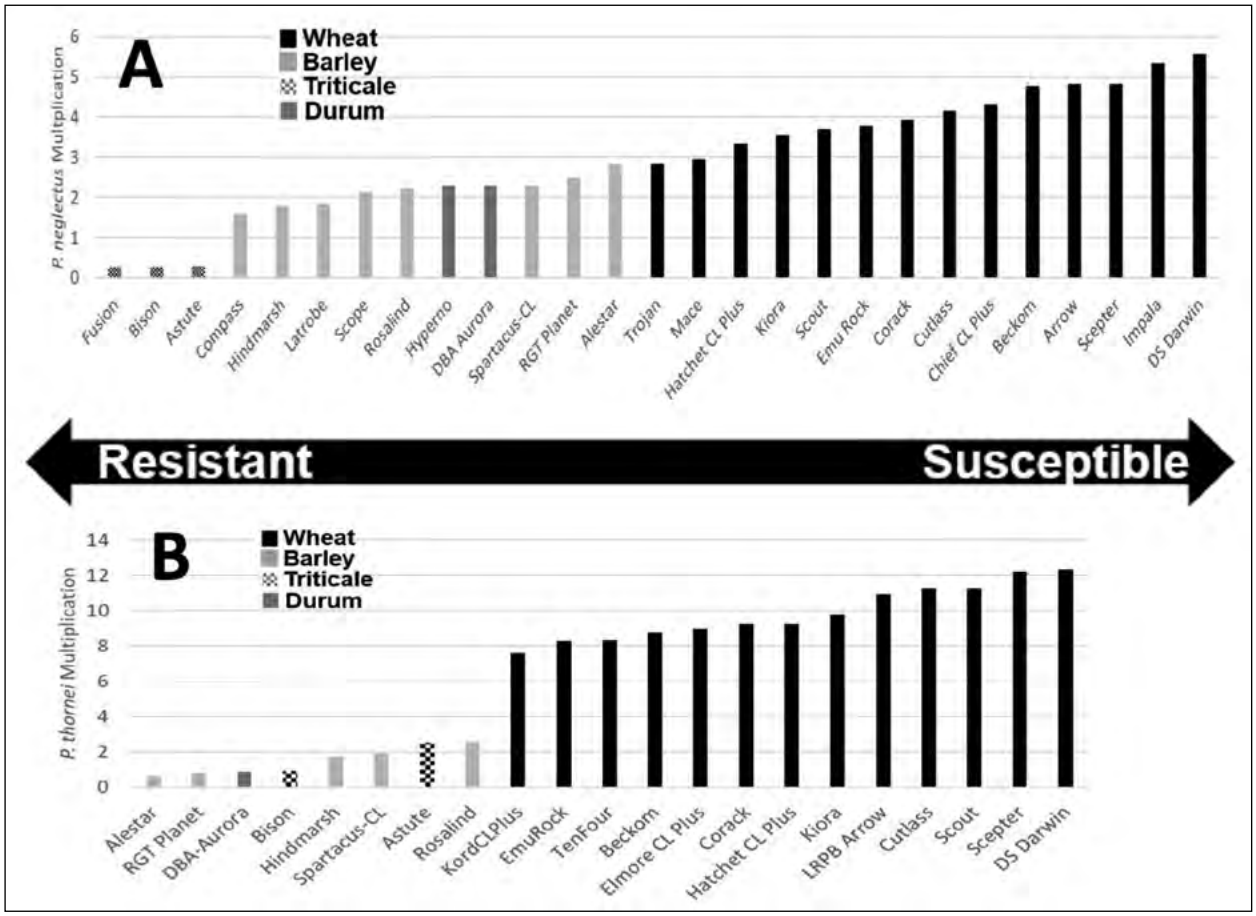

Figure 3. Multi-site analysis of *P. neglectus* **A)** and *P. thornei* **B)** multiplication in cereal varieties in field trials conducted in the Southern Region between 2011-2017 and 2016-2017, respectively.

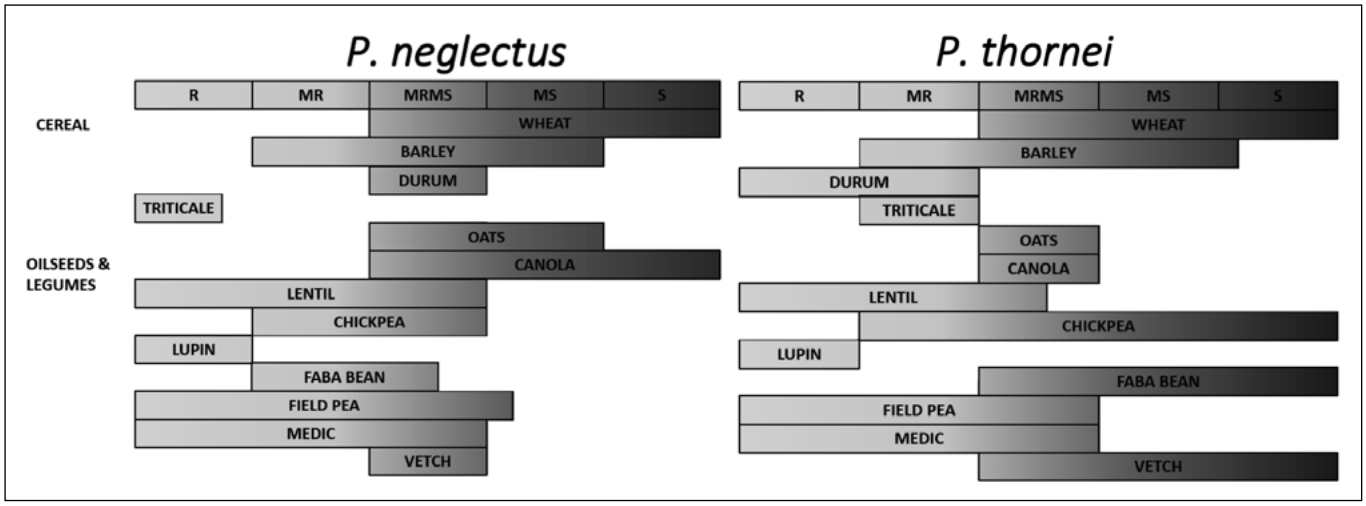

Figure 4. Resistance of cereals, oilseeds and pulses to *P. neglectus* and *P. thornei*.

Figure 4 for *P. neglectus* and *P. thornei*. Wheat is a susceptible crop for both species. For *P. neglectus*, canola is susceptible. For *P. thornei*, chickpea, faba bean and vetch are susceptible in seasons with good spring rainfall. Lentil, lupin and field pea are reasonable break crops for both species.

Conclusion

Proactive disease control is required as yield losses due to soilborne diseases can be greater than 20%. Therefore, it is important that the disease risk profile of paddocks is determined using PREDICTA®B testing well ahead of sowing in 2019 and plans are developed and implemented to manage disease risks in 2019.

Useful resources

PREDICTA®B website

http://pir.sa.gov.au/research/services/molecular_diagnostics/predicta_b

2018 Cereal Variety Disease Guide http://pir.sa.gov.au/__data/assets/pdf_file/0017/311084/Cereal_Variety_Disease_Guide_2018_booklet_WEB.pdf

2018 Pulse Disease Guide https://www.nvtonline.com.au/wp-content/uploads/2018/03/VIC-Pulse-disease-guide-2018.pdf

GRDC Tips and Tactics Root Lesion Nematode https://grdc.com.au/__data/assets/pdf_file/0026/126476/tatrootlesionnematodessouthlr-pdf.pdf

GRDC Tips and Tactics Cereal Cyst Nematode https://grdc.com.au/resources-and-publications/all-publications/factsheets/2017/03/tips-and-tactics-cereal-cyst-nematode-2017

GRDC Tips and Tactics Rhizoctonia https://grdc.com.au/__data/assets/pdf_file/0025/170386/grdc_tips_and_tactics_rhizoctonia_southern_web.pdf.pdf

GRDC Tips and Tactics Crown Rot https://grdc.com.au/__data/assets/pdf_file/0029/165917/grdc_tips_and_tactics_crown_rot_southern_web.pdf.pdf

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Contact details

Katherine Linsell
SARDI Plant Research Centre
Gate 2b Hartley Grove, Urrbrae, SA, 5064
0417 889 253
Katherine.linsell@sa.gov.au
@klinsell

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Notes

Grain and pulse storage – looking at the options for maintaining quality in storage

Ben White.

GRDC Grain Storage Extension Team.

GRDC project code: PRB00001

Keywords

- grain quality, storage, silo, grain bags, fumigation, weevils, seed treatments, hygiene, monitoring, aeration.

Take home messages

- Select a grain storage option that provides flexibility to meet market requirements.
- The only silos suitable for fumigation are gas-tight (meeting AS2628-2010), pressure tested.
- Hygiene and monitoring are keys to maintaining grain quality in storage.
- Aeration is an effective tool worthy of consideration – best paired with an automated controller.

Background

Storing grain on-farm is increasing in popularity nationally, but growers need to select storage options carefully to ensure grain quality is maintained and market options are not limited.

When it comes to storage options, gas-tight pressure-tested silos offer simple fumigation in insect disinfestation. Aeration is a valuable tool used to cool the grain with carefully selected air.

Grain bags have a place for improved harvest logistics but are a short term (3-4 months) option. For best results, site selection and preparation are critical, as are regular weekly inspection and maintenance to maintaining bag integrity and preventing grain spoilage.

Top ten tips

1. Start clean – hygiene is essential. Insects only need a handful of grain to survive and breed. Feed any spilt grain out or bury it away from the storage facility.
2. Make sure the pressure relief valve has light hydraulic oil (ISO46) in it (wetter can be used as an alternative).
3. To pressure test, pressurise the silo with an air compressor to 25mm water gauge (250Pa or 0.036psi). The pressure in the silo should not drop below 12.5mm (125Pa) over a three-minute period. Most silos have a marked semi-opaque or clear pressure relief valve to measure the 25mm and 12mm pressure lines, but if not, use a home-made u-tube manometer using a length of clear hose with some water in it.
4. Fumigate within three weeks of the completion of harvest while grain is still warm and any insects that may have come into storage with the grain are most active.
    - Silos must be gas-tight and seal-tested to meet a 3-minute half-life pressure test. Spread the tablets out – no more than 2-deep on a tray in the headspace or in the ground-level applicator. Do not mix tablets in with grain — there is nothing to be gained by doing this — phosphine is a very active gas.
5. Keep your gas-tight sealable silos for untreated grain – fill these first and if using for seed, apply any treatments on outload.
    - This also means you can sell this surplus pesticide residue free (PRF) grain if you do not use it at seeding.
6. Use your unsealed silos for treated grain and make sure any seed treatment includes an insecticide for protection but check with potential buyers first. Do not use phosphine in silos that do not meet the seal pressure test in point 4.
7. Follow the label — a fumigation cycle will take between 10 to 17 days including ventilation and withholding. Follow the GRDC fumigation flowchart.
8. Phosphine is usually applied at two tablets per tonne of capacity of wheat (regardless how full the silo is) but check the label to be sure.
9. Aeration cooling works well and is worth considering if purchasing new silos and there is power on site. Note that used properly, aeration will slow or even stop insect reproduction and activity by cooling the grain – but will not kill insects.
10. Call the GRDC grain storage extension team on 1800 WEEVIL (1800 933 845) and go to www.storedgrain.com.au if you are unsure or just want to check on anything grain storage related.

Useful resources

www.storedgrain.com.au/

Acknowledgements

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

Contact details

Ben White
1800 933 845
ben@storedgrain.com.au
@1800WEEVIL

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Notes

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- **Access** trials data and reports from across Australia
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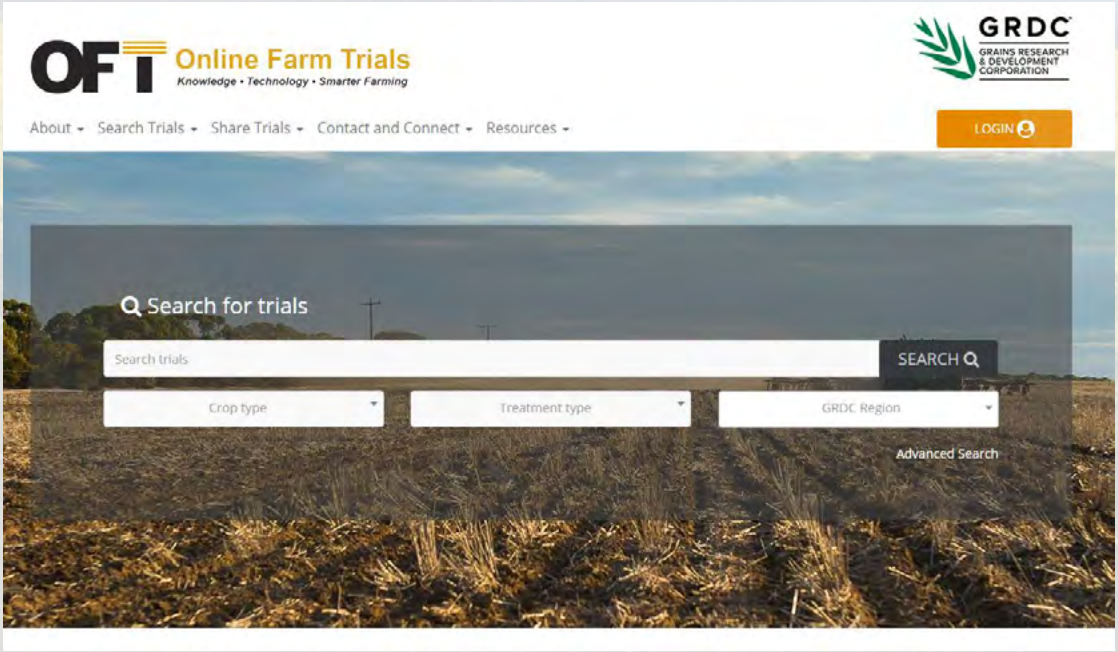
Looking for relevant and freely accessible information on issues such as crop nutrition, disease control or stubble management in your region? Online Farm Trials (OFT) contains more than 6000 trial projects, 80% of which are publically available, from across Australia on a wide variety of crop management issues and methods. Use OFT to discover relevant trial research information and result data, and to share your grains research online.



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Snail research – optimising control

Helen Brodie, Greg Baker, Kate Muirhead and Kym Perry.

Entomology Unit, South Australian Research and Development Institute.

GRDC project codes: DAS00134, DAS00160

Keywords

- snails, molluscicide baits, integrated control.

Take home messages

- Effective snail baiting requires applying baits at the right time and at sufficient pellet density to ensure good encounter rates.
- Bait in autumn as soon as snails become active and before they lay eggs, check spreader calibration, apply an adequate rate and select an appropriate product for the field conditions.

Background

Four introduced snail species of European-Mediterranean origin have established in southern Australia and become major pests of grain crops. These snails are: vineyard or common white snail [*Cernuella virgata* (Da Costa) (*Hygromiidae*)], pointed snail [*Cochlicella acuta* (Müller) (*Hygromiidae*)], small pointed snail [*Prietocella barbara* (L.) (*Hygromiidae*)], and the white Italian snail [*Theba pisana* (Müller) (*Helicidae*)]. The market access threat from these snails is substantial and increasing, particularly for the acceptance of Australian wheat and barley shipments by valuable east Asian markets, e.g. China, South Korea. The shift to minimal soil cultivation, retained stubbles and limited grazing has advantaged snail survival and reproduction in this system, and many of the harvester modifications and summer cultural controls developed and extended in the early 2000s (Bash 'Em, Burn 'Em, Bait 'Em;) have become increasingly incompatible with current farming practice.

Recent SARDI research in GRDC projects DAS00134 and YPA00002 focused on improving baiting performance by investigating the factors influencing the performance of commercial molluscicidal baits against different densities of the four snail species and under different environmental conditions. The current GRDC project DAS00160 is investigating the environmental factors influencing snail movement, feeding and reproductive activity to assist growers optimise the timing of baiting programs. The work has revealed unexpected findings suggesting that the susceptibility of snails to baits (and hence the efficiency of baiting) can change through the season. The past five years of research has generated refined baiting guidelines for snails and slugs which will be available in updated publications (e.g. Bash'em, Burn'em, Bait'em) by the end of 2019. In addition, a current GRDC- CSIRO-SARDI project (CSE00061) is aiming to improve biological control of the conical snail by potentially introducing a new strain of the parasitoid fly, *Sarcophaga villeneuveana*.

This paper summarises research findings on recent projects and preliminary observations on current projects.

Methods

Under project DAS00160 (2017-June 2019), microclimate effects on snail movement and reproductive activity are being measured at six field sites across South Australia and Western Australia). In addition to using micro-climate sensors and fixed cameras to monitor snail movement, common white snails and small-pointed snails (approx. 150) have been collected monthly at each site and dissected to determine their reproductive stage by measuring their albumen glands. Swollen albumen glands indicate snails are reproductively active. Changes in the susceptibility of snails to bait during the season have been measured in laboratory trials. This report presents preliminary data of common white snails collected from Palmer and Urania SA. Snails were placed into moist arenas (500mL ventilated plastic food containers with moist substrate, five snails per arena, 50 snails per treatment) in a laboratory environment (21°C) and provided with either pre-weighed Metarex® or placebo baits (Metarex® minus the active ingredient). Baits were removed after 2-3 nights and mortality assessed after a further 4-5 nights. Bait consumption and corresponding snail weights, body moisture, shell size and reproductive stage were determined (not presented).

Results and discussion

Snail movement and reproductive activity

In autumn, an increase in rainfall and dew events stimulates increasing snail activity. Dissection of monthly-collected common white snails in SA over the past three seasons has shown that the reproductive organs (albumen glands) of common white snails begin to enlarge from late March onwards, and then most reproductive activity occurs from late April to July (Figure 1). Depending on how quickly the season dries up, an increasing proportion of snails cease reproduction late winter and early spring and remain inactive until the following season. For growers, this suggests that under typically dry conditions, common white snail movement events prior to mid-March are unlikely to involve significant reproductive activity (noting that further testing under wetter summer conditions is required). Similar gland size patterns also occur in white Italian snails at Warooka, SA (preliminary gland monitoring December 2014-May 2017, data not presented here).

Controlling snails with molluscicides

Snails become inactive when they experience unfavourable (i.e. dry, low relative humidity) micro-climatic conditions. This 'on-off' behaviour makes them a difficult target for chemical control. The international literature indicates that molluscicide baits are generally more effective than sprays, and this appears to be because baits have greater persistence and hence greater likelihood of being encountered by the snails when they do become active.

Laboratory baiting experiments on mature common white snails suggest that snails may respond differently to the ingestion of Metarex® baits (5% metaldehyde) depending on the time of year. Mortality varied between approx. 30% to 75% for snails from Palmer and approx. 10% to 80% for snails from Urania (Figure 2). Higher kills were observed amongst snails collected during autumn and winter than in spring or summer, despite similar levels of bait consumption. Variation in the amount of Metarex® consumed (not presented) did not display any seasonal pattern nor correlate with mortality.

The Palmer 3-year data set shows that bait efficacy in killing snails increases sharply between March and April, corresponding with commencement of high snail activity (including mating and egg-laying). This distinct activity peak in April was not replicated in the Urania 9-month data set, which may be a result of the relatively small data set and limited rainfall (19.8mm) in April at Maitland, SA (BOM station 22088) that occurred after the snails had been sampled (i.e. after the 12th April). The data suggest snails may be metabolically more susceptible to metaldehyde during periods of reproductive activity. For growers, the implication is that baiting may be most efficient from April to approx. July, and less efficient at other times. However, it is more important to prevent breeding (juveniles are extremely hard to control with baits) than to restrict baiting to the April-July period since some breeding may happen earlier if regular rain/dew events occur. The reduced susceptibility to metaldehyde in spring and summer is a good reason to avoid 'last-ditch-effort' pre-harvest baiting. Late season baiting also increases the risk of bait contaminating grain at harvest.

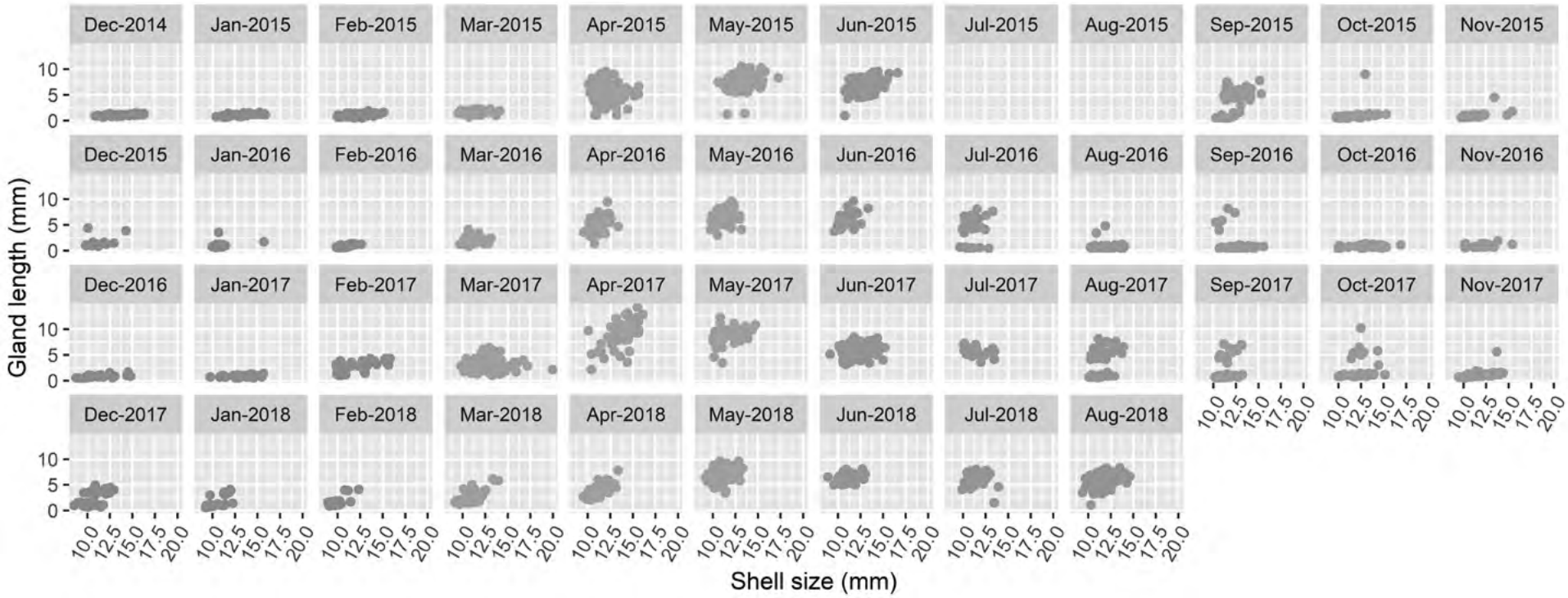

Figure 1. Albumen gland length (mm) and snail shell diameter (mm) plotted for each month for common white snails at Palmer, SA.

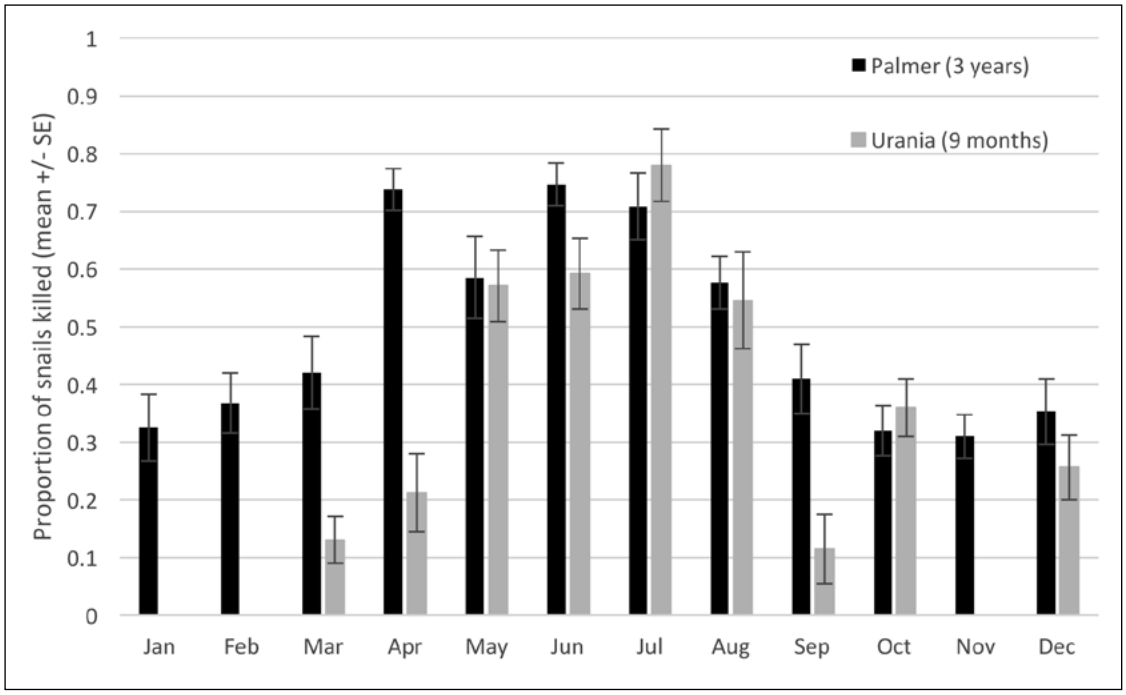

Figure 2. Mean mortality (± standard error) of mature common white snails collected monthly and offered Metarex® bait in consistent laboratory conditions. Palmer, SA data is monthly averages from March 2016 through to December 2018. Urania, SA data is monthly from March 2018 to December 2018. Data corrected for control mortality. For each sampled date, n = 50 and control mortality 0-6%.

Optimising bait operations

Below are general guidelines that have emerged from the recent body of snail research.

Bait encounter is random. Therefore, the effectiveness of a snail baiting program is governed by a number of factors that firstly dictate chance of encounter, then ingestion of the toxicant:

- Chance of encounter
  - o Level of snail activity
  - o Attractiveness of bait
  - o Baits per unit area.
- Ingestion of lethal dose
  - o Palatability of bait
  - o Quantity of bait
  - o Adequate active ingredient.

Hence, it is recommended that baiting programs take place when snails are active and that enough bait 'points' are provided to ensure good rates of encounters. The number of baits on the ground is of equal, if not greater importance, than weight of product on the ground.

Apply baits at the right time

- Baiting must occur in autumn as soon as snails become active, but before they lay eggs. Research results strongly support concentrating baiting efforts in autumn for several reasons: Preventing adult snails from laying eggs is critical to reduce population build-up. Juvenile snails are generally more difficult to control using baits due to reduced movement and bait encounter.
- Laboratory trials at SARDI have found higher efficacy when baits were applied under warmer temperatures within the range tested (10°C-22°C).
- Baiting is most efficient when there is less ground cover and alternative food. The presence of stubble, weeds and crop plants at later times reduces bait encounter.
- The susceptibility of snails to metaldehyde baits appears to be highest between April and July (Figure 2).

In autumn, even light showers or overnight dews are sufficient to stimulate movement. Ideal conditions for baiting are periods when the soil is likely to remain moist for several days. If unsure whether snails are active, bait a small area and check for dead snails after a few days. Even if snails do not look active during the day, slime trails across the soil surface can be a good indicator of night activity.

Apply an adequate rate of bait

Based on SARDI research, regardless of product used a minimum of 30 bait pellets per square metre and up to 60 pellets per square metre at very high snail densities, should be applied to ensure a sufficient density of bait points and chance of encounter. The higher rates may be needed in heavily infested areas, such as perimeters, fence lines or calcareous outcrops. Where current label rates do not permit this, a repeat application should be considered. Pellet densities for registered rates of commercial products are available in the SARDI Snail and Slug baiting guidelines brochure (refer to the Useful Resources section of this paper). Monitor live snail densities and re-apply bait as necessary. A repeat application may be needed in areas with high snail densities or when rainfall has broken down bait.

Spreader calibration important to achieve even bait distribution and good results

Do not assume your spreader is distributing bait pellets evenly. Research by the Yorke Peninsula Alkaline Soils Group and SARDI has shown spreaders calibrated for other applications (e.g. urea) may not broadcast baits as widely as expected, and ute spreaders may provide uneven distribution of bait. Different bait products also have different hardness and ballistic properties.

Therefore:

- For your **preferred bait product**, have your **spreader** professionally **calibrated** to evenly broadcast the target pellet density over the entire spread width.
- Operators should actively **check pellet distribution** across the entire spread width.
- The single spinner ute spreaders generally perform poorly with limited spread widths and uneven bait distribution.

Be aware of potential bait degradation

Some bait products are more stable under adverse weather conditions, such as cold temperatures and rainfall. Significant rainfall can degrade bran-based pellets and reduce efficacy, particularly for iron chelate products. SARDI trials found that UV exposure did not reduce the efficacy of baits in summer and early autumn, however, exposure to high temperatures (above 30°C–40°C) degraded the active ingredient in metaldehyde baits. Avoid storing bait for long periods in places where temperatures exceed 35°C (e.g. hot sheds).

Progress on biological control of conical snail

The parasitic fly, *Sarcophaga villeneuveana*, was released in SA during 2001-2004 at 21 sites (19 on Yorke Peninsula and two sites on the Limestone Coast) to control conical snails (*Cochlicella acuta*) (Hopkins 2005; Leyson et al. 2003; Coupland & Baker 2007). The flies established on Southern Yorke Peninsula, but to this day have displayed low parasitism rates and limited natural dispersal, with little impact on pest snail populations. CSIRO work has since determined that the fly population previously released in Australia parasitises a different host strain in its native (southern France) habitat, which may explain its poor performance in Australia. In a new GRDC project, CSIRO and SARDI aim to enhance the biological control provided by *S. villeneuveana* by introducing a different strain of the fly from European locations where the correct lineage of *C. acuta* predominates and the climate is more similar to SA.

Conclusion

Current research is strongly supporting concentrating baiting programs in autumn and early winter, due to (1) the need to prevent breeding, (2) to maximise the efficiency of baiting, by baiting when there is minimal alternative food, and when snail mortality response to baits appears to be highest.

Snail movement (i.e. baiting opportunities) occurs anytime there is adequate moisture, but under average seasonal conditions, minimal reproduction appears to occur prior to mid-March (note: yet to be assessed under very wet summers). Growers can aim to focus baiting efforts in the March to April period to pre-empt snail breeding. Baiting after late winter is likely to be less efficient and should cease at least two months prior to harvest to avoid bait contamination of grain (zero tolerance).

New baiting guidelines, incorporating new information on movement triggers from the camera/sensor work, will be made available to growers by the end of 2019 in a new version of the ‘Bash ‘em Burn ‘em Bait ‘em manual.

Baiting during autumn is a key component of a year-round systems approach, which is critical for effective snail management. Baiting should be used in conjunction with cultural controls during summer and autumn to reduce snail survival, such as cabling, rolling and/or burning, or summer grazing, along with effective weed control to remove refuge habitat.

The key to successful snail control is year-round integrated management:

- Continuous vigilance.
- Prepare in advance.
- Remove summer refuges.
- Roll or cable in summer when > 35°C.
- Bait before egg laying occurs.
- Baiting in winter and spring is less effective.
- Harvester modifications.
- Grain cleaning last resort.

Useful resources

http://www.pir.sa.gov.au/__data/assets/pdf_file/0004/286735/Snail_and_slug_baiting_guidelines.pdf

https://grdc.com.au/__data/assets/pdf_file/0024/117249/grdc-fs-snailbait-south_lr-pdf.pdf.pdf

https://grdc.com.au/__data/assets/pdf_file/0016/109060/snail-management-fact-sheet.pdf.pdf

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Contact details

Helen Brodie
SARDI Entomology, Waite Campus, Adelaide
08 8429 0557
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Rapid assessment of crop nitrogen and stress status – in-field assessment of a hand-held near infrared tool

Michael Zerner[1] and Kenton Porker[2].

[1]Landmark Pfitzner & Kleinig; [2]South Australian Research and Development Institute (SARDI).

Keywords

- infrared spectroscopy, nitrogen, water soluble carbohydrates, in-crop.

Take home messages

- New hand-held infrared instruments have shown promising results for use in predicting crop nitrogen (N) content of wheat and barley in the field.
- New spectroscopic tools offer improved non-destructive predictions of N compared to normalised difference vegetation index (NDVI) and other available tools.
- Accurate and robust predictive NIR calibrations enable a single calibration to be applicable to both wheat and barley across contrasting environments.
- Significant potential opportunities exist to incorporate infrared technology to manage N inputs.

Background

The use of infrared (IR) technology for prediction of plant nutrient status is a rapid and cheap means of tissue testing. Recent developments in spectroscopic instrumentation has reduced the size and cost of instruments. It has created greater opportunities to consider the use of hand-held equipment for in-situ tissue testing. The use of such devices in the field could provide real-time information and significant benefits to making agronomic decisions. Spectral reflectance techniques using both visible and near infrared wavelengths are quick and easy to apply in the field. They do not require destructive sampling, and therefore, a larger area can be measured, and many more measurements can be taken over the same area.

This research assessed the ability of a hand-held infrared device to predict crop N content and water-soluble carbohydrate (WSC) concentration in the field.

WSCs provide important reserves as a source of carbon for grain-filling, as grain demand frequently exceeds current assimilation. This trait can then be a measure for drought, heat, frost and/or disease stress tolerance as reserves of WSC are vital during the grain-filling period in southern Australia. By making WSC easier to measure it could be adopted in the plant breeding process as a phenotyping tool to help select for various stress tolerances. For instance, under terminal drought stress which is common in South Australian environments, WSC have been shown to buffer biomass production, grain yield and harvest index (HI), associated with increased water uptake (WU) and water-use efficiency (WUE). Trait-based breeding for genotypes with greater stem storage and remobilization of WSC may result in improved grain-filling and increased yields. This would potentially assist in fast tracking varieties with improved stress tolerances. This measurement would also be useful to grain growers as a crop diagnostic tool to determine the current, real-time ability of the crop to respond to or buffer against frost, heat, or drought stress events.

Plant N content is also a common measurement used by growers in their N management decision making process. Having a real-time, non-destructive measure of N content would improve the ability of grain growers to target specific grain yield and quality parameters for a given season. For example, plant N will relate to the supply of mineralised and fertiliser N and could help growers manage grain protein, through rapid crop assessments for timely applications of N.

Method

Over two contrasting growing seasons a large amount of data was obtained to develop calibrations for the near-IR (NIR) prediction of N content and WSC in wheat and barley. Over 1500 plant samples were taken and analysed for N content and WSC in conjunction with non-destructive field-based NIR spectroscopy (Hand-held FieldSpec®) and laboratory-based NIR spectroscopy (portable MicroNIRTM) in order to create predictive NIR models. Data was collected from a range of field trials in contrasting environments (Roseworthy, Mintaro and Loxton) that contained current commercial varieties of wheat and barley across multiple growth stages, sowing times and N management strategies. Data was also collected from differing soil type and crop row spacings; from 9-inch to 12-inch, to investigate any associated impact of varying ground cover that may influence the field-based NIR readings. This robust data set ensured there was a sufficient range in N content and WSC data to develop an accurate and predictive model suitable to all end users. Field-based NIR readings were obtained using a hand-held FieldSpec® Spectrometer, which recorded spectral reflectance from 350nm - 1100nm (Figure 1).

Figure 1. The FieldSpec® Handheld 2, remote sensing spectroscopy instrument.

Data analysis and interpretation was a crucial part of this research to link NIR spectral data to actual N content and WSC values. Spectral data was analysed using software, The Unscrambler X® (CAMO). This model development software is extremely powerful and was used for Partial Least Square (PLS) regression analysis in creating NIR spectral predictive models.

Results and discussion

N content

The use of the hand-held FieldSpec® NIR device to provide non-destructive predictions of N content showed potential to provide a new method of crop diagnostics for growers. Initial analysis using only one year of data provided some excellent early outcomes. Predictive model regression using only data from 2017 produced an R-value of 0.94 and predictive error of 0.5%. When data from both years was combined the predictive model produced an R-value of 0.9 (Table 1) and a predictive error of 0.64% and residual predictive deviation (RPD) equal to 2.41 (Table 1 and Figure 2). The RPD is defined as the ratio between the standard deviation of the population (SD) and the standard error in cross validation for the NIR predictions. The RPD was used to evaluate the predictive ability of the calibration models that were developed. The higher the value of the RPD, the greater the probability of the model to predict the chemical composition accurately in samples outside the calibration set. An RPD value greater than 5 (range 5 – 6.4) is considered good for quality control, while an RPD value between 3 and 5 is considered good for screening applications.

Consequently, an RPD of 2.41 (slightly lower than 3) indicates that the model is potentially suitable for screening applications of N content and robust enough to be used to make management decisions. This model includes wheat, barley, varied growth stages, contrasting crop canopy cover, size, and architecture. All data was found to be suitable to be included together. This was a very good result, as it indicates that the one predictive model can be use in all situations and environments rather than having a specific model for each scenario.

The ability to predict N content using the whole spectra of data with such devices as the hand-held FieldSpec® is a significant improvement on the current NDVI sensors available. Instead of using

Table 1. Summary of all data and model outputs (2016 & 2017) included in the total nitrogen and water-soluble carbohydrates NIR calibration models (MicroNIRTM – lab NIR, ground samples and FieldSpec® – field-based NIR).

		Field based Measurements		Lab Based Measurement	
		FieldSpec N% Data	FieldSpec WSC Data	MicroNIR N% Data	MicroNIR WSC Data
Predictive model summary	PLS Factors	12	14	4	3
	R	0.90	0.82	0.96	0.66
	R^2	0.82	0.68	0.94	0.44
	Prediction Error (±)	0.64	39.9	0.35	56.2
	RPD	2.41	1.78	4.40	1.26
Summary statistics of data included in each model	Mean	3.11	94.29	3.11	94.29
	Standard Deviation	1.54	71.01	1.54	71.01
	Minimum	0.80	0.0	0.80	0.0
	Maximum	7.20	364.16	7.20	364.16
	Count	1547	1493	1547	1493

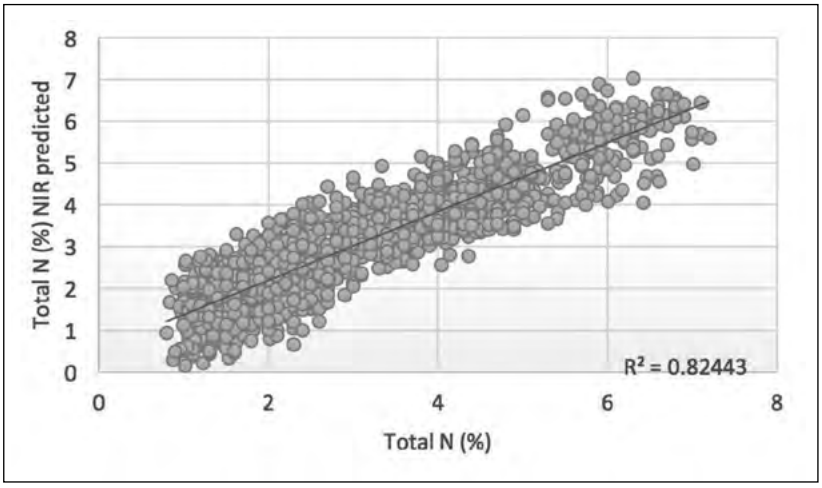

Figure 2. PLS regression calibration plots of NIR predicted total N content verses actual total N content using field-based FieldSpec® (350nm-1100nm) on crop canopies of wheat and barley at various growth stages across multiple locations during 2016 and 2017.

only 2-3 specific wavelengths as used in calculating NDVI, the method used in this study uses every wavelength from 350nm-1100nm. This provides much more information relating to the chemical composition of the crop canopy compared to just how green it is in the visible spectra as per NDVI sensors.

Sample preparation of dry, uniformly ground plant tissue samples (as prepared for wet chemistry) improved the accuracy of the model for total N. The R-value was 0.96 with a predictive error of 0.35% (Table 1 and Figure 3). This method however, is destructive but its prediction accuracy is acceptable for laboratory-based standards and provides a good option for a fast, high through-put method for prepared samples in a laboratory situation. Results from this test confirmed that a single calibration model is applicable across wheat and barley.

WSC using the FieldSpec® hand held device was 0.82 with a predictive error of 39 g/kg (Table 1 and Figure 4). This increased error resulted in a lower RPD of 1.78, which is below the screening threshold. This result would not enable any reliable use of this device to create plant stress related indices in its use as a measure of stored assimilates in the plant. Accuracy can be marginally increased if the data set becomes more specific to a particular environment (or trial) provided there is a sufficient range in data values to create the calibration regression, however it's not as robust as the predictive model for N content. The current regression may, however, still have potential for use as a selection/screening tool for plant breeders, as it may be sufficient to categorise varieties or treatments into high or low ability to store assimilates.

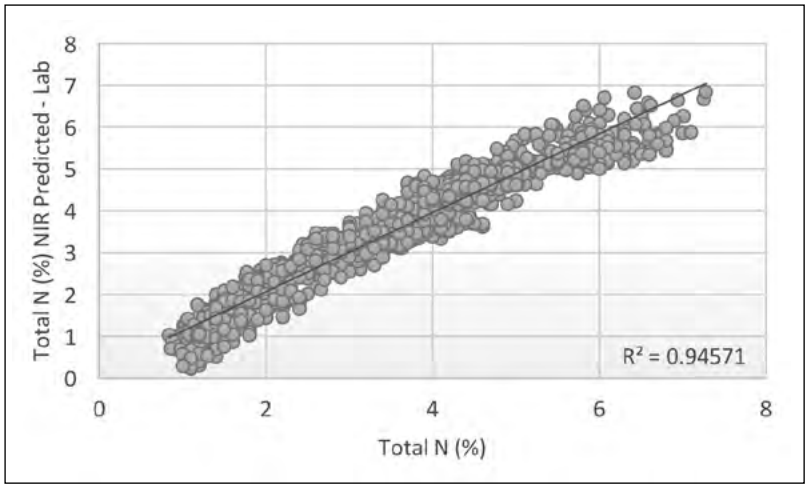

Figure 3. PLS regression calibration plots of NIR predicted total N content verses actual total N content using lab-based MicroNIR™ (900nm-1700nm) on dried, ground plant samples of wheat and barley at various growth stages across multiple locations during 2016 and 2017.

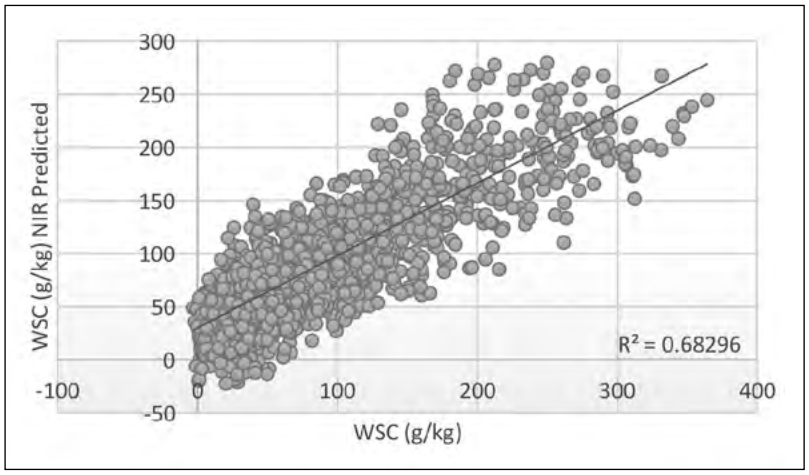

Figure 4. PLS regression calibration plots of NIR predicted WSC verses actual WSC using field-based FieldSpec (350nm-1100nm) on crop canopies of wheat and barley at various growth stages across multiple locations during 2016 and 2017.

Conclusion

The purpose of this research was to improve the ease of measurement of the plant trait components; WSC and N content. This study investigated the use of portable NIR devices to provide non-destructive, real-time measurements in the field. The hand-held FieldSpec® spectrometer was used to create field-based calibrations for N content and WSC. A laboratory-based MicroNIRTM spectrometer was also used for comparison on laboratory prepared samples.

The N content calibration regression developed for the field-based NIR sensor was less accurate than the corresponding model developed in the laboratory. Despite this however, the calibration model could be used to estimate N from a screening level of accuracy with an error of 0.6%. This level of accuracy could be used to screen a large number of plots or map the variation in N tissue concentration across a paddock.

Although not equivalent to a laboratory diagnostic accuracy level, the NIR predictions could be used to comfortably distinguish nutritional zones within the paddock for improved management of N fertilisers. The ability to have measurements conducted in-field in a matter of seconds, enables many more measurements to be taken, and therefore, provides much more information across the entire paddock rather than targeting a single test in specific zones, as currently practiced with tissue testing.

WSC prediction via the NIR model was much more variable and further research would have to be undertaken to develop a more accurate NIR calibration model. The current NIR predictive ability using the developed model in this project is only capable of providing comparisons of high and low levels of WSC and cannot be used as an accurate diagnostic tool for measuring WSC.

Acknowledgements

The research undertaken as part of this project is made possible by the significant contributions of South Australian growers through both trial cooperation and the support of SAGIT, the author would like to thank them for their continued support. This research was conducted at the University of Adelaide.

Contact details

Michael Zerner
Landmark Pfitzner & Kleinig,
3 Gunn Street, Eudunda SA 5374
0439 802 600
michael.zerner@bigpond.com

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Impact of chaff lining on the seed persistence and emergence of weeds

Annie Ruttledge[1], John Broster[2], Annie Rayner[3], Kerry Bell[1], Michael Walsh[3], Michael Widderick[1].

[1]Department of Agriculture and Fisheries, Toowoomba; [2]Charles Sturt University, Wagga Wagga; [3]University of Sydney, Narrabri.

Keywords

- harvest weed seed control, chaff lining, chaff tramlining, chaff decks, stripper fronts.

Take home messages

- Burial of weed seeds under chaff can reduce seedling emergence, but the amount of suppression depends on weed type, chaff type, and amount of chaff cover.
- There is no evidence that weed seeds rot more quickly in chaff tramlines, but it is likely environmental conditions and weed seed type could make a difference.
- Stripper fronts and conventional harvest fronts can capture similar percentages of weed seeds providing the header is set up and used appropriately.
- Chaff lining and chaff tramlining will not totally prevent weed emergence – be prepared to use other measures (e.g. spraying the tramlines with a shielded sprayer).
- The best reason to use chaff lining or chaff tramlining is to concentrate weed seeds into a narrow area for easy follow up.

Background

Herbicide resistance is a major concern for crop production due to the increasing frequency of resistance in key weeds. Non-herbicide weed management alternatives are needed to delay the spread and onset of further herbicide resistance (Walsh et al. 2013). One such alternative is harvest weed seed control (HWSC). HWSC refers to a suite of management practices which target the seed of weeds present at harvest time and borne at harvestable height (typically about 15cm or more above ground height, depending on header set up).

Current HWSC systems include narrow windrow burning, chaff tramlining, chaff lining, chaff carts, bale direct and seed destruction (Walsh et al. 2013). Chaff lining and chaff tramlining have potential for widespread adoption in Australia owing to their low cost and ease of implementation relative to some other HWSC practices. Chaff tramlining is the practice of concentrating the weed seed bearing chaff material on dedicated tramlines in controlled traffic farming (CTF) systems, typically using a chaff deck to deposit chaff into two lines (one per wheel track). Chaff lining is a similar concept, where the chaff material is concentrated using a chute into a single narrow row between stubble rows directly behind the harvester (i.e. not specifically onto tramlines).

Weed seed collection

The proportion of weed seed entering the front of the harvester is key to the efficacy of HWSC methods. An increasing number of Australian grain growers are adopting stripper harvester fronts. These fronts use rows of fingers on a spinning rotor to pluck grain heads and pods from mature crop plants. Conventional (known as Draper) header fronts cut and collect the entire plant above the harvest height. Stripper fronts leave more stubble standing. By reducing the quantity of material being

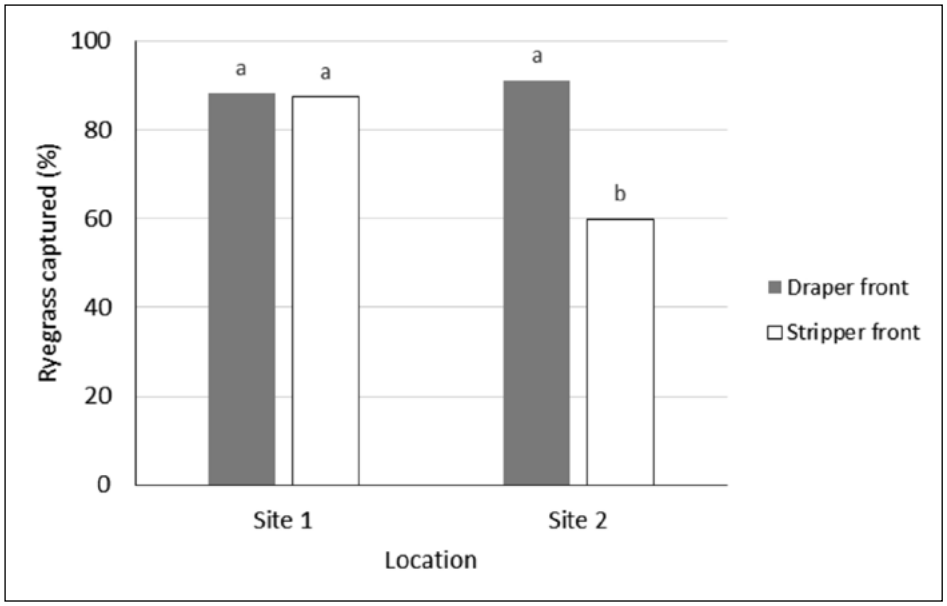

Figure 1. Percentage of ryegrass seed collected by stripper front and conventional front harvesters at two locations (means with same letter are not significantly different) (Broster et al. 2018).

processed, stripper fronts increase the speed and efficiency of harvesting. Because HWSC relies on weed seeds entering the harvester, it is important to know whether stripper fronts can achieve weed seed collection proportions similar to conventional fronts.

The weed seed collection effectiveness of stripper and conventional harvester fronts was compared in wheat paddocks on two different farms near Wagga Wagga (Figure 1). At Site 1 the proportion of annual ryegrass seeds collected by the stripper front was identical to that of a conventional front. In contrast, at Site 2 a lower proportion of ryegrass seed was collected by the stripper front. Row spacing was greater at this site and the harvester was running faster and higher than at Site 1, which could have reduced the seed collection and therefore HWSC efficacy.

These results suggest, with due diligence, a stripper front can collect a similar proportion of annual ryegrass seeds as a conventional front and can be used in conjunction with HWSC systems.

Fate of weed seeds

Weed suppression

There have been anecdotal reports that weed seeds die or fail to emerge from chaff lines and chaff tramlines. Pot trials were conducted at three locations (Toowoomba, Wagga Wagga and Narrabri) to investigate the influence of wheat, barley, canola and lupins chaff on seedling emergence of annual ryegrass (Broster et al. 2018; Ruttledge et al. 2018). Although the amount of chaff required to significantly reduce germination differed between studies, increasing amounts of wheat chaff reduced annual ryegrass germination and emergence at all three locations. Wheat chaff at 24t/ha reduced annual ryegrass emergence by approximately 15% to 35% across the three pot trials.

The type of chaff can also influence the emergence of weed seedlings. A pot study conducted at Wagga Wagga explored the emergence of annual ryegrass under four chaff types (barley, canola, lupins and wheat). While there was an interaction between crop type and chaff amount (Figure 2), overall barley inhibited emergence more than wheat, and both were better at suppressing emergence than canola and lupins. For each chaff type, the effect of rate was significant (i.e. for all four chaff types, weed emergence decreased as the amount of chaff increased).

Pot experiments conducted in Toowoomba compared the emergence of common sowthistle under wheat and barley. In the first study, wheat chaff suppressed emergence more than barley chaff, although there was no significant difference between the two chaff types. In a subsequent repeat of this pot study, wheat did have significantly greater suppression of common sowthistle compared with barley chaff (Figure 3). In both studies, 12t/ha was sufficient to significantly reduce sowthistle emergence in the wheat chaff treatment.

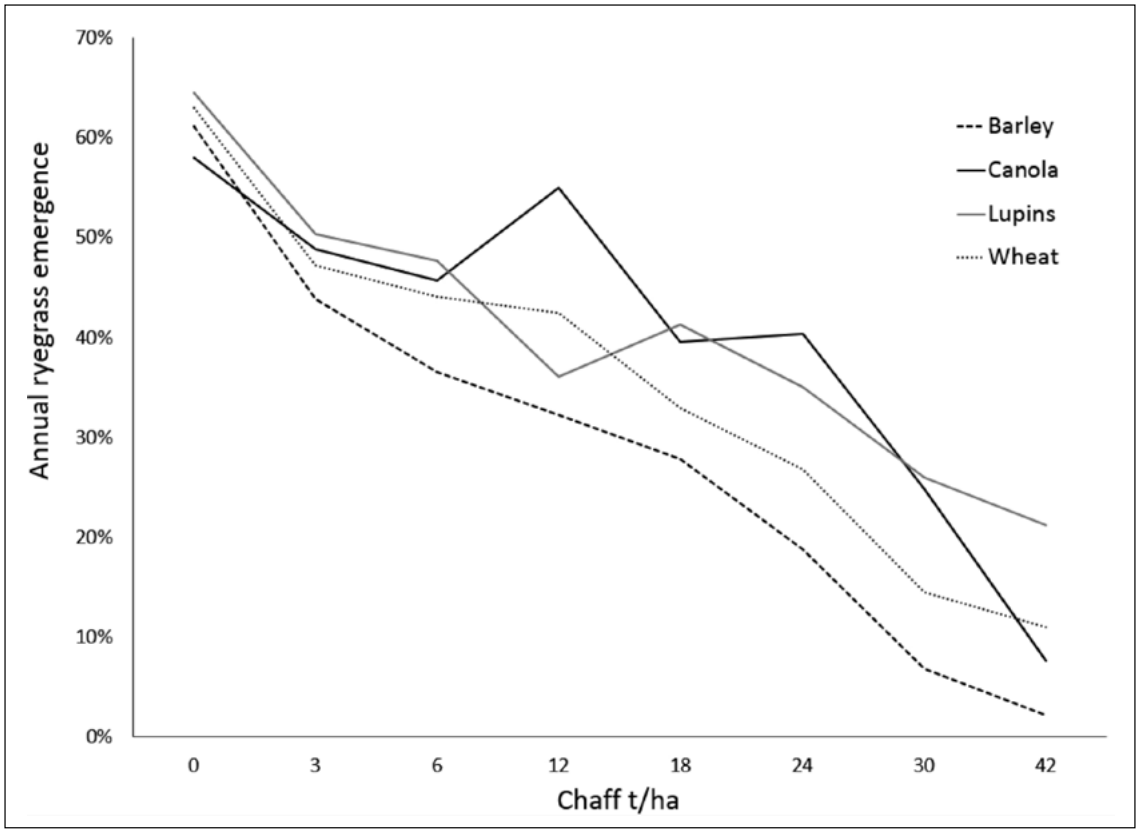

Figure 2. Emergence of annual ryegrass through wheat, lupins, barley and canola chaff at eight different rates (t/ha) in a pot trial conducted at Wagga Wagga (Broster et al. 2018). NB: Means with the same alphabetical characters are not significantly different at the P = 0.050 level based on LSD values (average LSD is shown on bar).

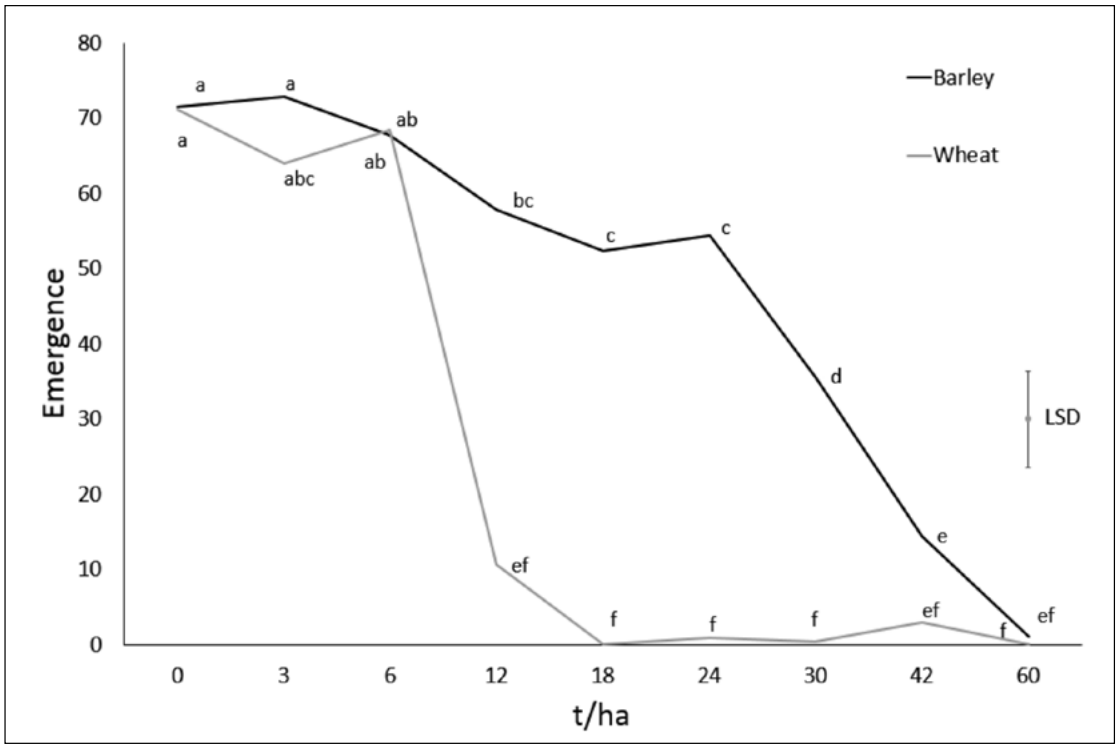

Figure 3. Emergence of common sowthistle through barley and wheat chaff at nine different rates (t/ha) in a pot experiment conducted at Toowoomba (Ruttledge et al. 2018). NB: Means with the same alphabetical characters are not significantly different at the P = 0.050 level based on LSD values (average LSD is shown on bar).

Weed seed decay

There are anecdotal reports of weed seed rot in chaff lines and chaff tramlines. On-farm research conducted on the Queensland Darling Downs has compared the viability of weed seeds inside and outside of chaff tramlines. Seeds of annual ryegrass, sowthistle, turnip weed and wild oats were placed in fibreglass mesh bags and left for six months in two barley paddocks (one harvested using a conventional draper front and one harvested using a stripper front) and in a wheat paddock (conventional front only). At the end of this period, the viability of the remaining seeds was determined. There were no significant differences between the seeds placed inside tramlines and those placed outside of tramlines, for any of the three paddocks (Figure 4). In other words, weed seeds placed in tramlines did not appear to decay any faster than those left on the soil surface outside of tramlines.

However, multiple factors are involved in weed seed decay, including temperature, moisture, chaff type and amount, and characteristics of the weed seeds themselves. In other words, what happens to weed seeds in chaff lines or chaff tramlines is likely to vary according to site, season, crop type and weed species.

Chaff production

As outlined above, research indicates that weed suppression increases with the amount of chaff cover. The amount of chaff that accumulates in chaff tramlines or chaff lines could also have implications for other farming operations (e.g. planting).

It is unlikely that all crop types will have the same chaff load percentage. A barley crop is likely to have a lower chaff proportion than a wheat crop. With a 12m wide conventional harvester forming a chaff line 30cm wide and a chaff proportion of 0.3, then 42t/ha of chaff equates to a 3.5t/ha crop (Figure 5). However, if the chaff proportion is 0.2 then 42t/ha equates to a 5.25t/ha crop. Conversely, with a chaff proportion of 0.5, only 2.1t/ha crop is required to produce a chaff line of 42t/ha (Broster et al. 2018). It should be noted that in chaff tramlining, two chaff lines are formed, which means that only half the amount of chaff residue is deposited in each line.

The type of header front is also important in determining the amount of chaff exiting the header. Research has established that draper fronts produce more than twice the amount of chaff compared with a stripper front (Figure 6). This is likely due to the larger amount of crop material collected by a draper front compared to a stripper front, resulting in a significant amount of straw material exiting in the chaff fraction when using a draper front (Broster et al. 2018).

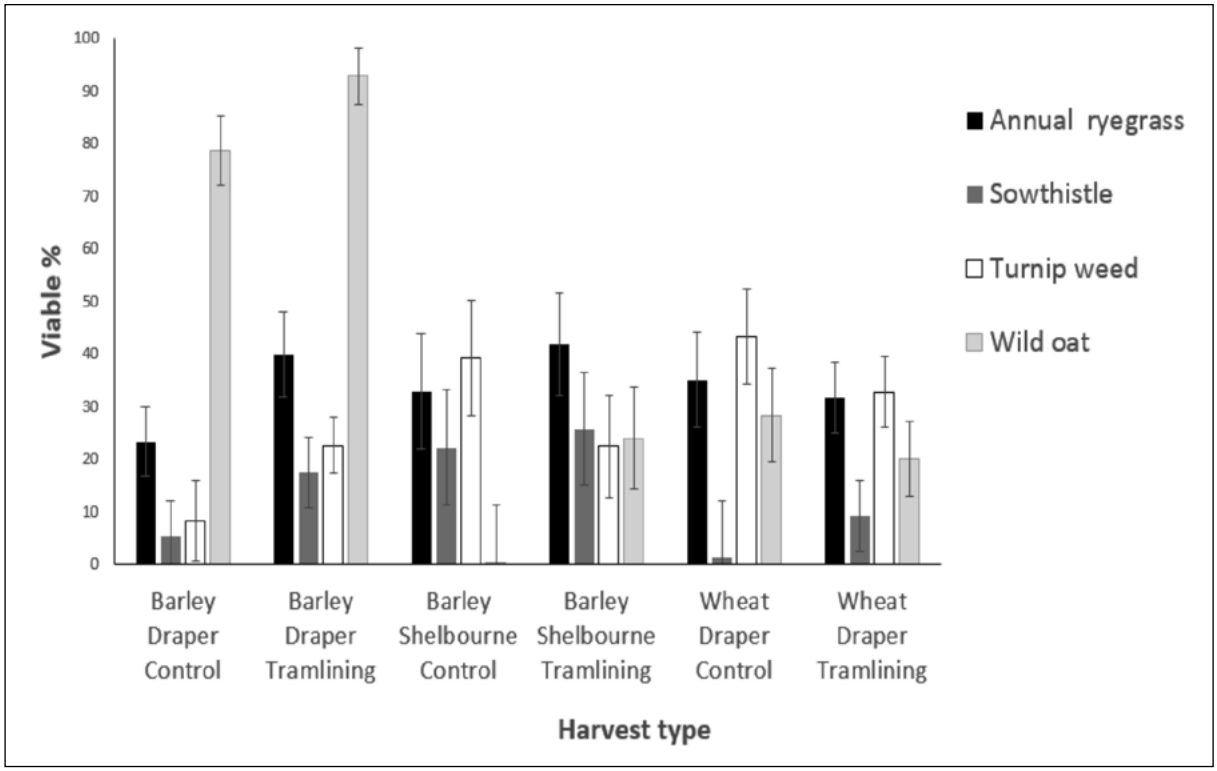

Figure 4. Viability of weed seeds collected after six months in barley and wheat fields, both under chaff tramlines and outside tramlines (control treatment). In barley, tramlines were produced using both Draper (conventional) and Shelbourne (stripper) harvest fronts (Ruttledge et al. 2018).

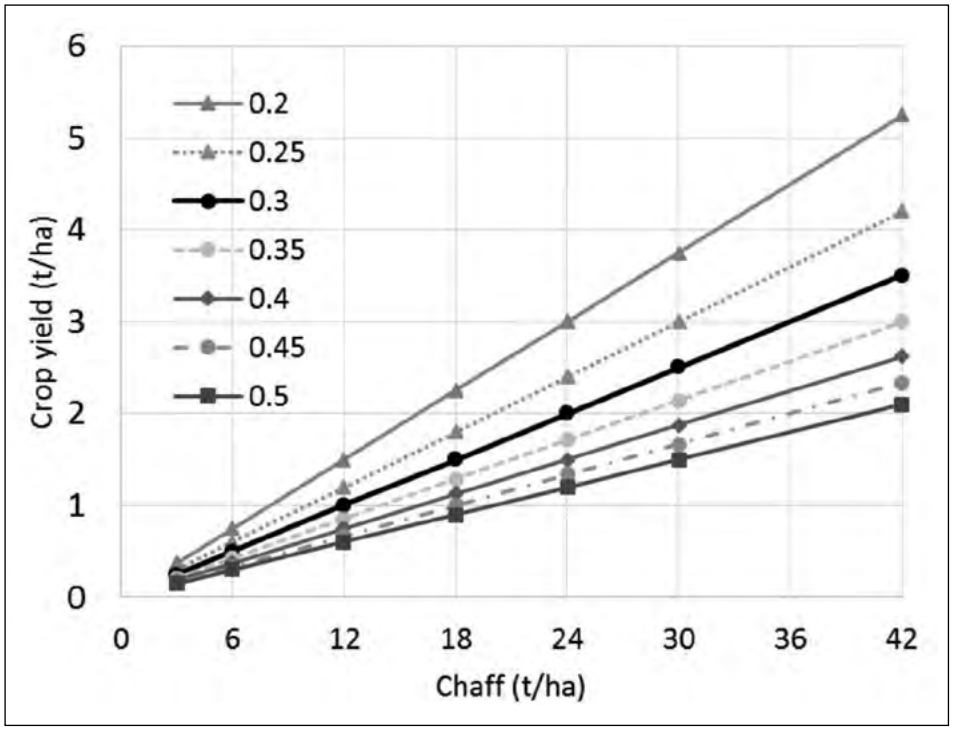

Figure 5. Estimated crop yield for various chaff rates at different chaff proportions for a 12m wide harvester and 0.3m chaff line (Broster et al. 2018).

Note: Calculations are regardless of header type, but different chaff proportions could relate to the different fronts, e.g. 20% = stripper front, 40% = draper front.

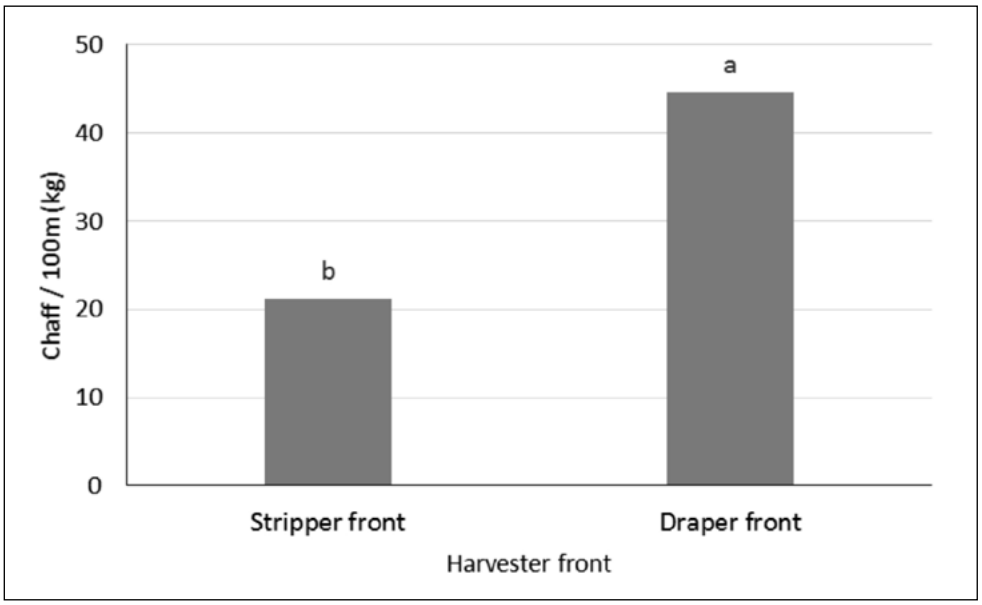

Figure 6. Amount of chaff fraction (kg) produced when using two different harvester fronts (means with same letter are not significantly different) (Broster et al. 2018).

Conclusions and recommendations

Chaff lining and chaff tramlining are forms of HWSC with the potential to capture weed seeds at harvest time and concentrate them in the chaff residues. Weed seeds buried in chaff can have reduced emergence, but the extent of suppression depends on the characteristics of the chaff (crop type, chaff thickness) and also on the weed species. Depending on the seed ecology of weed species, some weeds will be more susceptible to burial in chaff than other weeds.

Research conducted to date does not indicate that weed seeds rot more quickly when concentrated in chaff tramlines. However, the fate of weed seeds is strongly determined by environmental conditions (moisture, temperature, predation, etc.), as well as the characteristics of the weed seeds themselves. This means the extent and rapidity of seed decay is likely to vary from site to site, season to season, and between chaff type and weed type.

The amount of chaff deposited in chaff tramlines is likely to influence the fate of weed seeds, and this is in turn dependent on crop type, planting density, row spacing, header set-up, harvest speed, and the type of header front used (with less chaff produced by a stripper front).

The efficacy of HWSC techniques, including chaff lining and chaff tramlining, will depend on maximum capture of weed seeds at harvest time. The use of stripper fronts is compatible with HWSC, but care is needed in harvester operation to maximise seed collection. Header settings (e.g. height) and harvest speed can all influence the efficacy of weed seed collection by both conventional and stripper harvester fronts. Further research is needed to determine how agronomic considerations (e.g. crop architecture and planting design) can optimise weed seed collection during harvest. In addition, attributes of the weed species, the weather and the amount of seed shed which has occurred before harvest will have an impact on the accuracy of weed seed collection using HWSC practices (Broster et al. 2018).

In summary, weed seeds captured during harvest and concentrated into chaff residues can have reduced emergence due to the presence of the crop chaff, especially at high chaff loads. From current evidence, it is apparent weed seeds of key species can remain viable in a tramline environment for six months, and potentially longer (work being conducted at present will establish the viability of seeds after 11 months in the field). However, by using chaff tramlining or chaff lining, weed seeds captured during harvest are concentrated into one or two lines per header pass, where they can be monitored and treated in targeted weed control strategies (e.g. using high rates and a shielded sprayer).

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Contact details

Annie Ruttledge
DAF QLD
PO Box 2282, Toowoomba QLD 4350
07 4529 1247
Annemieke.Ruttledge@daf.qld.gov.au

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THE 2017-2019 GRDC SOUTHERN REGIONAL PANEL

JANUARY 2019

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

CHAIR - JOHN BENNETT

Based at Lawloit, between Nhill and Kaniva in Victoria's West Wimmera, John, his wife Allison and family run a mixed farming operation across diverse soil types. The farming system is 70 to 80 percent cropping, with cereals, oilseeds, legumes and hay grown. John believes in the science-based research, new technologies and opportunities that the GRDC delivers to graingrowers. He wants to see RD&E investments promote resilient and sustainable farming systems that deliver more profit to growers and ultimately make agriculture an exciting career path for young people.

M 0429 919 223 **E** john.bennett5@bigpond.com

DEPUTY CHAIR - MIKE MCLAUGHLIN

Mike is a researcher with the University of Adelaide, based at the Waite campus in South Australia. He specialises in soil fertility and crop nutrition, contaminants in fertilisers, wastes, soils and crops. Mike manages the Fertiliser Technology Research Centre at the University of Adelaide and has a wide network of contacts and collaborators nationally and internationally in the fertiliser industry and in soil fertility research.

M 0434 765 574
E michael.mclaughlin@adelaide.edu.au

PETER KUHLMANN

Peter is a farmer at Mudamuckla near Ceduna on South Australia's Western Eyre Peninsula. He uses liquid fertiliser, no-till and variable rate technology to assist in the challenge of dealing with low rainfall and subsoil constraints. Peter has been a board member of and chaired the Eyre Peninsula Agricultural Research Foundation and the South Australian Grain Industry Trust.

M 0428 258 032 **E** mudabie@bigpond.com

JON MIDWOOD

Jon has worked in agriculture for the past three decades, both in the UK and in Australia. In 2004 he moved to Geelong, Victoria, and managed Grainsearch, a grower-funded company evaluating European wheat and barley varieties for the high rainfall zone. In 2007, his consultancy managed the commercial contract trials for Southern Farming Systems (SFS). In 2010 he became Chief Executive of SFS, which has five branches covering southern Victoria and Tasmania. In 2012, Jon became a member of the GRDC's HRZ Regional Cropping Solutions Network.

M 0400 666 434 **E** jmidwood@sfs.org.au

FIONA MARSHALL

Fiona has been farming with her husband Craig for 21 years at Mulwala in the Southern Riverina. They are broadacre, dryland grain producers and also operate a sheep enterprise. Fiona has a background in applied science and education and is currently serving as a committee member of Riverine Plains Inc, an independent farming systems group. She is passionate about improving the profile and profitability of Australian grain growers.

M 0427 324 123 **E** redbank615@bigpond.com

ROHAN MOTT

A fourth generation grain grower at Turriff in the Victorian Mallee, Rohan has been farming for more than 25 years and is a director of Mott Ag. With significant on-farm storage investment, Mott Ag produces wheat, barley, lupins, field peas, lentils and vetch, including vetch hay. Rohan continually strives to improve productivity and profitability within Mott Ag through broadening his understanding and knowledge of agriculture. Rohan is passionate about agricultural sustainability, has a keen interest in new technology and is always seeking ways to improve on-farm practice.

M 0429 701 170 **E** rohanmott@gmail.com

RICHARD MURDOCH

Richard along with wife Lee-Anne, son Will and staff, grow wheat, canola, lentils and faba beans on some challenging soil types at Warooka on South Australia's Yorke Peninsula. They also operate a self-replacing Murray Grey cattle herd and Merino sheep flock. Sharing knowledge and strategies with the next generation is important to Richard whose passion for agriculture has extended beyond the farm to include involvement in the Agricultural Bureau of SA, Advisory Board of Agriculture SA, Agribusiness Council of Australia SA, the YP Alkaline Soils Group and grain marketing groups.

M 0419 842 419 **E** tuckokcowie@internode.on.net

MICHAEL CHILVERS

Michael runs a collaborative family farming enterprise at Nile in the Northern Midlands of Tasmania (with property also in northern NSW) having transitioned the business from a dryland grazing enterprise to an intensive mixed farming enterprise. He has a broad range of experience from resource management, strategic planning and risk profiling to human resource management and operational logistics, and has served as a member of the the High Rainfall Zone Regional Cropping Solutions Network for the past six years.

M 0409 974 556 **E** fchilvers@bigpond.com

KATE WILSON

Kate is a partner in a large grain producing operation in Victoria's Southern Mallee region. Kate and husband Grant are fourth generation farmers producing wheat, canola, lentils, lupins and field peas. Kate has been an agronomic consultant for more than 20 years, servicing clients throughout the Mallee and northern Wimmera. Having witnessed and implemented much change in farming practices over the past two decades, Kate is passionate about RD&E to bring about positive practice change to growers.

M 0427 571 360 **E** kate.wilson@agrivision.net.au

ANDREW RUSSELL

Andrew is a forth generation grain grower and is currently the Managing Director and Shareholder of Lilliput AG and a Director and Shareholder of the affiliated Baker Seed Co - a family owned farming and seed cleaning business. He manages the family farm in the Rutherglen area, a 2,500 ha mixed cropping enterprise and also runs 2000 cross bred ewes. Lilliput AG consists of wheat, canola, lupin, faba bean, triticale and oats and clover for seed, along with hay cropping operations. Andrew has been a member of GRDC's Medium Rainfall Zone Regional Cropping Solutions Network and has a passion for rural communities, sustainable and profitable agriculture and small business resilience.

T 0417 401 004 **E** arussell@lilliput-ag.com.au

LUCY BROAD

Lucy Broad is the General Manager of the Grains Research and Development Corporation's (GRDC) Grower Communication and Extension business group. Lucy holds a Bachelor of Science in Agriculture, majoring in agronomy, and prior to working at the GRDC spent the last 13 years as Director and then Managing Director of Cox Inall Communications and Cox Inall Change, Australia's largest and leading public relations agency working in the Agribusiness and Natural Resource Management arena. Her entire career has been in communications, first with the Australian Broadcasting Corporation and then overseeing communications and behaviour change strategies for clients across the agriculture, natural resource management, government and not-for-profit sectors.

T 02 6166 4500 **E** lucy.broad@grdc.com.au

T +61 8 8198 8407
P Grains Research and Development Corporation (GRDC) | Level 1 | 187 Fullarton Road, Dulwich 5065, South Australia

2017–2019 SOUTHERN REGIONAL CROPPING SOLUTIONS NETWORK (RCSN)

JANUARY 2019

The RCSN initiative was established to identify priority grains industry issues and desired outcomes and assist the GRDC in the development, delivery and review of targeted RD&E activities, creating enduring profitability for Australian grain growers. The composition and leadership of the RCSNs ensures constraints and opportunities are promptly identified, captured and effectively addressed. The initiative provides a transparent process that will guide the development of targeted investments aimed at delivering the knowledge, tools or technology required by growers now and in the future. Membership of the RCSN network comprises growers, researchers, advisers and agribusiness professionals. The three networks are focused on farming systems within a particular zone – low rainfall, medium rainfall and high rainfall – and comprise 38 RCSN members in total across these zones.

REGIONAL CROPPING SOLUTIONS NETWORK SUPPORT TEAM

SOUTHERN RCSN CO-ORDINATOR: JEN LILLECRAPP

Jen is an experienced extension consultant and partner in a diversified farm business, which includes sheep, cattle, cropping and viticultural enterprises. Based at Struan in South Australia, Jen has a comprehensive knowledge of farming systems and issues affecting the profitability of grains production, especially in the high rainfall zone. In her previous roles as a district agronomist and operations manager, she provided extension services and delivered a range of training programs for local growers. Jen was instrumental in establishing and building the MacKillop Farm Management Group and through validation trials and demonstrations extended the findings to support growers and advisers in adopting best management practices. She has provided facilitation and coordination services for the high and medium rainfall zone RCSNs since the initiative's inception.

M 0427 647 461 **E** jen@brackenlea.com

LOW RAINFALL ZONE CO-LEAD: BARRY MUDGE

Barry has been involved in the agricultural sector for more than 30 years. For 12 years he was a rural officer/regional manager in the Commonwealth Development Bank. He then managed a family farming property in the Upper North of SA for 15 years before becoming a consultant with Rural Solutions SA in 2007. He is now a private consultant and continues to run his family property at Port Germein. Barry has expert and applied knowledge and experience in agricultural economics. He believes variability in agriculture provides opportunities as well as challenges and should be harnessed as a driver of profitability within farming systems. Barry was a previous member of the Low Rainfall RCSN and is current chair of the Upper North Farming Systems group.

M 0417 826 790 **E** theoaks5@bigpond.com

LOW RAINFALL ZONE AND MEDIUM RAINFALL ZONE LEAD: JOHN STUCHBERY

John is a highly experienced, business-minded consultant with a track record of converting evidence based research into practical, profitable solutions for grain growers. Based at Donald in Victoria, John is well regarded as an applied researcher, project reviewer, strategic thinker and experienced facilitator. He is the founder and former owner of JSA Independent (formerly John Stuchbery and Associates) and is a member of the SA and Victorian Independent Consultants group, a former FM500 facilitator, a GRDC Weeds Investment Review Committee member, and technical consultant to BCG-GRDC funded 'Flexible Farming Systems and Water Use Efficiency' projects. He is currently a senior consultant with AGRIvision Consultants.

M 0429 144 475 **E** john.stuchbery@agrivision.net.au

HIGH RAINFALL ZONE LEAD: CAM NICHOLSON

Cam is an agricultural consultant and livestock producer on Victoria's Bellarine Peninsula. A consultant for more than 30 years, he has managed several research, development and extension programs for organisations including the GRDC (leading the Grain and Graze Programs), Meat and Livestock Australia and Dairy Australia. Cam specialises in whole-farm analysis and risk management. He is passionate about up-skilling growers and advisers to develop strategies and make better-informed decisions to manage risk – critical to the success of a farm business. Cam is the program manager of the Woady Yaloak Catchment Group and was highly commended in the 2015 Bob Hawke Landcare Awards.

M 0417 311 098 **E** cam@niconrural.com.au

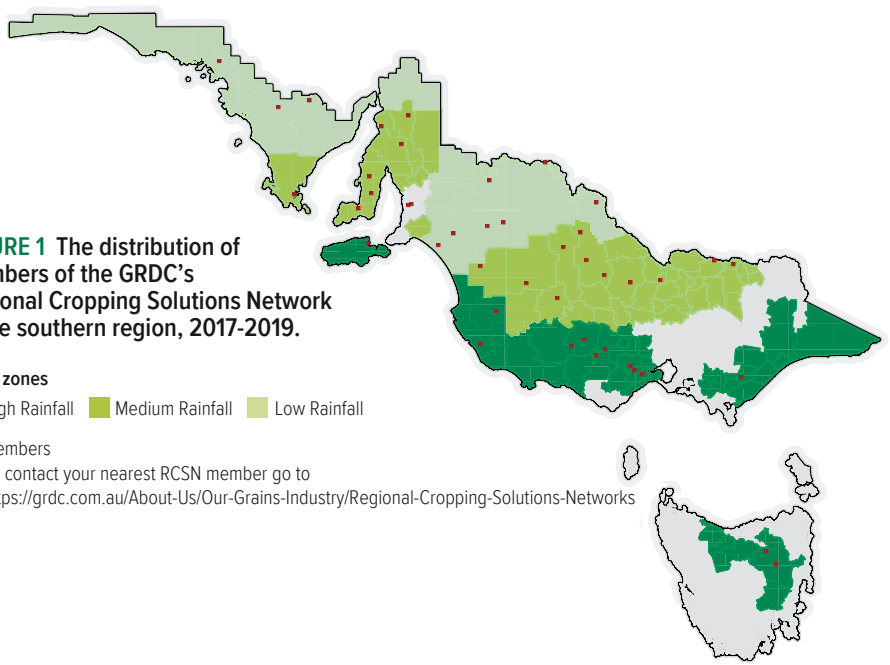

FIGURE 1 The distribution of members of the GRDC's Regional Cropping Solutions Network in the southern region, 2017-2019.

To contact your nearest RCSN member go to https://grdc.com.au/About-Us/Our-Grains-Industry/Regional-Cropping-Solutions-Networks

KEY CONTACTS

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

SOUTHERN REGION

ADELAIDE
Level 1
187 Fullarton Road
DULWICH SA 5065

P: +61 8 8198 8400
southern@grdc.com.au

APPLIED RESEARCH AND DEVELOPMENT GROUP

SENIOR REGIONAL MANAGER
Craig Ruchs
Craig.Ruchs@grdc.com.au
M: +61 4 7771 0813

BUSINESS SUPPORT TEAM LEADER
Amanda Kendall
Amanda.Kendall@grdc.com.au
P: +61 8 8198 8402

CONTRACTS AND TEAM ADMINISTRATOR
Claire West
Claire.West@grdc.com.au
P: +61 8 8198 8401

CONTRACT ADMINISTRATOR
Mark Waterhouse
Mark.Waterhouse@grdc.com.au
P: +61 8 8198 8406

MANAGER AGRONOMY, SOILS AND FARMING SYSTEMS (Agronomy & Farming Systems)
Andrew Etherton
Andrew.Etherton@grdc.com.au
M: +61 4 0850 5566

MANAGER AGRONOMY, SOILS AND FARMING SYSTEMS (Soils & Nutrition)
Stephen Loss
Stephen.Loss@grdc.com.au
M: +61 4 0841 2453

MANAGER WEEDS
Jason Emms
Jason.Emms@grdc.com.au
M: +61 4 3954 9950

GENETICS AND ENABLING TECHNOLOGIES GROUP

SENIOR MANAGER ENABLING TECHNOLOGIES
Tom Giles
Tom.Giles@grdc.com.au
M: +61 4 1788 9860

MANAGER NATIONAL VARIETY TRIALS
Rob Wheeler
Rob.Wheeler@grdc.com.au
M: +61 4 0114 8935

CONTRACT ADMINISTRATOR
Cindy Hall
Cindy.Hall@grdc.com.au
P: +61 8 8198 8400

GROWER EXTENSION AND COMMUNICATIONS GROUP

GROWER RELATIONS MANAGER
Darren Arney
Darren.Arney@grdc.com.au
M: +61 4 4787 7178

GROWER RELATIONS MANAGER
Courtney Ramsey
Courtney.Ramsey@grdc.com.au
M: +61 4 2827 4018

GROWER RELATIONS MANAGER
Randall Wilksch
Randall.Wilksch@grdc.com.au
M: +61 4 3776 9098

COMMUNICATIONS MANAGER
Sharon Watt
Sharon.Watt@grdc.com.au
M: +61 4 0967 5100

BUSINESS AND COMMERCIAL GROUP

HEAD OF BUSINESS DEVELOPMENT
Ron Osmond
Ron.Osmond@grdc.com.au
M: +61 4 000 0264

MANAGER BUSINESS DEVELOPMENT AND COMMERCIALISATION
Fernando Felquer
Fernando.Felquer@grdc.com.au
M: +61 4 1351 1412

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- The local GRDC Grains Research Update planning committee that includes both government and private consultants and GRDC representatives.

- Partnering organisation: YPASG

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CORPORATION

Prefer to provide your feedback electronically or 'as you go'? The electronic evaluation form can be accessed by typing the URL address below into your internet browsers:

www.surveymonkey.com/r/Maitland-GRU

To make the process as easy as possible, please follow these points:

- Complete the survey on one device
- One person per device
- You can start and stop the survey whenever you choose, **just click 'Next' to save responses before exiting the survey**. For example, after a session you can complete the relevant questions and then re-access the survey following other sessions.

2019 Maitland GRDC Grains Research Update Evaluation

1. Name

ORM has permisssion to follow me up in regards to post event outcomes.

2. How would you describe your <u>main</u> role? *(choose one only)*

- ❑ Grower
- ❑ Agronomic adviser
- ❑ Farm business adviser
- ❑ Financial adviser
- ❑ Communications/extension
- ❑ Grain marketing
- ❑ Farm input/service provider
- ❑ Banking
- ❑ Accountant
- ❑ Researcher
- ❑ Student
- ❑ Other* (please specify)

Your feedback on the presentations

For each presentation you attended, please rate the content relevance and presentation quality on a scale of 0 to 10 by placing a number in the box (**10 = totally satisfactory, 0 = totally unsatisfactory**).

3. Pesticides and regulatory impacts – the road ahead: *Gordon Cumming*

Content relevance ____ /10 Presentation quality ____ /10

Have you got any comments on the content or quality of the presentation?

4. Root lesion nematodes (RLN) in pulses: *Katherine Linsell*

Content relevance ____ /10 Presentation quality ____ /10

Have you got any comments on the content or quality of the presentation?

5. Grain and pulse storage – looking at the options for maintaining quality in storage: *Ben White*

Content relevance ____ /10 Presentation quality ____ /10

Have you got any comments on the content or quality of the presentation?

6. Snail research – optimising control: *Helen Brodie*

Content relevance ____ /10 Presentation quality ____ /10

Have you got any comments on the content or quality of the presentation?

7. Rapid assessment of crop N – in field assessment of a hand-held near infra-red tool: *Michael Zerner*

Content relevance ☐ /10 Presentation quality ☐ /10

Have you got any comments on the content or quality of the presentation?

8. Impact of chaff lining on seed persistence and emergence of weeds: *Annie Ruttledge*

Content relevance ☐ /10 Presentation quality ☐ /10

Have you got any comments on the content or quality of the presentation?

Your next steps

9. Please describe at least one new strategy you will undertake as a result of attending this Update event

10. What are the first steps you will take?

e.g. seek further information from a presenter, consider a new resource, talk to my network, start a trial in my business

Your feedback on the Update

11. This Update has increased my awareness and knowledge of the latest in grains research

Strongly agree	Agree	Neither agree nor Disagree	Disagree	Strongly disagree
❑	❑	❑	❑	❑

12. Overall, how did the Update event meet your expectations?

Very much exceeded	Exceeded	Met	Partially met	Did not meet
❑	❑	❑	❑	❑

Comments

13. Do you have any comments or suggestions to improve the GRDC Update events?

14. Are there any subjects you would like covered in the next Update?

Thank you for your feedback.