Issue 153 | July – August 2021

GRDC

GROUNDCOVER SUPPLEMENT

SOWING SEEDS OF SUCCESS

3 DECISION AIDS
To improve soil water predictions

10 NEW TRAITS
To chase soil moisture

20 INFORMED DECISIONS
Guides for specific scenarios

Photo: Michael Lamond

New traits, such as the long-coleoptile wheats shown here, are being sought by growers to improve productivity with changing climates and increasing enterprise sizes.

Unending innovation drives cropping progress

By Dr Pip Wilson, Liam Ryan **and** Dr Kaara Klepper

■ Since the dawn of settled agriculture, growers have sought better crop types to match climatic and environmental conditions while also honing management practices and improving whole-farm performance through improved productivity. In more recent times, the advance of agricultural science has made the deeper understanding of the interaction of crop genetics and management practices essential knowledge for maximising crop production in different environments. GRDC investment is critical to advancing this knowledge and, along with research partners, GRDC continues to develop tools, techniques and recommendations offering growers choices and information to make decisions to maximise profitability. Making informed decisions about sowing involves:

- having detailed knowledge of your system, management options, and crop and variety choices;
- weighing up the risks and returns of options; and
- making and implementing a clear plan.

Reflecting on good decisions, or what did not work so well, is also important for improving whole-farm performance, including being open to integrating new tools and techniques.

RESEARCH AND DEVELOPMENT

GRDC partners with many innovative research teams, delivering outcomes for Australian growers to assist in making informed sowing decisions now and in the future.

Timing of sowing, for example, will be better informed by SoilWaterNow, which will more accurately and easily predict plant-available water across and within paddocks, while fortified climate decision tools stand to boost grower confidence in the use of new weather forecasts and seasonal climate forecasts for sowing decisions.

An international scientific network is continually hunting down new phenology genetics to ensure crop varieties are well-suited and adapted to Australia's changing climate. CSIRO researchers have been investigating long-coleoptile wheats to chase moisture at depth and enable earlier sowing. This adaptive trait is now being integrated into varieties by Australian breeding companies.

Heat and water stresses are driving a rethink of traditional sorghum sowing times by University of Queensland scientists, which could provide multiple benefits for growers including building profitability by increasing cropping intensity.

GRDC continues its drive for improved knowledge through a recent expression of interest (EOI) to develop prediction tools to quantify yield losses from frost and heat. This will advance the ability to define optimum flowering period for a given crop, variety and paddock.

Underpinning some of these robust investments are new statistical techniques being developed by Statistics for the Australian Grains Industry (SAGI), which can tease apart the environmental and genetic influences on yield.

DECISION-MAKERS

GRDC invests in research, development and extension on behalf of some 22,300 grain growers who possess a breadth of formal education and off-farm experience, which is drawn upon to inform decisions.

Anyone associated with cropping knows it is a risky business and one of the few industries where the main production driver is highly variable and unpredictable climate. Combine this production variability with volatile prices and input costs, and it creates a challenging business environment.

Risk and reward are part of every cropping decision made and these decisions are influenced by the decision-maker's risk appetite; it is a skill and requires practise and refining.

This *GroundCover™ Supplement* provides an overview of GRDC investments that are working hard and fast to help growers sift through complexity and make decisions that result in success for their businesses' profitability and sustainability. □

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GROUNDCOVER™ SUPPLEMENT edited by Dr Sue Knights

COVER IMAGE: Dry sowing PBA Hallmark XT(b) lentils with MAP and mouse bait, Long Plains, South Australia. **PHOTO:** Nathan Parker

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Forecasts fortified for decision-making confidence

Two complementary forecasting projects should help lift grower confidence in the use of weather forecasts and seasonal forecasts

By Dr Sue Knights

■ To bolster grower confidence in climate forecasting tools, GRDC has invested in two companion projects to assist with season decision-making.

The AgScore project will provide report cards benchmarking international climate models against a set of agriculturally relevant metrics, while the other – 'Forewarned is Forearmed' – is taking a whole-of-industry approach to enhance locally developed forecasting tools.

"There's real value in weather forecasts and seasonal climate forecasts to aid decision-making, but the information often isn't made available in the most practical or useful manner for growers and the agricultural industry," GRDC's manager of transformational technologies Liam Ryan says.

To this end, growers are actively involved in both projects.

BENCHMARKING AND TEST-DRIVING

The AgScore project uses a customised AgScore™ tool developed by CSIRO to evaluate the performance of a suite of international climate models specifically within an agricultural context.

"As Peter Hayman from SARDI (the South Australian Research and Development Institute) says, the skill of seasonal forecasts is often such that they're 'too good to ignore, but not good enough to be sure'," Mr Ryan says.

"For growers and advisers, there's often a desire to identify whether one or more models tend to be more reliable in your own neck of the woods and, if so, under what conditions and what times of the year."

The project began by testing 10 models that currently produce operational forecasts for Australia, including systems such as ECMWF's SEAS5, NASA's GEOS-S2S-2 model and the Bureau of Meteorology's (BoM) ACCESS-S1 system.

"The aim is to explore if there are circumstances in which some models reliably outperform other models. That requires us to do quantitative comparisons using as close as we can to an 'apples to apples' methodology, which can be tricky," Mr Ryan says.

"A few of the better-performing models will be investigated for their skill in simulating agriculturally relevant metrics using the AgScore™ tool and report cards will be produced to benchmark their performance."

Growers will be involved in case studies that will test-drive these forecasts to assess the economic value for some key grain production decisions. "Test-driving the forecasts using grower case studies will further our understanding of how additional information on the forecast can assist strategic decisions, such as crop selection, sowing time and fertiliser management, and provide improved profit to growers," Mr Ryan says.

"This will hopefully help complement the foundational work that people like Peter Hayman and Barry Mudge are doing with their Rapid Climate Decision Analysis Tool – a simple but powerful tool to manage climate risk in decision-making."

GROWER DESIGN INPUT

The Forewarned is Forearmed project works closely with the BoM, guided by six reference groups comprising growers, farmers and advisers from the grains, northern beef, southern beef, sugar, dairy and wine grape industries.

"The active engagement of users from these industry groups ensures direct input to the BoM on the type of tools being developed," Mr Ryan says.

The project will provide five new products for forecasting extreme events weeks to months in advance.

"Some products will provide simple yet new and informative information on the forecast, while others will provide more detailed information catering for a broad audience and user base.

"For instance, some products will be expandable maps showing the likelihood of very cold/hot and very dry/wet conditions in different locations, while others will provide more detailed information on the shift in probabilities for rainfall and temperature for the weeks, fortnights, months and seasons ahead in specific locations (see Figure 1 for an example)."

Growers will benefit from these projects through improved confidence in using forecasting tools to manage weather and climate-related risks in decision-making. □

GRDC Code CSP2004-007, RnD4P-16-03-007

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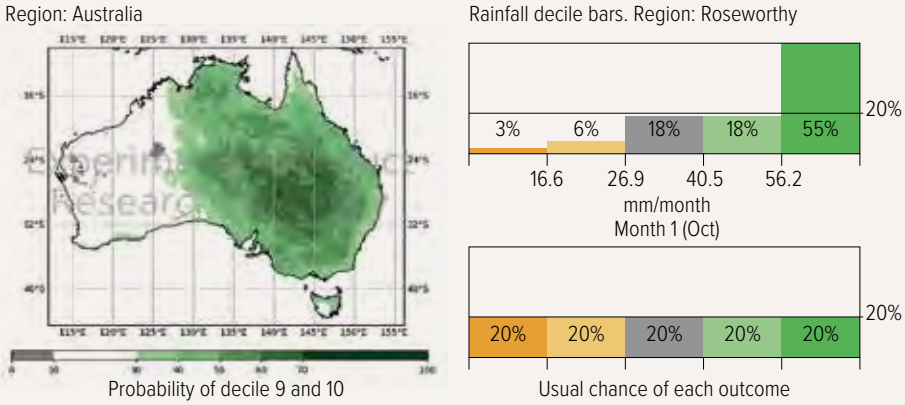
Figure 1: Examples of the forecasting products that will be available from the Forewarned is Forearmed project.



Source: BoM

Improved sowing date data to lift crop potential

By Dr Sue Knights

KEY POINTS

- Understanding the genetic basis of crop phenology is key to better matching crop varieties to target environments
- A huge, collective, multidiscipline effort is underway to provide growers with access to accurate predictions of wheat and barley cultivar flowering dates from a broad range of sowing dates

Phenology is the study of periodic events in an organism's life cycle. For plant breeders it has historically been a means of breeding crops better-matched to environments.

With recent scientific advances GRDC will soon deliver improved phenology information to help growers optimise crop productivity.

Phenological understanding for different crop varieties allows for specific variety and sowing time selection ensuring flowering occurs at the optimum time for a particular location to maximise productivity (Figure 1). It underpins prediction of yield risks, such as drought, frost or heat, and thereby improvements in crop management.

PHENOLOGY PIPELINE

Since phenology can be controlled by multiple genes, the genetic basis needs to be investigated first. This information can then be used in models to determine environmental influences on various genetic combinations. From this, crop variety and sowing time can be selected to better match specific locations optimising yield.

Described as the 'Phenology Pipeline' (Figure 2), GRDC has supported this research for many years. The crops in GRDC's portfolio are at different stages within the pipeline; wheat and barley are most advanced, followed by canola, with oats, chickpeas and lentils at the beginning.

GENE DISCOVERY

For 20 years, the genetic basis of plant phenology has dominated research of a broad team at CSIRO Agriculture and Food. With GRDC investment, it has been dissecting genetic control of phenology at the start of the phenology pipeline.

"Two important environmental stimuli of crop phenology are daylength, or photoperiod – the cycle of light and dark periods – and temperature, particularly a period of cold required by some plants to trigger flowering, which is known as vernalisation," says Dr Ben Trevaskis, speaking on behalf of colleagues at CSIRO.

Crop plants can be described on a scale as having varying speeds of development from spring to winter habits dependent on their responses to these environmental stimuli. Of particular importance is resolving the genetic basis of control and also gene–environment interactions to understand and predict flowering behaviour.

"A decade ago, we used molecular biology to study individual genes, one at a time, which was labour-intensive and slow. But science has developed significantly, and we now use powerful, high-throughput genomic sequencing to provide detailed insights into the genetic makeup of plants," Dr Trevaskis says.

"Also incredibly valuable are breeding pedigrees of plant varieties developed over many years by plant breeders.

"Using a big data approach to interrogate this information we can match it to the genetic sequencing information to create gene databases for plant breeders, which can then inform breeding programs. For example, it can identify appropriate parent plants to cross to obtain a desired genetic combination in the offspring.

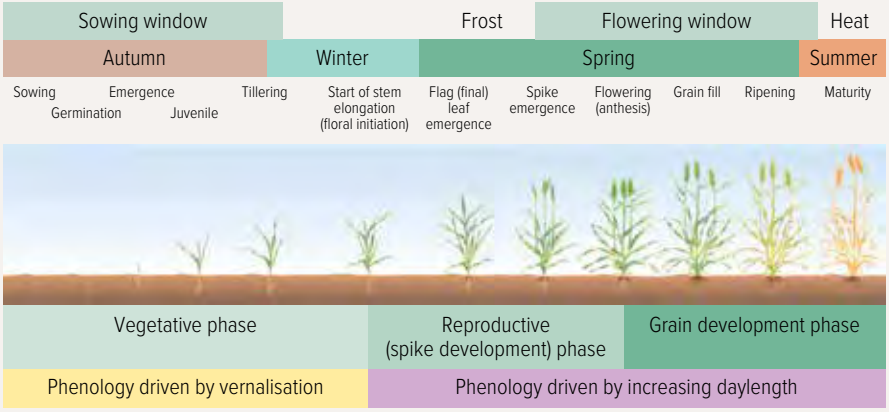
"We are also exploring the application of machine learning to trait prediction, using flowering behaviour as a test system.

"This research aims to integrate multi-level genomic data with detailed environment characterisation to resolve gene–environment interactions and predict traits under field conditions. It could significantly accelerate scientific discovery. We are collaborating with the CSIRO Future Science Platform for Machine Learning and Artificial Intelligence with this work.

"Collaboration, with the seamless integration of components along the phenology pipeline, is key to successfully delivering these traits to Australian growers.

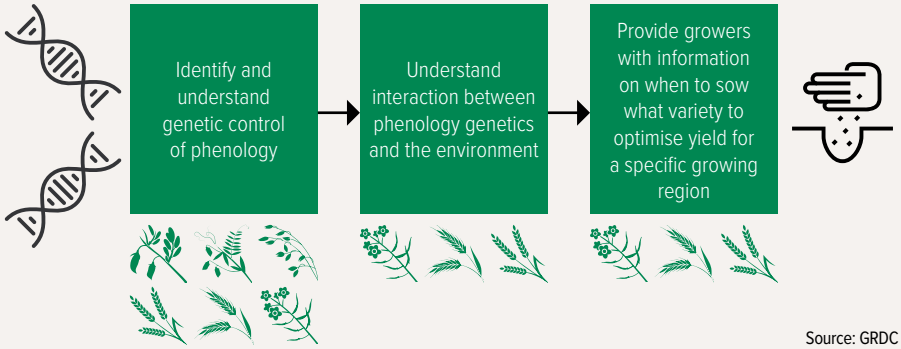
"In the genetic area, we have long-term collaborations with other Australian grains

Figure 1: The different growth stages, optimum sowing and flowering windows and the dominant environmental signals that influence growth and development in each stage in wheat.



Source: GRDC

Figure 2: GRDC's phenology pipeline showing the progress of various crop species along the pipeline.



Source: GRDC

Table 1: Description of industry-wide endorsed maturity classes for wheat, which will be updated annually.

Maturity description	Quick wheat boundary	Slow wheat boundary
Very quick spring	N/A	Axe$^{\Phi}$
Very quick – quick spring	>Axe$^{\Phi}$	Vixen$^{\Phi}$
Quick spring	>Vixen$^{\Phi}$	Corack$^{\Phi}$/LRPB Mustang$^{\Phi}$
Quick – mid spring	>Corack$^{\Phi}$/LRPB Mustang$^{\Phi}$	Mace$^{\Phi}$/Suntop$^{\Phi}$
Mid spring	>Mace$^{\Phi}$/Suntop$^{\Phi}$	LRPB Reliant$^{\Phi}$/Sheriff CL Plus$^{\Phi}$/ LRPB Trojan$^{\Phi}$
Mid – slow spring	>LRPB Reliant$^{\Phi}$/Sheriff CL Plus$^{\Phi}$/ LRPB Trojan$^{\Phi}$	Yitpi$^{\Phi}$/EGA Gregory$^{\Phi}$
Slow spring	>Yitpi$^{\Phi}$/EGA Gregory$^{\Phi}$	Sunzell
Slow – very slow spring	>Sunzell	Sunmax$^{\Phi}$
Very slow spring	>Sunmax$^{\Phi}$	N/A
Quick winter	N/A	Illabo$^{\Phi}$
Mid winter	>Illabo$^{\Phi}$	RGT Accroc
Slow winter	>RGT Accroc	N/A

Source: Australian Crop Breeders

industry researchers located with the ARC Centre of Excellence for Plant Success in Nature and Agriculture (University of Queensland), Queensland Alliance for Agriculture and Food Innovation (QAAFI), La Trobe University, University of Tasmania, University of Adelaide, and NSW Department of Primary Industries (DPI), as well as international researchers at Oregon State University (US), the Chinese Academy of Science, Department of Botany, the International Maize and Wheat Improvement Center in Mexico, University of California, Davis, in the US, John Innes Centre in the UK and IPK Gatersleben in Germany.

"But equally important is our collaboration with Australian-based farming systems researchers, where we learn about the environmental and agronomic place for the genetics we study."

It is through the tight connections along the pipeline, with farming systems research teams such as those led by Dr John Kirkegaard at CSIRO and Associate Professor James Hunt at La Trobe University, that Dr Trevaskis gleans information on the agronomic significance and business cases of phenological traits for Australian cropping environments on which to focus his team's research.

NATIONAL PHENOLOGY INITIATIVE

Associate Professor James Hunt leads the GRDC National Phenology Initiative (NPI), a cross-functional team of more than 22 agronomists, crop physiologists, geneticists, modellers, data scientists, bio-informaticians and web programmers from La Trobe University, CSIRO, Plant & Food Research NZ, the Western Australian Department of Primary Industries and Regional Development, the South Australian Research and Development Institute, NSW DPI and Statistics for the Australian Grains Industry West. The team is building a phenology platform to support Australian wheat and barley industries.

"Growers need to know about the phenology of new crop varieties to determine optimum sowing time for their environment," Dr Hunt says. "But there has neither been a recognised industry-wide scale for plant development, consistent terminology nor a readily available tool to determine sowing dates."

As part of the project, the team is developing an industry-wide crop development scale for researchers and agronomists, and working with Australian plant breeders to standardise phenological wheat maturity descriptions (Table 1).

"The NPI is building on plant modelling power of the next-generation Agricultural Production Systems sIMulator (APSIM) – a massive piece of research infrastructure initiated by Agricultural Production Systems Research Unit in the early 1990s," Dr Hunt says.

"Sixty-four wheat and 32 barley genotypes, selected for diverse phenology, are being genotyped and phenotyped under different controlled conditions to parameterise the model."

The same genotypes are being grown and phenotyped at five field sites in WA, SA, NSW and Victoria, and across eight sowing times to validate the model.

This will provide data about yield losses related to frost and heat, generating foundational information to optimise trade-offs with frost risk, heat risk and soil moisture deficit in spring.

"The activities are integrated across the phenology pipeline and are fundamental to its success, as we rely on the genetic information from Ben Trevaskis's team to provide insights into the biological significance of the genes," Dr Hunt says.

"Adapting the model for other crop species to provide similar information for growers' sowing decisions will then be straightforward." ☐

GRDC Research Codes ULA1806-004, CSP00183

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Nowcasting plant-available soil water

Cropping decisions are made in the face of Australia's highly variable climate, but next-gen tools are being developed to better inform these decisions

By Professor Thomas Bishop and Dr Niranjan Wimalathunge

■ Although seasonal forecasts can be fraught with uncertainty, on-farm decisions could be made more certain with improved real-time predictions of stored soil water and how it varies between and within paddocks. This is called 'nowcasting' soil water.

Soil water is estimated several ways, including installation of probes, remote sensing and using water balance models; however, each has limitations. Probes cannot be installed everywhere. Remote sensing only measures surface soil moisture. Water balance models need good soil variability representation in terms of water-holding capacity and plant water use evapotranspiration estimates. The solution is not to rely on one data source but to leverage the best features of each.

In response, GRDC has partnered with the University of Sydney, CSIRO, University of Queensland, Australian National University and the Bureau of Meteorology (BoM) to invest in SoilWaterNow.

The project extracts the best features of all methods in terms of accuracy and spatial and temporal resolution to provide improved plant-available water (PAW) predictions using scaleable, modular modelling frameworks. These could be used to underpin new digital farming/decision aid products developed by commercial third parties.

This approach means next-generation sensors, remote-sensing platforms and water balance models could be incorporated into decision aids. The project will test, develop and refine data-driven, data assimilation, water balance modelling and ensemble-based approaches.

Results for 'Llara', the University of Sydney farm near Narrabri, are shown in Figure 1. Soil water is estimated by spatially running a water balance model with estimates shown for February and June 2020 (Figure 1b, c), which involves parameterising the water balance equation:

Change in soil water = rainfall – evapotranspiration – run-off – deep drainage

Rainfall can be estimated from BoM weather surfaces or local weather stations, and evapotranspiration can be estimated by remote sensing.

Soil water movement and storage within the profile is estimated by digital soil maps; an example is shown in Figure 1a from the CSIRO-developed Soil and Landscape Grid of Australia.

Figures 1a–1c show what is possible with nationally available and free geospatial datasets where water is predicted at different depths in the soil profile at any point in time for anywhere in Australia. This is what we call a 'data-poor' situation.

In the next stages, analytical workflows will be developed to incorporate local on-farm data, in a 'data-rich' scenario; for example, when electromagnetic (EM) surveys and soil probes are available, as shown in Figure 1d. This could be used to create an improved digital soil map in the case of the EM maps to characterise water-holding capacity better or, in the case of probes, to calibrate the water balance model.

The aim is for growers to have options from data-poor to data-rich.

Growers can use better PAW estimates in many ways. The biggest benefits are to better determine fertiliser rates based on soil water conditions and rapidly quantify soil moisture profile across paddocks and farms prior to planting.

The first series of prototype PAW products are available on an R Shiny platform, where the predictions are at 90 metres for multiple depths in the soil profile based on the data-poor scenario. These are for university farms in northern NSW. The link is https://januarharianto.shinyapps.io/nowley_llara//.

Over the life of the project, we will increase the number of locations where the PAW products are deployed and tested. Growers interested in getting involved should contact thomas.bishop@sydney.edu.au, as should AgTech businesses with an interest in testing products and/or potentially commercialising them. □

GRDC Code UOS2002-001

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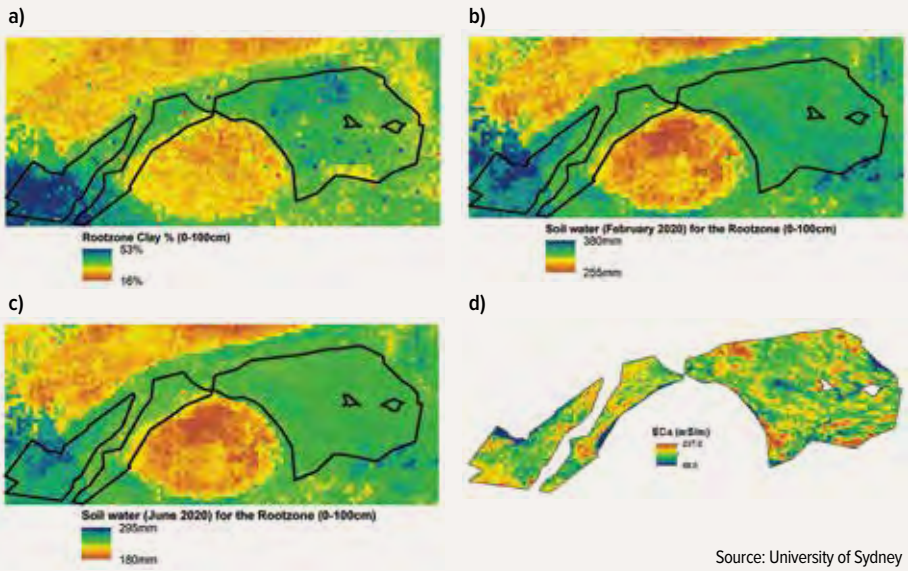
Figure 1: A variety of maps showing soil water availability for the University of Sydney's 'Llara' farm (a) Clay content map, (b) Soil water estimate (Feb 2020) (c) Soil water estimate (Jun 2020) (d) Electromagnetic induction survey.



Source: University of Sydney

Phenology fundamentals to optimise wheat yield

By Dr Felicity Harris, Rick Graham, Peter Matthews, Greg Brooke, David Burch and Dr Hongtao Xing (NSW DPI), and Darren Aisthorpe and Michael Mumford (QDAF)

KEY POINTS

- Understand the phenology of commercial wheat varieties
- Use the right variety for the right sowing date and remain disciplined with sowing dates

Research into the impact of sowing strategies on optimising yield potential has updated the 'fundamental' knowledge base for growers in New South Wales and Queensland.

With GRDC and NSW Department of Primary Industries co-investment under the Grains Agronomy and Pathology Partnership (GAPP), in collaboration with the Queensland Department of Agriculture and Fisheries, the 'Optimising yield potential of winter cereals in the northern grains region' project has delivered what are considered sowing fundamentals for today's varieties and practices across a range of environments.

The information has been derived from three years of trials – from 2017 to 2020 – in which 36 wheat varieties were sown from early April to late May across 10 locations in NSW and Queensland. Annual rainfall across the sites ranged from 184 to 853 millimetres and grain yields ranged from 0.2 to 10 tonnes per hectare.

SOWING FUNDAMENTALS

1. Understand differences in phenology

New varieties are frequently released and it is important to understand what drives their phenology and how they fit your cropping system.

In wheat, flowering is generally accelerated under long-day photoperiods and varieties can be broadly classified into two main types: winter or spring.

Winter types can be sown early and remain vegetative for an extended period (for example, DS Bennett[Φ], LRPB Kittyhawk[Φ] and Illabo[Φ]). This extended vegetative period is due to the plant's requirement for prolonged cold temperatures (vernalisation) to trigger flowering. This delays cold-sensitive reproductive stages to ensure flowering coincides with optimal conditions in spring.

In contrast, spring types generally do not require a period of cold to trigger flowering and are suited to later sowing. However, they can have varied responses to cold. For some, exposure to cold can hasten their development (such as LRPB Lancer[Φ]); for others there is no effect on development (such as Vixen[Φ]). This can influence sowing recommendations.

Multiple combinations of vernalisation and photoperiod genes give a wide range of flowering responses among both winter and spring types across environments and in response to sowing time.

2. Use the right variety for the right sowing date

Slower-developing winter types are suited to cooler, medium-high rainfall environments in southern NSW, which have a longer growing season and increased risk of frost. Winter types, when sown early, are capable of high water-limited yields, can extend the sowing period and can also be a useful frost mitigation tool.

However, the vernalisation requirement of these winter types makes them less suited to the warmer environments of northern NSW and Queensland, where flowering later than optimal can result in significant yield penalties due to heat stress. In contrast, quicker-developing spring types are better adapted to regions with shorter growing seasons and in environments or later-sowing scenarios where both frost and heat stress can occur in close proximity time-wise.

Despite environmental and seasonal variability, varieties that maintained stable grain yields across many sowing dates at some sites were identified and offer increased flexibility for growers (see weblink).

Photo: Nicole Baxter

Dr Felicity Harris, research scientist with NSW Department of Primary Industries, is leading a cross-institutional team optimising yield potential of winter cereals in the northern grains region through in-depth understanding of phenology.

3. Stay disciplined with sowing dates – know the risk of getting it wrong

For winter varieties, a yield penalty in many mid-fast winter types was observed when sown prior to early April. This was often due to difficulties establishing crops with high soil temperatures and rapid seedbed drying after sowing. Additionally, some winter varieties' vernalisation responses have been less stable when sown very early, resulting in early stem elongation and flowering, increasing the risk of frost damage.

Another consideration for winter wheats sown before early April and not grazed is that excessive growth under warmer conditions can increase crop water use, creating greater risk of lodging in taller crops and extended disease pressure.

For spring varieties, significant variation in phenology responses across sowing dates can also occur driven by seasonal conditions.

In general, sowing earlier than recommended increases the risk of earlier flowering and grain yield penalties due to frost damage. In later-sown crops, biomass accumulation could be limited and grain yield reduced due to heat stress during flowering and grain fill. ☐

GRDC Code DAN00213

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https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2021/02/phenology-is-fundamental-applying-key-project-learnings-to-optimise-grain-yield

Novel agronomy enhanced by innovative extension

Former South Australian Research and Development Institute researcher Dr Kenton Porker says early sown spring wheat and barley could benefit from defoliation to delay flowering.

Photo: SARDI

By David Foxx

■ Innovative research into how wheat phenology can be manipulated requires equally innovative methods to extend the information to growers.

Former South Australian Research and Development Institute (SARDI) researcher Dr Kenton Porker has been doing just that, engaging with growers and identifying crucial knowledge gaps using a smartphone-based real-time survey app.

Supported by the strategic research partnership between GRDC and SARDI, Dr Porker explored using agronomic interventions to alter the flowering time of early sown spring wheat and to optimise yield.

The project had an additional focus on extension, which included partnering with AgCommunicators and Ag Innovation & Research Eyre Peninsula (AIR EP).

Dr Porker says the main purpose of the research was to help mitigate climate risk by identifying new strategies to reduce the yield losses caused by seasonal drought, frost and heat stresses.

"Our research focused on trialling novel agronomic levers to slow down or speed up crop plant development during the season, to give growers more options in-season," he says.

The research has led to the development of a 'reset' strategy for wheat that offers the opportunity to plant a quick-developing variety early, irrespective of seasonal break timing.

"Following early rains, the 2020 season was notable for the number of growers who planted early and then contacted me for advice on slowing down crops they felt were developing too fast," Dr Porker says.

"It showed me growers were keen to adopt new strategies that would help them realise the benefits of early sowing, and often dry sowing, while mitigating risk once the season was underway."

Given the high level of interest among researchers, advisers and growers, a number of small demonstration trials were established in 2020 to build on experimental data from 2019. These included sites at Cummins and Giles Corner in South Australia and in the Victorian Mallee through Frontier Farming Systems.

Trial plots of early sown spring wheat and barley had their emerging apex deliberately pruned or 'reset' using either mechanical or chemical defoliation during the growing season. Mechanical defoliation (mowing) was found to be a simpler and more effective mechanism.

The results showed a timely intervention could delay flowering by between nine and 18 days.

While flowering was successfully delayed at every trial location, the effect on yields varied. Across all sites in 2019, the reset strategy yielded an average 0.4 tonnes per hectare better than the mean yield for the slow-developing winter cultivar and was not significantly different to a quick-mid spring wheat sown on time (May) (Figure 1).

The yields for winter cultivars sown early were not significantly different to quick-mid spring wheat sown on time, but they were 0.6t/ha less than the quick-mid cultivar when both were sown on time and 0.8t/ha less when both were sown late.

A second objective for the project was to improve capacity for crop management, grower engagement and agronomic research in SA.

Dr Porker worked with AgCommunicators to deliver innovative extension sessions for growers at five sites across the Eyre Peninsula, Mid North and Mallee.

For the first time, these interactive workshops were enhanced by the use of Mentimeter, a commercial smartphone app that allows participants to engage with the presentation and answer survey questions in real time.

AgCommunicators director Belinda Cay says being able to survey growers while they were attending Dr Porker's presentations provided detailed insights into their agronomic practices, preferences and knowledge gaps.

"While there were issues with mobile coverage at some sites, we captured enough good data to compare the different locations and aggregate the overall results," she says. "Grower feedback was positive and we felt the interactivity improved their level of engagement."

Growers at each workshop were asked a range of questions to assess their attitudes to early sowing times and early sowing risks, sowing time decision drivers and optimal flowering periods.

The data showed growers had a good understanding of the importance of flowering time and the risks in each location. However, the results also revealed some interesting anomalies.

"We could see that Eyre Peninsula growers believed their optimal flowering time was about a week earlier than the modelled data would suggest, while Mallee growers estimated their optimal flowering period to be a week later than the models," Dr Porker says.

"We were able to drill down into their responses and determine that Eyre Peninsula growers were understandably more concerned about the onset of heat stress, while Mallee growers were more concerned about frost."

Questions about barley sowing times revealed lower Eyre Peninsula growers preferred to plant barley later than wheat, while Mallee growers preferred planting barley before wheat. However, Mallee growers do not necessarily have access to cultivars suitable for earlier sowing in their region.

The feedback highlighted a need for a greater diversity of barley cultivars to suit different regions.

Dr Porker and AgCommunicators are now working to deliver additional extension materials, while the GRDC National Phenology Initiative has been established to better predict optimal flowering times for wheat and barley varieties across Australia's major cropping regions.

The initiative will deliver data that growers and advisers can use to make cultivar and time of sowing decisions for their specific environments. This will be available by the middle of 2022.

Meanwhile, Dr Porker says research manipulating plant development in-season has the potential to increase yields by optimising flowering times and decreasing losses to frost.

"Growers generally base their key agronomic decisions around time of sowing, but in-crop management enables a more flexible response to the unfolding season," he says.

"Based on our modelling, the reset technique has potential to provide growers with a relatively low-cost adaptation tool in a warming and drying climate.

"The reset technique is more readily adoptable than winter wheats because growers do not need to buy and store seed for a back-up cultivar, with no clear timeframe for its use.

"The method is also applicable to barley, which does not have the same late emergence downside as winter wheat, allowing it to be grown in a wider range of agro-ecological zones." ☐

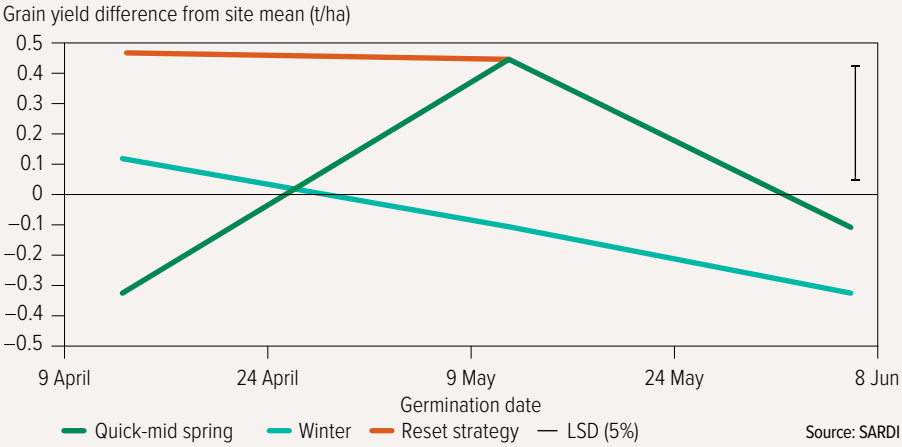
GRDC Codes DAS1910-003, UOA1910-006

More information: Dr Kenton Porker, kenton.porker@faraustralia.com.au. A video report from the Mallee can be seen at https://www.facebook.com/watch/?v=803512673800058

"Growers generally base their key agronomic decisions around time of sowing, but in-crop management enables a more flexible response to the unfolding season."

– DR KENTON PORKER

Figure 1: Mean grain yield responses of quick-mid cultivar Scepter(Φ) and slow-developing winter wheat to germination date and defoliation treatment (applied to early sown Scepter(Φ)) at Minnipa, Tarlee, Cummins and Loxton in 2019.



Source: SARDI

Are long coleoptile wheats an early sowing game changer?

New genetics are emerging that stand to better match varieties to changing farm sizes and climate dynamics

By Dr Sue Knights

KEY POINTS

- Changing climate and increasing enterprise size require new plant traits and management systems
- The long coleoptile trait may improve the performance of wheat in these changing circumstances

Photo: Sarah Rich, CSIRO

Root growth of a long-coleoptile wheat sown at 120 to 130mm depth. Extensive root system and the very long sub-crown internode places the crown near the soil surface. Extensive crown and nodal root growth has ensured foraging of nutrients while the seminal roots from the seed show opportunity for deep water and nutrient uptake.

Adaptive traits to improve rain-fed winter cereals' water utilisation in the face of increased summer rainfall, less in-crop rainfall and greater seasonal variability generally are beginning to emerge from 25 years of research. At the helm of this traits research in recent years at CSIRO Agriculture and Food has been Dr Greg Rebetzke, who says these climatic changes are further compounded by increasing farm sizes that are extending the sowing period.

"These factors are evolving together and driving growers to seek additional tools to maximise crop potential and reduce risk," he says.

"Earlier sowing, for example, has been facilitated by longer-season standard coleoptile length wheat varieties, but this is usually into dry topsoil. Even though there may be moisture at depth, from summer rain, it is out of reach of these varieties."

Enter, after exhaustive research, the long coleoptile adaptive trait that equips the plant to reach and use this moisture.

It looks to be a new early sowing crop development breakthrough, but still no silver bullet. "As with any new 'tool' we need to weigh up the opportunity with the risks and returns, working with growers to understand how exactly to deploy the tool to achieve a benefit," Dr Rebetzke says.

HUNT FOR GENES

The coleoptile is a modified leaf that protects the developing shoot as it emerges. A longer coleoptile enables seed to be sown deeper.

"Although the green revolution of the 1960s provided a transformative step forward for crop production, combining reduced height with improved fertiliser use, it was not without its drawbacks," Dr Rebetzke says.

He says the green revolution dwarfing genes, used widely in Australian wheat varieties, have been a "handbrake" constraining coleoptile and early leaf area development, and why there has been an intensive search for alternative dwarfing genes for long coleoptiles.

Much of the work has focused on identifying and sourcing new genes from across the world and then assessing them in Australia under both laboratory and field conditions. These genes have been assessed for early growth and agronomic performance, and their biology is now well understood.

"We have assessed over 20 genes and are now working with three to four with the greatest potential for deep sowing or sowing into warmer soils early in the season," Dr Rebetzke says.

"These new genes have been tagged with molecular markers developed at CSIRO and we are now working with breeding companies exploring their role in further increasing coleoptile length to improve establishment when deep-sown.

"Australian breeding companies are also on the hunt for novel coleoptile genetics.

"These genes and technology packages are now being used by Australian breeding companies to incorporate the long coleoptile trait into new wheat varieties, which will be ground-truthed in the field to develop agronomic packages.

"It is estimated that varieties with these long coleoptile genes are three to five years away from being available for growers."

RISKS

However, Dr Rebetzke points out that just because long coleoptile wheat varieties allow sowing deep and early, it does not automatically mean you should. It is important to have the trait in an appropriate wheat variety with the right phenology for your environment to ensure flowering occurs in the optimum flowering window.

"Sowing deep delays emergence by five to 10 days, depending on depth. Early growth is reduced and tillering delayed to potentially lower spike number. This might curtail yield but could be compensated for by a small increase in sowing rate. Further research is needed here."

Further research is also required to determine whether sowing deep will increase the susceptibility of these wheats to root diseases and also expose them to more nematode damage.

"We also need to determine the effect of soil temperature on coleoptile length. We know that increasing temperature increases coleoptile growth but may reduce cell size and therefore coleoptile length, so this needs ground-truthing."

REWARDS AND OPPORTUNITIES

Nonetheless, Dr Rebetzke says it is exciting talking to growers about the opportunities long coleoptile wheat varieties may bring: "Growers are very inventive in how they fit such developments into their systems."

The ability to deep sow up to almost 14 centimetres with long coleoptile wheat varieties will mean better use can be made of stored soil moisture. A longer period for root growth will also increase access to deeper moisture and opportunities for exploring increased nutrient uptake.

"Growers could further reduce risk by sowing long coleoptile wheats at two different sowing depths to hedge their bets."

In addition to earlier sowing, long coleoptiles can provide other system benefits including the potential for controlling herbicide-resistant weeds using knockdown herbicides on earlier emerging weeds ahead of the crop.

Long coleoptile wheat varieties may also play an important role in soil amelioration. This has become a widespread practice, particularly in Western Australia. However, newly ameliorated soils face an erosion risk, so seeding with long coleoptile wheat varieties early and deep should provide critical root growth and ground cover to help protect these soils.

PRACTICAL CONSIDERATIONS

Several environmental and equipment considerations need to be contended with in adopting long coleoptile wheat varieties.

Soil texture, seed-zone water content, temperature, light penetration and crop residue can all influence plant performance. Sowing equipment might need to be modified and some pre-emergent herbicides and seed treatments might also affect coleoptile growth. Their use needs to be factored in when deciding on sowing depth. ☐

GRDC Codes CSP00156, CSP00199, CSP00200

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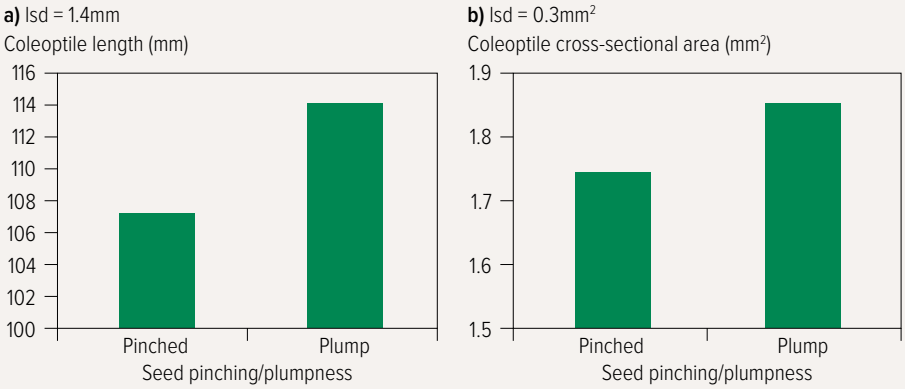
"As with any new 'tool' we need to weigh up the opportunity with the risks and returns, working with growers to understand how exactly to deploy the tool to achieve a benefit." – DR GREG REBETZKE

Figure 1: Selecting plump seed can increase coleoptile length and cross-sectional area by six to seven per cent. This gives the growing coleoptile increased energy and mass to germinate and elongate from depth.



Source: CSIRO

Grower driven to search for new wheat genetics

Novel dwarfing genes are helping growers adapt to changing rainfall patterns in the western growing region

SNAPSHOT

Owners: Callum, John and Adrian Wesley
Location: Southern Cross, Western Australia
Farm size: 8000 hectares
Enterprises: 50 per cent cropping; 50 per cent cattle stud
Average annual rainfall: 315 millimetres, with a shift from winter to summer rainfall
Soil types: heavy red loam, red sands
Cropping program: wheat, barley, oats, chickpeas and lupins

Photo: James Tolmie

Grower Callum Wesley has trialled long coleoptile wheat lines as a response to changing rainfall patterns in Western Australia.

By Dr Gio Braidotti

■ Callum Wesley is among many grain growers facing environmental conditions that call for wheat varieties with a different set of early growth characteristics.

Callum faces persistent changes in rainfall patterns that can drench his paddocks over summer but leave the topsoil dry by sowing time (and also over winter). The new rainfall pattern has made it difficult to get a decent break for the past three seasons.

"The frustrating thing was detecting plenty of soil moisture in the soil profile at about 120 millimetres deep, but not being able to sow that deep with existing varieties," he says.

He reached breaking point in 2020, a year that delivered an exceptional 150mm of rain in February but no follow-up rain until late May. He knew, however, that CSIRO pre-breeders had developed wheat lines that could be sown deeper, right down to where his soils contained moisture.

These lines were developed by Dr Greg Rebetzke and his team by swapping out the commonly used dwarfing genes that were found to also slow the seedlings' early growth. They were replaced with dwarfing genes that reduce crop height but allow seed to produce a much longer coleoptile and, therefore, an emerging shoot that can establish well, even when sown deep at about 100mm. Wheat lines containing the longer coleoptile trait have not yet been commercially released but are being progressed by breeding companies.

Callum contacted Dr Rebetzke over the Anzac Day long weekend in 2020 during the national COVID-19 lockdown to request seed for an on-farm trial. Designing and running the trial remotely with Dr Rebetzke was not an issue, as both have research and development experience.

The problem was a lack of seed: "I wasn't planning on running a long coleoptile trial in 2020, which meant I had not bulked-up any seed," Dr Rebetzke says. "That, however, did not stop Callum. He was like an attack dog. So, I collected and cleaned up every bit of seed carrying the trait. But it was several years old and we were taking a chance that the older age of the seed could affect seedling emergence."

With only 100 kilograms of seed available, Callum had to modify his planter, including manufacturing a hopper to handle the small quantities, a feat he pulled off with his uncle, Adrian. He then managed to use the commercial-scale machinery to sow a small scheme of carefully controlled strips.

The trial was sown dry on 4 May at a depth of 100 to 120mm, and at 30 to 40mm for the controls not containing the long coleoptile trait. Ten lines containing the long coleoptile trait were tested against three commercial varieties as a control, including Mace[(b)].

Callum reports that the long coleoptile lines successfully germinated on summer water deep in the soil profile. They germinated unimpeded and gained a three-week head start in the warm autumn soils compared with the shallow-sown controls.

"Those extra weeks of growth meant the long coleoptile lines got extra rooting length and continued to access moisture deeper in the soil," Callum says. "That head start also helped to mitigate against heat and drought stress in September and October."

Between May and October, the trial site received 85mm of in-crop rain, ranking the season among the lowest for rainfall. However, the long coleoptile lines proved their worth, producing a crop with heads full of ripened grain at a time when the shallow-sown controls were struggling to fill grain.

"I'm looking at an overall yield of about 1.2 tonnes per hectare with the long coleoptile lines sown deep when I have a season to chase summer rain," Callum says. "For me, that makes for a much-needed risk management tool and would amount to a profitable crop despite a horrible season."

Callum has used the harvested seed to repeat the trial in 2021 to further explore gene-by-environment benefits from CSIRO's alternative dwarfing genes. Dr Rebetzke, who continues to collaborate with Callum, says uptake of these genes by breeding companies has been strong and the genes are due to appear in commercial varieties over the next five years. □

More information: Callum Wesley, cwesley@live.com.au, @Callum_Wesley, #Deepsowing

Ground-truthing long coleoptile wheats

Darren Aisthorpe, senior regional research agronomist with the Queensland Department of Agriculture and Fisheries, checking on long coleoptile wheat trials a month after being sown on 19 April 2021 at the Emerald Research Facility.

Photo: Melissa Aisthorpe

Regional pilot studies are underway to engage with growers to evaluate a new adaptive wheat trait

By Dr Sue Knights

■ Finding a solution to increasing crop production in changing climates and with increasing enterprise size requires new tools and management practices – and just a bit of vision.

Chasing soil moisture and sowing earlier is one such inventive approach and long coleoptile cereal varieties might be the tool growers need.

The coleoptile is the protective sheath enclosing the emerging shoot and first leaves, and the longer it is, the greater the emergence potential when deep sowing. Wheats with this trait can be sown at depths of more than 10 centimetres.

After decades of research and development, the long coleoptile wheat research of Dr Greg Rebetzke's team at CSIRO has come of age and is now set to be ground-truthed for growers in regional cropping systems. The trials will also include new long coleoptile wheat lines from commercial breeding companies.

To ensure wheat growers can take advantage of new varieties with this trait when they become available, GRDC is investing in on-farm trials over two years with growers in the northern and western regions to deliver agronomic and farming systems guidelines.

WEST INVESTMENT

Mike Lamond and Craig Brown from SLR Research and Development, part of Synergy Consulting, lead the western region project.

"The long coleoptile trait stands to become an important risk-management strategy for western region growers to deal with changing climate and increasing enterprise size," Mr Lamond says.

"Growers will be able to chase moisture deeper in soil profiles from summer rains prior to normal sowing windows in medium to low-rainfall zones. By sowing into moisture with a variety with correct genes for a planting date, a spring flowering window is more certain than with dry sowing."

The small-plot trials are on a range of soil types at Holt Rock, Hines Hill, Bunjil, York, Beacon and Latham. Sowing started as early as 19 March and continued to late April.

"The trait has application for main-season sowing as well as early sowing. With a decent seasonal break, sowing can continue rather than stop when the moisture is thought to be too far down for the crop to emerge. Crops being able to emerge through furrow fill and pre-emergent herbicide damage from wind events will be another benefit from the trait when available in main-season varieties."

NORTH INVESTMENT

Darren Aisthorpe, a senior regional research agronomist with the Queensland Department of Agriculture and Fisheries based in Emerald, leads the northern region project.

"Demonstration sites are being run in central and southern Queensland. In these regions, growers are not strangers to sowing deep, thanks to chickpeas, but are reluctant to do so with wheat, as previous experiences may not have been positive," Mr Aisthorpe says.

"Typically, growers waited too long for rain before attempting to sow late in the season, which exposed wheat crops to a short growing season as heat stress kicks in at the end of the season. Potential yield loss can be significant, even at a standard depth, but with a suboptimal establishment due to depth added into the mix, the desire to repeat the exercise can be pretty low."

In these regions there has been more intermittent wheat production due to the environmental constraints, so long coleoptile wheat types are being evaluated as a tool to develop a more reliable platform for wheat production, leveraging stored water in profiles rather than waiting for autumn planting rains.

"Times of sowing started as early as mid-April this year, with a view to look at a mid to late March plant in 2022.

"We need to consider how soil temperature will affect coleoptile growth from depth, as temperature is a major challenge with these times of sowing."

To this end, the trial sites have been established with TinyTags and will be carefully monitored. Higher temperatures are known to reduce cell size and, therefore, coleoptile length.

Growers are encouraged to follow the trials and get involved in the conversation in the West @SlrAgriculture or North @DarrenAis. ☐

GRDC Codes SLR2103-001, DAQ2104-005

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Retained lupin seed germination puzzle

Both genetic and management factors can affect lupin seed integrity, germination and, ultimately, yield but the puzzle is yet to be completely solved

By Katrina Venticinque and Judith Storer

KEY POINTS

- **Lupin seed integrity can influence germination and, ultimately, yield but there are both genetic and management aspects that affect this**
- **A survey of grower-retained seed in the 2019-20 season has shown a 19 per cent decline in lupin germination, on average, from pre-harvest to post-seeding**
- **Investigations into mechanical handling effects on seed integrity are continuing**

■ Although retaining seed can reduce sowing costs, poor lupin crop germination from retained seed can negate this saving and has become more common for growers in low to medium-rainfall zones of the northern agricultural region of Western Australia.

To better understand the cause, the Liebe Group, based in Dalwallinu, has been undertaking research through a two-year GRDC-invested project, although answers are proving elusive.

The project aims to assess seed integrity by conducting germination tests and evaluating crop establishment to assess the effect that seed characteristics and multiple handling practices might have on the integrity of the lupin seed coat.

The problem is complex because many factors can affect seed integrity, including manganese deficiency of the seed, variety, harvester settings and treatment of seed by augers.

This project looks to determine which factors affect seed integrity most and where in the handling processes practical changes can be made to improve germination.

SURVEY OF RETAINED SEED

Initial results from the 2019-20 season have shown a 19 per cent decline in lupin germination, on average, from pre-harvest to post-seeding (Figure 1).

This trend was identified through germination test results from 27 seed sources provided by participating growers.

The sample set included six different varieties – Barlock$^{\phi}$, Coramup, Gunyidi$^{\phi}$, PBA Jurien$^{\phi}$, Mandelup$^{\phi}$ and Coyote$^{\phi}$ – and were obtained from lupin crops grown in 2019 that either had foliar, compound or no manganese applied.

While manganese deficiency is thought to be a significant factor affecting the decline in germination, all samples showed adequate manganese levels above the standard minimum threshold of 15 milligrams per kilogram, despite variation in manganese application.

As the 2019 season received below-average rainfall, it would be worth testing manganese levels in lupin seed crops that experienced higher rainfall and yielding situations.

There were no clear varietal differences in lupin seed integrity, but this could require further investigation as well.

MECHANICAL DAMAGE

The mechanical handling factors identified throughout the harvest, storage and seeding process are subject to ongoing investigation, with research underway to pinpoint where the production system can be improved.

Investigations of various header rotor speeds have revealed no clear trends. Targeted trial work was done in December 2020 with three rotor speeds, identified as the most common, at four sites with no significant correlation between treatments.

Analysis of the results from these grower-scale demonstrations suggest that rotor speed may not have a significant impact on germination within the current range of standard grower practice.

ONGOING WORK

The genetic and management factors affecting lupin seed integrity are obviously complex and, although some factors have been eliminated, there is a need for further work to unravel the puzzle.

To this end, the Liebe Group also conducted an auger use and condition trial in March 2021; however, results are not yet available. The aim of this experiment is to compare the effect of one to 10 consecutive auger journeys on establishment percentages. This testing will be duplicated across an auger with old worn blades and an auger with new blades, to assess the impact that auger conditions might have on lupin seed integrity.

Six growers are participating in another season of data collection and research, including three enterprises that experienced significant losses in germination and three that maintained high germination rates throughout the initial testing.

The Liebe Group also plans to develop case studies outlining what management practices can be changed for growers to improve or maintain lupin seed integrity to increase lupin productivity. These will be made available on the Liebe Group website (liebegroup.org.au) in early to mid 2022. □

GRDC Code LIE1910-00

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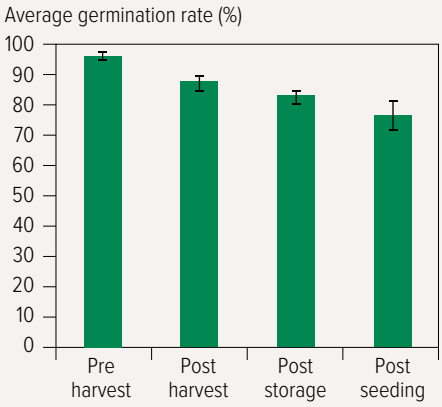
Figure 1: Average germination percentage of 27 lupin seed sources, each tested at four times; pre and post-harvest 2019, and post-storage and post-seeding 2020. Error bars are ± 1 S.E.



Source: Liebe Group

Photo: DPIRD

Jackie Bucat from DPIRD is leading a team of researchers investigating the risks and rewards of very early sown canola in Western Australia (L-R Salzar Rahman, Jackie Bucat, Stacey Power, Andrew Blake, Helen Cooper, Stephanie Boyce).

Risks and rewards of very early sown canola

By Jackie Bucat, Stacey Power, Andrew Blake, Dr Imma Farre and Martin Harries

KEY POINTS

- **DPIRD trials have shown sowing triazine-tolerant canola in March can be as profitable as sowing in April**
- **March sowing is not better than April sowing, but may provide growers with more flexibility, as seeding opportunities become more irregular**
- **Risks, including poor crop establishment, seedling survival, frost at the end of flowering, predation and disease, need to be carefully considered when sowing early**

Changing cropping practices and increasingly unpredictable season breaks are prompting Western Australian growers to consider sowing canola earlier, but there is a lack of information for determining the risks and rewards of doing so.

To address this gap, a project led by the Western Australian Department of Primary Industries and Regional Development (DPIRD), with GRDC co-investment, undertook eight large field trials with four to five different times of sowing (TOS) from 19 March to 11 June in low and medium-rainfall sites in 2019 and 2020.

The sites were at Mullewa, Wongan Hills, Dale and Grass Patch. To generate data for early sowing in late-breaking seasons (6 June for 2019 for most sites), trials were irrigated prior to sowing and as necessary to ensure crop survival post-seeding.

The canola varieties were all triazine-tolerant and included both open-pollinated and hybrid plant types with a wide range of variety maturities.

REWARDS

Sowing in March produced profitable canola crops. Yields were highest in all trials when sown on 18 March or 8 April, and did not differ significantly at these dates (Table 1).

At Dale, there was no significant difference between yields at the first three TOS in 2020 and the first four TOS in 2019, reflecting its longer growing season.

Average TOS yields ranged from 1.3 tonnes per hectare at Mullewa in 2019 to 3.5t/ha at Wongan Hills in 2020. There was a general trend for the oil content to decline with later sowing times. Gross returns followed the same pattern as yield.

RISKS

Although March-sown canola produced similar yields to April-sown canola, there were greater risks. Higher soil temperatures in March reduced plant establishment at all sites. There was also greater risk of crop death with insufficient follow-up rain. This risk was particularly important in warmer northern areas where, unlike other sites, trials needed regular light irrigation after emergence. Early sowing also increased the risk of damaging frosts at the end of flowering or during grain fill. A low incidence of frosts characterised 2020, contributing to the observed profitable yields with March sowing.

Frost-prone areas should be avoided for very early sowing. Additional risks of March sowing come from predation and disease. Summer rains and an early break reduce the environmental risk of early sowing, but may lead to a green bridge and build-up of predator insects.

Diamondback moth (DBM) was difficult to control in the 2020 Grass Patch trial. Both DBM and green peach aphid are likely problems with early sowing due to the fast breeding cycle in warm early sowing conditions. There is also greater risk of Sclerotinia with early sowing due to longer flowering duration. Each risk needs to be evaluated for different environments before sowing canola early.

Other strategies to reduce risks of very early seeding are sowing only part of the canola program in March, increasing the sowing rate of open-pollinated canola, and regular monitoring for pests and diseases. ☐

GRDC Code DAW1901-005

More information: Jackie Bucat, 08 9368 3481, jackie.bucat@agric.wa.gov.au

Table 1: Average yield (t/ha) for triazine-tolerant canola types at four times of sowing at three locations in Western Australia.

Year	2020				2019				
TOS	18 Mar	8 Apr	29 Apr	20 May	18 Mar	8 Apr	29 Apr	20 May	11 Jun
Mullewa	1.58a	1.40ab	1.18b	0.29c	1.38a	1.23a	0.83b	0.64b	0.14c
Wongan Hills	3.42a	3.23a	2.05b	1.05c	2.48a	2.38a	1.43b	1.25b	1.22b
Dale	2.35a	2.33a	2.75a	1.47b	2.21a	2.45a	2.12a	2.04a	1.32b

Yields with different letters are significantly different at p=0.05

Source: DPIRD

Statistics help decipher 'noisy' agronomic trials

Teasing out the influence that different environmental characteristics have on trials could lead to a better understanding of agronomic management across changing seasons

Photo: Professor Daniel Rodriguez

Biometrician Michael Mumford, from the GRDC-supported Statistics for the Australian Grains Industry (SAGI) team (right), joins Queensland Alliance for Agriculture and Food Innovation research officer Dr Erin Wilkus for some field-based data collection. Mr Mumford is part of a team of statisticians developing a game-changing new method of analysing agronomic trials.

By Rebecca Thyer

■ A new statistical methodology that 'untangles' the effects that different environmental conditions have on field trials could be a game changer.

When agronomic trials are conducted, trials are repeated across multiple sites or seasons to determine environmental influences on results.

Environmental influence is key in most trials, affecting data interpretation, says principal biometrician Dr Alison Kelly, who is leading the GRDC-supported (SAGI) North team in developing the new approach.

Michael Mumford and Clayton Forknall, from the Queensland Department of Agriculture and Fisheries (DAF) and part of the SAGI-North team, say these environmental characteristics can be measured and incorporated into the analysis.

"We call these factors environmental covariates, and they can include anything from rainfall, soil and air temperature to radiation and evapotranspiration that might vary from season to season or from site to site.

"These environmental conditions are all tangled together. It is hard to unpick them to understand the influence of each one individually," Mr Mumford says.

Professor Dr Daniel Rodriguez from Queensland Alliance for Agriculture and Food Innovation (QAAFI), who has been working with the SAGI-North team, agrees.

"Researchers roughly know what the interacting factor was," he says. "This might be: 'well, one site had less rain so that could be it'. But we want to know more. When did that stress occur, at what stage of the crop, how did that stress impact yield? We want to tease that information out."

He says the method will better translate trial results, accounting for environmental, management and seasonal factors, and help extrapolate more information from the data. "This work with SAGI is a game changer."

One of the 'game changing' aspects of this statistical methodology is its ability to capture interactions between management practices and environmental covariates. Often the focus of agronomic trials is optimising management of a select few genotypes. This is very different to the plant improvement area where existing statistical methods incorporating environmental covariates have been developed.

SORGHUM APPLICATION

Using data from the GRDC-supported Optimising Sorghum Agronomy program, Professor Rodriguez identified covariates across six trials as a mix of phenology measurements (emergence, flowering and maturity), weather data and outputs from the Agricultural Production Systems sIMulator (APSIM), a highly advanced platform for modelling and simulating agricultural systems.

The statistical method was able to explain interactions between the hybrid, time of sowing and plant density using climate variables. This information will help increase capacity to extrapolate agronomic experimentation results across different sites and seasons, increasing the accuracy of the recommendations and agronomists' capacity to answer questions with fewer trials.

"This is based on one year of data and will become even clearer when the second and then third year of data becomes available," he says

Professor Rodriguez says the method shows what the future could look like when analysing field trials. In this instance it identified key environmental drivers and management strategies that explained the overall genotype by environment by management (G×E×M) interaction. "This enhances the biological understanding of the results and allows for more robust agronomic practice recommendations."

EFFICIENCY

Trial efficiency and return on scientific investment will be improved with this model, as less data is required over multiple sites and seasons. "The model has the potential to predict 'new' untested environments, based on the most influential environmental covariates identified by the model. We are at the early stages of this work," Mr Mumford says.

The statistical model links to information generated from APSIM and can also 'borrow' information from other trials, again improving efficiency, Mr Mumford says. "Each environment has a different level of variability, with some more variable than others. If that is the case, our model will automatically allocate greater importance to trials that are less variable. It is a clever way of being more efficient." □

GRDC Codes DAQ00208, UOQ 1808-001

More information: Michael Mumford, 07 4529 1240, 0413 438 083, michael.mumford@daf.qld.gov.au

Michael Mumford will be presenting his research at the 20th Australian Agronomy Conference in Toowoomba in October. https://agronomyconference.com

Radical rethink of sorghum cold tolerance

Sorghum production is becoming a victim of changing climate in the northern cropping region, but some outside-the-box thinking could give it a different place in crop rotations and prove a win-win

By Professor Daniel Rodriguez, Dr Joe Eyre, Loretta Serafin and Darren Aisthorpe

■ Limited water and extreme heat at flowering are common constraints on sorghum production. However, in recent seasons lack of spring sowing opportunities has reduced sown areas and grain yields, and eliminated double cropping opportunities, as most sorghum crops have been sown too late in summer. Traditionally, sorghum is a summer crop, sown when morning (9am) soil temperatures at sowing depth are 16°C or higher and the risk of frost has passed. However, with GRDC investment, these ideas are being challenged by researchers proposing sorghum could be sown in late winter, into soil moisture, as long as soil temperatures at sowing depth are 12°C and rising. The strategy might seem simple, but its implications and implementation are not.

RISKS AND OPPORTUNITIES

A sorghum crop sown in winter will risk having a long emergence period. This will increase likelihood of some seeds running out of soil moisture, and soil insect damage resulting in non-uniform stands with implications for weed competition and yield. This can be overcome by sowing with high-quality seed into moist soils when soil temperatures are at least 12°C.

However, there are many advantages:

- sowing sorghum in winter and early spring increases opportunities for sowing in regions where spring rainfall is highly variable and shifting towards late summer months;
- high solar radiation and lower temperatures in winter and early spring provide environments more conducive to higher yield potentials and water use efficiencies;
- crops sown in winter will flower earlier and avoid heat stresses and dry finishes, increasing seed set and reducing screenings; and
- winter and early spring sown sorghum will significantly increase chances of double cropping a winter crop after a short summer fallow, or allow for the crop to be ratooned into a second harvest, if irrigation is available.

So, the advantages appear to outweigh the risks and provide a new opportunity for sorghum growers to increase cropping intensity and profitability.

INITIAL RESULTS

Results from two years of on-farm collaborative experimentation with the Queensland Department of Agriculture and Fisheries and NSW Department of Primary Industries led by the Queensland Alliance for Agriculture and Food Innovation have been analysed using a new method developed in collaboration with SAGI. The results show important interactions between hybrid and management across the tested environments. Figures 1a and b show sorghum can be sown into cooler soils at no yield loss and with reduced screenings. Benefits of early sowing also include the avoidance of heat stresses at flowering with benefits on seed set (Figure 1c). Growing sorghum earlier in the year will significantly increase chances of double cropping into a winter crop, or in irrigated systems, ratooning the sorghum into a second harvest to produce gross margins higher than those of cotton.

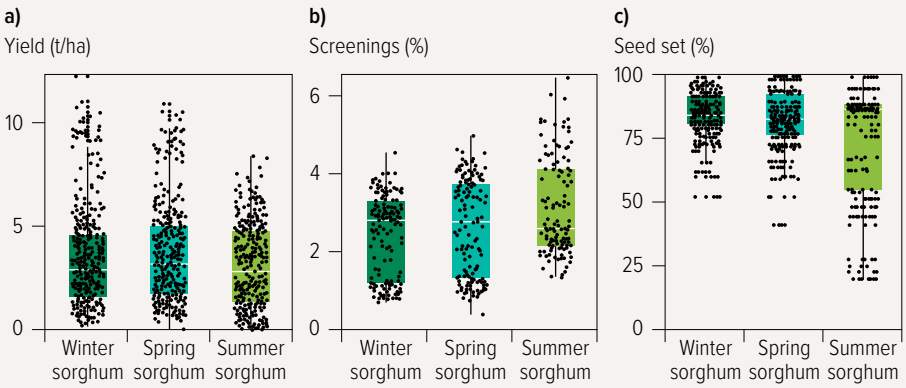
ADDITIONAL CONSIDERATIONS

Seed quality and control of soil insects are vital for uniform establishment in cold soils. Seed quality should be tested, especially vigour at low temperatures. Sorghum appears to tolerate frosts of -2°C and -3°C before the crop has six to seven leaves, although if sowing with about 12°C at sowing depth, a 20 to 40 per cent increase in plant populations is recommended. This necessary increase in seeding rate is a minor cost given the possibility of growing a second crop in the same year.

FURTHER RESEARCH

Further research will quantify crop and root growth and function in cold soils and consider implications on crop water use and cropping systems' water use efficiency. Initial results suggest that winter-sown crops will transfer water use from vegetative stages to the crop's reproductive stages, significantly reducing the chances of dry finishes, high screenings and crop lodging. Impacts on cropping system economics are being modelled for winter, spring and summer sorghum cropping systems using the Agricultural Production Systems sIMulator (APSIM). □

Figure 1: Boxplot and observations (dots) of (a) averaged yields, (b) per cent screenings and (c) effect of high temperatures around flowering on seed-set (%) of six commercial sorghum hybrids sown at four plant densities in winter, spring and summer across 15 site seasons in eastern Australia.



Source: QAAFI, The University of Queensland

GRDC Code UOQ 1808-001

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Benefits of precision seed placement

Precision planting is a practice extensively used for summer cropping in the northern region, but there is little uptake in the winter-dominant cropping systems of southern and western Australia

By Dr Glenn McDonald, Dr Jack Desbiolles, Claire Pickles, Genevieve Clarke, Sarah Noack, Rebekah Allen, Ashleigh Amourgis, Jon Midwood, Stefan Schmidt and Dr David Minkey

KEY POINTS

- **Precision planting improved the uniformity of winter crop stands and often allowed reductions in plant density without loss of yield**
- **Although yield gains from precision planting have been variable, potential benefits will be greatest in crops with high seed input costs**
- **Growers should consider the most cost-effective way in which to transition to more precise sowing equipment**

In an effort to reduce the cost of hybrid canola seed – but also to maximise productivity in other winter crops – precision planting technology is gaining interest in the southern and western regions.

Particular interest is focusing on seed singulation technology, which is the ability to precisely locate a single seed in the seeding row. By placing seed at consistent depth and distance apart, uniform emergence can be achieved, reducing plant competition and maximising growth and yield per plant.

In 2018 and 2019 GRDC invested in a multi-pronged project, managed by the University of Adelaide, to survey crops in the southern and western regions to assess variation in seedling emergence and seedling depth and to examine what factors contribute to this variation.

The team also undertook a series of small-scale and large-scale trials comparing conventional sowing – either a cone seeder or an airseeder – with precision planting, and carried out a qualitative survey of users of precision planters for winter grain crops (see breakout box for growers' tips).

PADDOCK SURVEY FINDINGS

The survey highlighted the variation in crop establishment that occurs within a paddock and between paddocks. Crop establishment in canola and lentil crops was found to be variable and improvements were foreseen in many cases that could improve establishment and reduce seed costs. Establishment was lower and more sensitive to sowing conditions in canola than lentils and provided greater scope for improvement.

The survey highlighted that the age and make of a seeder was less important than knowing a seeder and the factors that affect establishment, such as seeder set-up, calibration, sowing speed and depth.

A consistent feature among growers who achieved good rates of crop establishment was their attention to detail in setting up the seeder, making adjustments according to sowing conditions and monitoring performance during seeding.

The survey found that establishment of canola and lentils is influenced by different factors. While some factors are outside grower control, there were simple changes that could maximise establishment.

Establishment in canola was lower with early (April to early May) sowing, which was associated with many crops being dry-sown or with low soil moisture during the dry autumn in 2019. Establishment in lentils, however, was not affected by time of sowing.

Establishment was greater with hybrid canola varieties than with open-pollinated varieties and also tended to be better when seed and fertiliser were separated during seeding.

Maintaining good surface structure to minimise crusting was found to assist seedling emergence and this could be achieved, for example, through stubble retention or management of sodicity.

TRIAL RESULTS

A series of small plot trials were conducted between 2018 and 2020 in South Australia and Victoria using a purpose-built six-row seeder that could sow seeds as a conventional cone seeder or as a precision planter.

The precision planting units were commercial row units supplied by Spot On Ag, in Boort, Victoria. A trial at Merredin in 2019 used a small-plot seeder operated by the Western Australian Department of Primary Industries and Regional Development with the capacity for singulation as well as conventional sowing.

Both plot seeders used disc seeding systems, except in 2018 when cone seeding could only be done with a tyned seeding system.

Large-scale trials were also conducted

Photo: University of Adelaide

A small-plot precision seeder being used by the University of Adelaide is showing that precision planting can improve stand uniformity and has the potential to reduce seed costs per hectare, especially in crops with high seed input costs such as canola.

CHECKLIST FOR ADOPTING AND OPERATING PRECISION PLANTERS:

- Precision planting = precision placement first and seed singulation second (the benefits of seed singulation are not realised unless accurate seed placement can be delivered, through technology features, settings and operation, and including low paddock roughness).
- Plan the shift to precision planting, and address soil constraints, paddock preparation, seed grading/cleaning/quality, residue, weed management and logistics.
- Do some homework; research, talk to users and manufacturers, and look internationally for up-to-date information.
- Ensure technical support is available with the choice of technology or be ready to struggle.
- Be confident in your choice of planter or delay selection until you are confident.
- Hi-tech planters might not imply higher cost-effectiveness.
- Use clean seeds, graded and of high quality.
- Keep an eye on performance, monitor regularly, be conscious of speed.
- Precision planting of larger seeds is less challenging when starting.

Table 1: Companies currently providing precision planting technologies in Australia*.

Manufacturer or distributor	Associated precision planting technologies	Web address
AGCO Australia, Vic	White Planters, Precision Planting Inc	www.white-planters.com
BOSS Agriculture, NSW	Precision Planting Inc, John Deere	https://bossagriculture.com.au/vacuum-planters.html
Bourgault Australia, NSW	Bourgault Air-Planter XP meter and components	www.bourgault.com/product/en-US/air-planter-/841/air-planter.aspx
CNH Industrial Australia, NSW	Case-IH, Precision Planting Inc	www.caseih.com/anz/en-au/products/planting-and-seeding
Great Plains Ag. Australia (Kubota Australia), Qld	Great Plains	https://greatplainsaustralia.com.au/product/range/yield-pro-planter
Groundbreaker Precision Agriculture (Toowoomba Engineering – Precision Ag Solutions), Qld, N-NSW	Precision Planting Inc, Monosem, Ag-Leader, Groundbreaker components	www.groundbreaker.com.au; www.precisionagsolutions.com.au
John Deere Australia, Qld	John Deere, Deere-Bauer, Deere-Orthman	https://www.deere.com.au/en/planting-equipment
Landpower Australia, Vic	Väderstad	www.vaderstad.com/au www.vaderstad.com/en/planting
Muddy River Agricultural, Vic	Horsch	https://muddyriver.com.au/maestro-cc-rc-sw
NDF Ag Design, NSW	Precision Planting Inc, NDF downforce control	www.ndf.com.au/summer_planter.html
Norseman Machinery, Qld (N-NSW)	Norseman, Kinze	www.norsemanmachinery.com
Precision Seeding Solutions, NSW (Qld)	Precision Planting Inc	www.pssag.com
Spot On Ag, Vic	Harvest International, Precision Planting Inc Prescription Tillage Technologies	https://spotonag.com.au
Vanderfield (RDO Australia Group), Qld, NSW, NT, WA	John Deere, Dawn Equipment, Monosem, Horsch	www.vanderfield.com.au

* This is an extensive list to the best of the author's knowledge; please consult your local retailer for more information.

with canola and faba beans near Skipton in western Victoria using a Väderstad airseeder (Seed Hawk model in 2018; Rapid model in 2019) and a Väderstad precision planter (Tempo). Each trial compared the responses to row spacing (25 centimetres versus 50cm) and sowing rate (recommended versus half-recommended) and were sown in plots 150 metres long.

In most of the plot trials there was no significant difference in the yields between the two seeders, with significant differences being measured in two of the nine trials; in both cases precision planting improved yields.

Crop establishment in the pulses was generally higher than in canola, but for both plant species there was no consistent effect of precision planting on establishment, while crop uniformity was improved substantially with precision planting. When there were differences in yield, precision planting improved grain yield by 18 per cent and 22 per cent for faba beans, 10 per cent for lupins and 14 per cent for lentils. In a number of cases, precision planting achieved equivalent yields to conventional planting but with a lower plant population.

The results for canola and pulses indicated that despite variable effects on establishment, precision planting resulted in yields equivalent to or higher than those achieved with conventional sowing and sometimes at lower plant populations.

The potential economic benefit of this is the saving on seed costs from producing the same yield with fewer plants per square metre. However, the responses to precision planting varied among experiments and the factors influencing the yield benefits from precision planting are still unclear.

SOURCING PRECISION EQUIPMENT

Precise and smart seeding technology is evolving rapidly, with airseeder-based transitional options becoming available that could allow a more practical and cost-effective pathway to greater planting precision.

A list of suppliers and support for precision planting technologies is given in Table 1. ☐

GRDC Research Code UOA1803-009

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Multi-skilled team gets the edge on climate

Management expertise is proving to be a key factor in successfully cropping with unpredictable rainfall

SNAPSHOT

Growers: Bruce, Karina, Jim and Janelle Watson and Mark and Katrina Swift
Location: Tichborne, New South Wales
Farm size: 3700 hectares
Average annual rainfall: 550 millimetres
Soil types: sandy loam
Soil pH: 4.5 to 5.5
Enterprises: cropping only
Crops grown: bread wheat, durum wheat, barley, oats, triticale, canola, linseed, safflower, faba beans, lentils, lupins, chickpeas, sorghum, mungbeans, sesame and dryland cotton

By Dr Sue Knights

■ Cropping in a volatile rainfall area has required the Watson and Swift families to adopt a suite of management tools to optimise their crop production.

"It takes multi-faceted thinking to optimise crop production," Mark Swift says. "You need to use all the tools at your disposal: crop genetics, machinery, soil moisture, forecasts – for what they are worth – and management. But another important dimension to consider is time."

The Watson and Swift families operate a grain growing business at Tichborne, near Parkes, NSW, producing a mixture of dryland winter cereals, pulses and oilseeds as well as summer dryland cereals and pulses. The property nominally receives an average annual rainfall of 550 millimetres but it typically ranges from 400 to 800mm.

Mark attributes their ability to deal with this seasonal variability to the combination of skills and experience within the business's management.

Bruce Watson holds a Bachelor of Agricultural Economics from the University of Sydney and previously worked with PricewaterhouseCoopers in its transfer pricing practice. Bruce's sister Katrina and her husband Mark hold degrees in agribusiness from Marcus Oldham College. Additionally, Katrina has brought experience in banking and agronomy back to the family business. Bruce's wife

Mark Swift (left) and Bruce Watson, members of an extended family business team of tertiary-qualified growers using informed decisions to crop in the volatile rainfall region of Parkes, NSW.

Photo: Nicole Baxter

Karina is a qualified pharmacist and brings detailed attention to the bookkeeping, while parents Jim and Janelle bring the wisdom of years of farming and board experience (Jim) and a degree in agricultural economics (Janelle) to the team.

Both Bruce and Mark received Nuffield Scholarships, a program through which they have honed their leadership and questioning skills. Mark has also taken the Executive Program for Agricultural Producers at Texas A&M in the US. Adding to this, Bruce is a member of the GRDC Northern Panel.

To complement the management team, the business employs two full-time, experienced diesel mechanics, one of whom has been with the family business for nearly 10 years.

The make-up of the management team shows a clear and significant educational investment underwriting the business and this, they say, leads to some robust decision-making.

"We operate on a division of labour," Mark says. "Bruce looks after the marketing of crops, I focus on machinery, Katrina is the summer crop specialist, Karina looks after administration. Although we have specialised roles, we all have an understanding of each other's areas so we can step up to cover others if necessary."

This also enables the specialists to devote time to their part of the business and this improves attention to detail.

CROP GENETICS

The business originally was a mixed farm and in 2006 mainly cropped wheat and barley. This has changed over the past 15 years as the regional climate has changed and additional skills have been added to the business.

"We are now solely cropping but as the rainfall pattern has changed over time and farming practices improved, we have more scope to add further crop species to our portfolio," Marks says.

Given the change in farming practices the Watsons and Swifts have moved into summer cropping, which is in its infancy in this region. The business's summer crop program is managed by Katrina, who spent some time working off-farm as a summer crop agronomist.

"This experience has given me the confidence to seek out information from summer crop experts further north as well as attending accreditation courses for crops like mungbeans and soybeans," Katrina says.

"The COVID-19 pandemic has brought about some great improvements in access to information through online webinars, which are much more accessible for women in cropping businesses who are also juggling child-raising.

"Summer cropping is inherently more risky than winter cropping and timing of management decisions can be critical, but incorporating them into our cropping sequence gives us greater flexibility and improved operational timeliness.

"As we have more diversity in our cropping system, we have more tools to deal with herbicide-resistant weeds and can deal with mice and insect pressure better by having the flexibility of several sowing windows."

The Watsons and Swifts use several varieties of cereal and canola with different phenology to assist in spreading sowing dates. However, they prefer to have several pulse types in their portfolio rather than several varieties of each.

"Pulses are more risky to market, so you need to plan over time … better to hedge your bets with a number of different types like faba beans, lupins and chickpeas than use several varieties of one species," Bruce says.

"Drought towards the end of the winter crop cycle is a consideration and sowing times for all crops and varieties need to be considered, with this timeframe restriction top of mind."

PRECISION PLANTING

The Watsons and Swifts have been precision planting most of their crops since 2016.

"Our equipment choice is vital to set crops up at sowing for maximum yield," Mark says. "We use an Excel Agriculture double-disc planter matched with a Bourgault air cart to establish our cereal crops on 25-centimetre rows and use the same disc planter on 50cm row spacings with precision planting gear for break crops.

"We sow row-on-row and are able to do this due to low disease pressure from our diverse crop rotation. This results in rapid root growth as the germinating crops follow old root channels where there is a high concentration of nutrients and biological activity."

Mark says precision planting is not for the faint-hearted as it adds a great deal of logistical effort between crops and varieties, and growers need to have an eye for detail.

"Precision planting, however, presents many benefits including significant savings on seed and – for example – in canola, reduced disease pressure as there is more airflow through the plants. Additionally, canola plants will branch and flower more if they have access to more moisture within the season." ☐

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Useful guides to boost crop potential

■ GRDC has invested in several guides to help growers make informed decisions to maximise crop potential under changing climatic situations. These guides are a mix of the latest research results and include grower case studies. They also provide guidelines for implementing the research lessons under certain circumstances. Selected tips are presented in the following booklet summaries.

20 TIPS FOR PROFITABLE CANOLA

Canola is Australia's third-largest grain crop and is known for its value as a profitable break crop for weed and disease management if managed well. Despite these accepted benefits, growers and advisers across the country were concerned about managing the risks and high relative costs of growing canola under more variable seasonal conditions.

In 2014, GRDC co-invested in 'Optimised canola profitability', a five-year research program across eastern Australia that aimed to equip growers with tactical canola agronomy strategies, underpinned by world-leading crop physiology research. The research team comprised CSIRO, New South Wales Department of Primary Industries and collaborators in three eastern mainland states (northern, central and southern NSW, Victoria and South Australia) using 60 field experiments and detailed physiological studies across nine regions. The team focused on gaining a thorough understanding of factors driving crop growth, development, flowering time, yield formation and response to stress to provide tips and tactics to improve canola profit and reduce risk.

The comprehensive guides released in 2019 can be accessed at:

20 tips for profitable canola – northern NSW – https://grdc.com.au/20-tips-for-profitable-canola-northern-nsw

20 tips for profitable canola – central and southern NSW – https://grdc.com.au/20-tips-for-profitable-canola-central-and-southern-nsw

20 tips for profitable canola – Victoria – https://grdc.com.au/20-tips-for-profitable-canola-victoria

20 tips for profitable canola – South Australia – https://grdc.com.au/20-tips-for-profitable-canola-south-australia

Selected tips

- Manage fallows thoroughly to conserve moisture for canola production.
- Select paddocks carefully with particular focus on nitrogen and stored soil water status.
- Carefully select the variety type according to phenology, breeding type (open-pollinated or hybrid) and herbicide tolerance package.
- Sow winter canola late summer to early autumn.
- Sow slow spring canola late March to mid April.

TEN TIPS FOR EARLY SOWN WHEAT

Timely operations are key to maximising farm profit, and sowing is one of the most time-critical operations. The yield penalty from delayed sowing is often associated with delayed sowing in most regions and is due to only a short period in spring (approximately 10 days) during which crops can flower to maximise yields. This is referred to as the optimal flowering period and its timing and length varies with location and climate.

During the optimal flowering period, the combined yield loss from drought, heat, frost and insufficient radiation are, on average, minimised and yields are maximised in the long term.

In any individual year, these abiotic stresses can still damage crops even when the crop flowers during the optimal period. Achieving optimal flowering can make a big difference to yield and profit and costs very little to achieve. However, there are some challenges with sowing wheat early and this guide provides useful insights.

The booklet was released in February 2020.

Selected tips

- Consider your location as optimal flowering time will differ with location.
- Select paddocks with few weeds and low levels of root disease.
- Use the right winter cultivar for the right environment.
- Use the right variety for the right sowing date.
- Consider seedbed and stored soil moisture levels.

https://grdc.com.au/ten-tips-for-early-sown-wheat

SEEDING SYSTEMS – CASE STUDIES OF GROWERS IN WA

At their August 2017 meeting, Kwinana West port zone grower network members noted that with a tricky start to the season, some growers had managed to successfully establish crops evenly and uniformly across paddocks, which translated into increased yield at the other end of the season.

So, what was the difference? One way to find out was to identify some of these growers and then ask them what seeding system they were using and why it worked for them. As a result of these interviews, a collection of grower case studies in the western region documented real data and experiences.

Twenty-five growers were interviewed and their experiences have been summarised in this booklet, which was published in February 2019.

Captured in the guide are many of the tips and tricks growers are using to help improve crop establishment on their properties and how they have modified seeding systems for their circumstances. Using this shared knowledge growers can determine the risks and rewards for making changes on their own properties.

https://grdc.com.au/seeding-systems-case-studies-of-growers-in-wa

MAXIMISING SOWING OPPORTUNITIES UNDER DRY SOIL CONDITIONS IN THE HIGH-RAINFALL ZONE

In the high-rainfall zone, dry sowing is a risk management strategy that can be used to increase the chance of establishing crops before soils become too wet to sow and too cold for vigorous early crop growth. Dry sowing capitalises on sowing opportunities before the break of the season, allowing crops to begin germinating immediately following break-of-season rainfall.

As a consequence, dry-sown crops can be days, or sometimes weeks, ahead of those sown after the seasonal break, especially in large cropping programs and/or operations where there is limited seeding capacity. Dry-sown crops germinate when the ground is likely to be warmer, promoting early vigour and reducing the likelihood of crops becoming waterlogged. Earlier establishment also provides a longer growing season, ultimately enabling crops to set higher yield potential. With the general reliability of winter and spring rainfall in the high-rainfall zone and the ability to adjust in-crop management to the unfolding season, higher yield potential is usually translated into increased yields and greater profit potential.

An initiative of the GRDC's southern region high-rainfall zone grower network, the guide was released in February 2021. It covers the risks and rewards of dry sowing, provides consolidated research information on agronomic aspects to consider when dry sowing, and includes a few grower case studies illustrating their success with this practice.

https://grdc.com.au/maximising-sowing-opportunities-under-dry-soil-conditions-in-the-high-rainfall-zone

MAXIMISING CROP POTENTIAL IN A DRYING ENVIRONMENT

Growers have pooled their experience to assist others in their decision-making to maximise crop potential in drying environments through an initiative of the grower networks in the Geraldton and Kwinana East port zones of Western Australia.

Changing weather patterns in these zones, where the seeding window often experiences warmer and drier conditions than in the past, mean that growers are frequently attempting to sow and establish crops in less-than-favourable and potentially risky conditions. However, these changing climatic conditions are seeing more frequent summer rainfall events, often providing a reasonable level of subsoil moisture. This subsoil moisture provides more confidence in earlier seeding and many growers seed deeper to reach this moisture. Deep sowing to chase moisture can be critical in some seasons to getting crops established early.

Completed in 2019, the GRDC-invested project, managed by CussonsMedia, has drawn upon the regional experience of 17 growers in sowing in drying conditions and delivered a booklet that combines research relevant to the topic. Growers featured in the booklet outlines the risks associated with sowing in challenging conditions and their experiences with a range of tactics.

Selected tactics

- Analyse how deep the seed can be placed.
- Select cultivars with appropriate traits, for example, varieties with long coleoptiles, larger seeds and longer seasons.
- Consider practices that allow for accumulation of soil moisture at seeding; for example, furrow sowing, application of soil wetter and stubble retention on row sowing.
- Consider practices to improve establishment on water-repellent soils, for example, mouldboard ploughing or spading.
- Assess which equipment provides the best establishment.

https://grdc.com.au/maximising-crop-potential-in-a-drying-environment ☐

GRDC Codes CSP00187, ULA1703-004, GAPPBLG104, CWF1804-001, CMP1802-002, COR1912-003, CMP1806-003

SOWING SEEDS OF SUCCESS

KNOW YOUR MANAGEMENT

- Personnel
- Economic considerations
- Soil preparation and seeding systems
- Stubble and previous crop
- Fertiliser delivery
- Harvest systems and storage

KNOW YOUR SEED

- Phenology
- Early vigour
- Long coleoptile types
- Seed integrity
- Seed dressings
- Herbicide packages

KNOW YOUR SYSTEM

- Location
- Terrain
- Soil type and constraints
- Plant-available water
- Weather forecasts
- Climate and weather constraints

CONSIDER NEW RESEARCH

- New crop genetic traits
- New management practices for new traits
- New decision-support tools

INTEGRATE KNOWLEDGE

- Evaluate risks and rewards
- Refer to GRDC management guides for specific crop or growing conditions
- Develop your customised plan

Optimise crop performance for maximum productivity

REVIEW AND IMPROVE

GRDC