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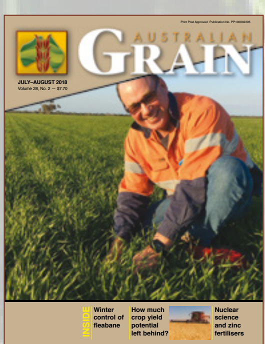
FRONT COVER



Neridup farmer Tony Meiklejohn is very happy with his Flinders barley crop. The Neridup region is one the better performing areas on the South Coast of WA this season. (PHOTO: Quenten Knight)

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Covering cropping systems of Southern NSW, Victoria, South Australia, Western Australia and Tasmania

Northern Focus

Covering Northern NSW and Queensland

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Editorial... Lloyd O'Connell

FIRST, the good news... grain prices are fantastic! You don't really need to be told the bad news bit so here's hoping Hughie has delivered in the past week or so and you're looking at a crop worth firing up the header for.

Pretty much all around the world, this year is shaping up to be a season where the record global grain stocks we keep hearing about, might just have a big chunk taken out of them. Having travelled through Western Canada and the Pacific North West of the US over the past month – and now northern Europe – I've had the chance to get a good look at crops in a large slab of the northern hemisphere bread basket. And like most of the Australian grainbelt, crops in the ground are not looking that flash. In many parts of northern Europe, there has been no decent rain for nearly two months and temperatures are at record highs.

These dry conditions have been telling on highly vegetative cereal crops where sowing rates of 140 to 160 kg per hectare are commonplace. If August rainfall in Europe and North America is anything less than good, we can expect yields in those two continents, to come under extreme pressure. A few 'local' agronomists I have spoken to suggest production in their particular regions could be down around 20 per cent if decent rain doesn't arrive soon. And this is in prime cropping areas where a 10 per cent drop from average yields is considered highly unusual and often financially devastating.

The agronomic and marketing task for Australian growers this season is pretty simple really – grow a decent crop and be handsomely rewarded for it. How hard can it be? The answer is 'very' if you're confronted with drought conditions.

Farming systems and soil moisture

Several articles and district reports in this issue point to the huge advantages of having farming systems where the focus is on maximising stored soil moisture – in other words – having money in the bank. Our conservation tillage strategies have enabled many crops in eastern Australia to 'hang on' in this very difficult season. Twenty years ago most crops would have run out of moisture by now.

This is testament to some excellent farming systems research in Australia over the past few decades as well as constantly improving varieties and agronomy. But this clever science is worthless without its practical application by equally clever and innovative Australian farmers making a go of it in what has to be one of the most hostile cropping environments you can get.

Here's hoping your tenacity and patience is rewarded with a wet turn in the season.

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In this issue...

Ramping up the battle against off-target herbicide drift

A MAJOR collaborative project aimed at reducing off-target herbicide drift has been ramped up, with new methodologies and technology to predict unfavourable weather conditions at its heart.

In a continuation of a Cotton Research Development Corporation and Grain Research Development Corporation project started in 2016 on drift mitigation in northern NSW and southern Queensland, monitoring towers to detect the most hazardous surface temperature inversions will be rolled out across the northern region in the near future. Planning is currently underway and the use of novel mobile monitoring technology is also being considered. These towers and technology attached to them could result in predicting long distance drift out to 36 hours ahead, as well as real-time updates for spray applicators.

Unintended herbicide damage is an issue affecting a number of broadacre and intensive agricultural industries. Off-target spray drift has been identified as a key RD&E priority by growers across a number of regions. As a result, in September 2016, this project to develop a spray drift hazard prediction system was commissioned. With CottonInfo Climate Technical Lead Jon Welsh, private consultant Graeme Tepper then set out to install a wireless sensor network across northern NSW and southern Queensland grain and cotton growing areas.

Monitoring towers were erected in the Lower Namoi Valley, Gwydir Valley, Border Rivers and Darling Downs regions in 2016. The equipment monitors wind and temperature at heights between two and 10 metres. These observations will be compared and calibrated with a high resolution meteorological/air pollution model to provide timely advice and warning of site specific hazardous conditions.

The photo below shows one of the research towers on the Boyle family farm 'Waiwera' Wee Waa. Realtime wind and temperature data is accessed by local landholders and spray operators during the research phase of the project.

Uplift of pesticides

When spray droplets are captured and transported in very stable and highly stratified inversions, these compounds can affect cotton and other crops and severely damage or kill sensitive vegetation. Figure 1 shows the potential for uplift of pesticides in a range of conditions and the impact of fine, medium and coarse droplet sizes. Vehicles travelling on outback gravel roads leaving a plume of dust can also provide an indication of atmospheric stability.

As Australia moves toward the adoption of 2,4–D and dicamba-tolerant varieties, growers themselves must be mindful of the effect spraying these type of chemicals in unfavourable conditions. Vineyards are highly sensitive to off-target phenoxy herbicide injury from applications on other crops in the vicinity.

An inversion monitoring tower near Wee Waa.

FIGURE 1: Potential for herbicide uplift

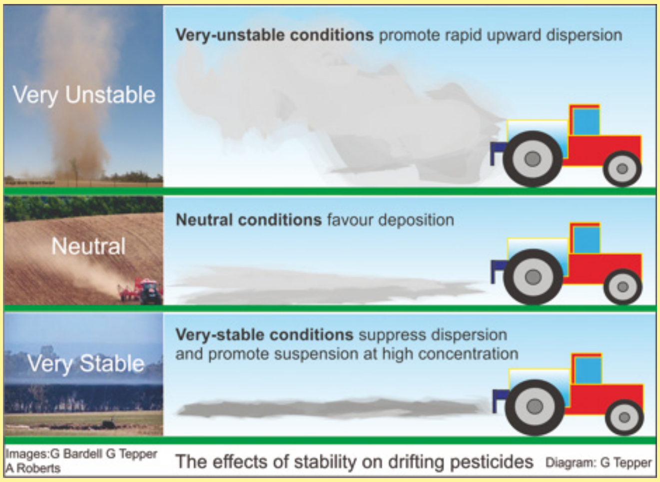
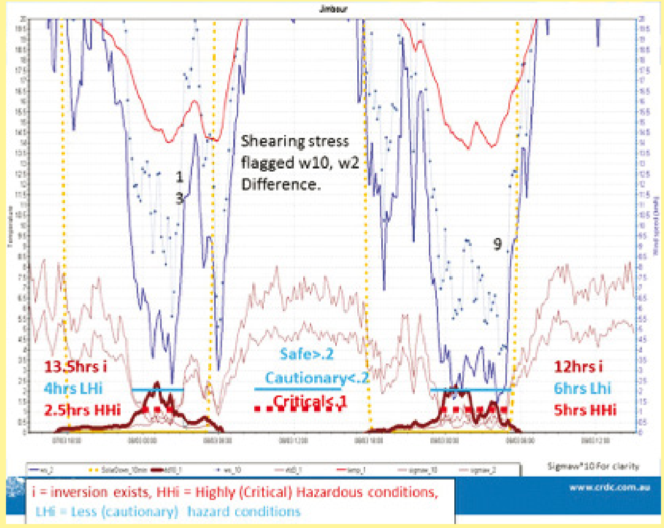


FIGURE 2: Inversion management at Jimbour



Vineyards are common in the southern cotton growing region around Griffith and Coleambally. Lucerne pasture and bee colonies are also highly susceptible to phenoxy.

The initial stages of the project involved collating and gathering site observations, followed by in-depth analysis of one second to 10-minute data to determine hazard variability and associated factors that correlate to hazardous conditions. Once observations are checked and a set of indices developed the decision criterion can discriminate hazardous inversions from non-hazardous inversions.

A sample of observational data in Figure 2 shows a thick maroon line (along the x-axis) representing an inversion index during night time over a 48-hour period at Jamie Grant's farm at Jimbour, Queensland.

The duration where the inversion becomes highly hazardous (HHi) varies from 2.5 hours in the first night to five hours during the second night. The research aims to create a dependable set of indices which can then be used for predictive modelling. The final objective of the project is to develop a communication strategy alerting users of current and forecast spraying conditions.

CRDC and GRDC have also compiled an inversion fact sheet, which is available at *www.grdc.com.au/GRDC-FS-sprayinversions* ■

Digging deep into 2,4–D resistance

By Dr Danica Goggin – Australian Herbicide Resistance Initiative

Synthetic auxins might be the oldest kids on the herbicide block but that doesn't mean they are well understood. In fact, there are very large knowledge gaps that researchers like AHRI's Danica Goggin are trying hard to fill in a bid to find ways to overcome resistance to this herbicide group in weeds such as wild radish.

Dr Danica Goggin.

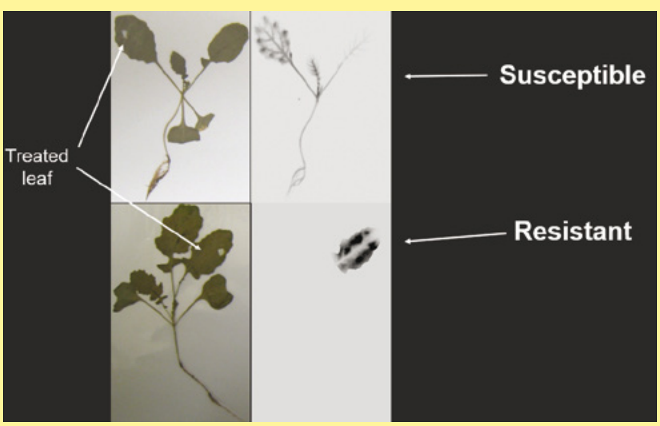
AS recently as 2016, international researchers published a paper explaining how synthetic auxin herbicides like 2,4–D actually work. As outlined in AHRI Insight – *How stuff works: 2,4–D, free radicals and monkeys* – we now know that synthetic auxin herbicides cause the over-expression of genes responsible for cell elongation, cell division and hormone production. Instead of enabling the plant to grow at an extraordinary rate, this over expression causes excessive production of free radicals, along with excessive ethylene production and closure of the plant's stomata – both of which also cause additional production of free radicals.

This usually results in unusual plant growth and eventual plant death following the application of 2,4–D or dicamba.

How does wild radish survive?

In a plant species such as wild radish that is known to be susceptible to this mode of action, how does herbicide resistance evolve?

FIGURE 1: Radio labelled C14 herbicide auto radiogrph 24 hours after application



To find out, Danica originally studied one susceptible and two known resistant populations of wild radish, using radioactive 2,4–D to determine whether resistant and susceptible plants translocated the herbicide differently.

The results were stark and Danica thought she had solved the puzzle! It was clear from this experiment that the resistant wild radish plants were able to prevent the herbicide from moving out of the leaves that it was applied to, keeping the vulnerable growing points safe and allowing the rest of the plant to grow as normal and ultimately 'survive' the herbicide application.

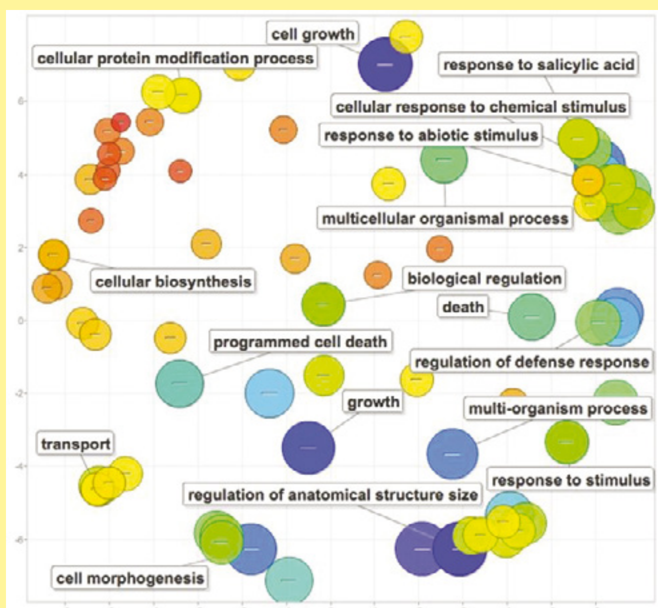
Digging deeper proved that the answer is more complex

Having identified a very plausible resistance mechanism in two wild radish populations, Danica went on to test the translocation theory in another nine 2,4–D resistant populations of wild radish from WA.

Danica characterised the resistance profile of the 11 resistant populations to find that resistance to 2,4–D and dicamba appears to be capped. This conclusion is based on results showing that selection with 2,4–D did not increase the level of resistance and that progeny of paired crosses were no more resistant than the parents.

Characterisation of the 11 resistant populations also showed that while all 2,4–D resistant populations were also resistant to dicamba, the level of resistance to the two herbicides varied,

FIGURE 2: This diagram shows the biological processes that went up in the resistant plants but down in the susceptible plants in response to 2,4–D. Bigger and darker blue indicates increased importance.



Wild radish uses enhanced, irreversible metabolism as a resistance mechanism for 2,4–D.

suggesting that there is no consistent cross resistance to these two auxinic herbicides within a population.

Conducting the same experiment with the radioactive 2,4–D applied to the leaves, she also found that translocation varied enormously both between and within resistant populations. In fact, several of the resistant populations translocated 2,4–D just as efficiently as susceptible populations.

This proved that wild radish has other, more complex mechanisms at its disposal to avoid the effects of excessive free radical production following exposure to phenoxy herbicides.

Auxin signalling and defence genes

On further investigation Danica demonstrated that there is nothing to indicate that wild radish uses enhanced, irreversible metabolism as a resistance mechanism for 2,4–D. Having ruled this mechanism out, all the evidence is now pointing toward mechanisms involving auxin signalling and plant defence genes.

Preliminary studies suggest that gene IAA30 may contribute to the ability of a wild radish population to grow in the presence of 2,4–D. The association of this gene with 2,4–D resistance was more clearly observed in the root elongation experiments that were conducted in a controlled (indoor) environment compared to the foliar experiments that were conducted outdoors.

This suggests that environmental conditions may also play a part in determining which mechanisms provide the best defence for wild radish populations in different geographic areas.

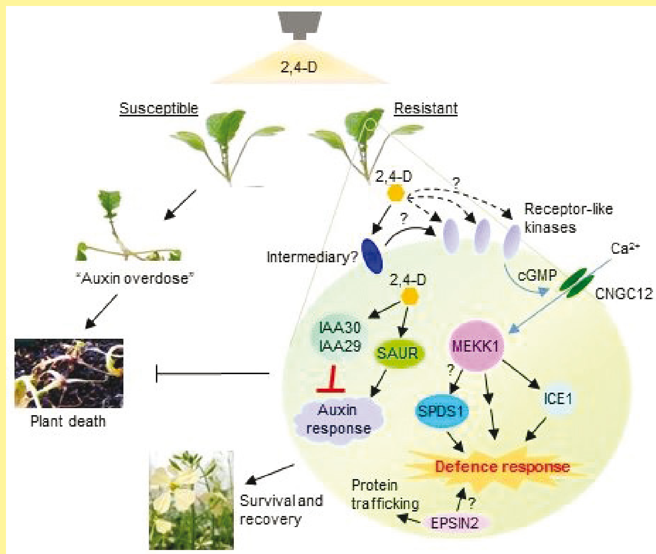
There is additional evidence that a component of the plant stress–response system is already 'switched on' in 2,4–D-resistant plants, even before the herbicide is applied.

Delving right down to cell membrane level

Given the variety of auxin responses within and between the 11 resistant populations, Danica is sure that there is more than one signalling protein involved in 2,4–D resistance in wild radish.

Given the high genetic variability found in wild radish populations, there is good reason to suspect that repeated use of 2,4–D could alter the sequence or expression of different co-receptor components in different populations, affecting not only their resistance to various auxins, but also the fitness of the survivors.

FIGURE 3: This diagram groups all the genes that went up in resistant plants but down in susceptible plants – the story of resistance



Resistance is still resistance and requires diverse management tactics

Evolved resistance to 2,4–D in wild radish is now believed to be conferred by a variety of auxin signalling defects that all result in resistance levels of four to eight times the recommended field rate. While some resistant populations appear to suffer a fitness penalty, this is not always the case.

Further research will investigate strategic mixes of 2,4–D and synergists to help increase the efficacy of 2,4–D in resistant populations. Any herbicide treatments will rely heavily on complementary strong crop competition and harvest weed seed control.

Any synthetic auxin-tolerant corn, soybean and cotton cultivars introduced into Australia will potentially increase selection pressure on 2,4–D and will require careful stewardship to manage herbicide resistance. ■

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Why is winter the best time to control fleabane?

CONTROLLING the weed, flaxleaf fleabane, continues to be a challenge for grain growers across Australia, but research has proved targeting smaller plants during the winter fallow or winter crop phase is key to an effective management strategy.

Six tips for effective fleabane control:

- Management in winter (crop or fallow) can be more effective than summer;
- Increase crop competition with narrow row spacing and or higher planting rates;
- Consider strategic cultivation for seed burial or for salvage management;
- Utilise residual chemistry where possible and control 'escapes';
- Including 2,4–D or picloram/2,4–D in the first application is critical for consistent double-knock control; and,
- Control escapes and prevent weed seed set.

An investment by the GRDC into trials conducted by the Northern Grower Alliance (NGA) found fleabane management improved dramatically when grower focus shifted from controlling the weeds in summer fallow to using fleabane control tactics during winter cropping at pre-plant, in-crop and post-harvest stages or in winter fallows.

NGA's Richard Daniel said flaxleaf fleabane (*Conyza bonariensis*) control had become an increasingly complex and expensive weed for grain growers, as a result of the industry's heavy reliance on glyphosate and due to the wide spread implementation of no-till or reduced tillage farming systems.

"For nearly two decades, fleabane has been a major weed management issue in the northern cropping region," Richard said.

"Factors that make fleabane a major weed includes the fact it is a prolific seed producer, with each plant producing up to 110,000 seeds – it is windborne and occurs in fallows, summer and winter crops and pastures; is difficult to control with herbicides with some populations glyphosate resistant; and, the weed can emerge throughout the year."

Richard said one of the key issues leading to fleabane being such a problem – particularly in the northern region – was that knock-down control of large plants in the summer fallow was expensive and delivered variable results.

"Glyphosate resistance has been confirmed in fleabane, but resistance status is variable with many samples from non-cropping areas still well controlled by glyphosate, whilst increased levels of resistance are found in fleabane in reduced tillage cropping situations."

Research has shown flaxleaf fleabane management is often more effective during winter, both in-crop or fallow.

So what are the control and management options for growers?

Monitoring

Monitoring is a key part of weed management but it is particularly important for fleabane.

Germination of fleabane can occur all year round when wet conditions and temperatures of 10–25°C (optimal 20°C) occur. These conditions are more prevalent in autumn and spring, with fleabane often emerging with winter crops or during the winter fallow in the northern regions.

Knowing when new germinations of fleabane occur in an attempt to target control of small plants is critical as it is more effective than on larger plants. As fleabane grows its stem becomes harder and it develops a strong root system. The harder stems and large root system of larger plants enable the plants to regrow more effectively following herbicide applications.

Actively managing fleabane during winter in fallows or in-crop is more effective than summer as emerging seedlings are slower to grow.

This slower growth allows more time to apply effective herbicide control options. It is also very important to manage winter germinating fleabane prior to spring as fleabane grows rapidly as the season warms and rainfall increases in northern regions leading into summer.

While paddock control is critical so is monitoring fencelines and channels. As fleabane is wind dispersed, continual replenishment of the seedbank can occur if these areas are ignored.

Crop competition

Managing fleabane in-crop is a useful tool as fleabane does not establish well in low light conditions. Light conditions can be manipulated by planting crops at higher density and on narrower row spacing. Narrow rows and higher plant populations are primarily used when planting winter crops compared with the wider summer row spacing configurations in the northern region.

It is important to monitor crops as fleabane can survive at small growth stages under a competitive crop and be easily overlooked. But once the crop is removed the fleabane which

is present can develop quickly and the opportunity for effective control can be missed without regular monitoring.

Cultivation

Fleabane is a weed that proliferates in no-till farming systems. This is partly because many populations of fleabane present under this system now have a level of resistance to glyphosate but also due to the weed's ecology. Due to its small seed size, fleabane will only emerge from the top one centimetre of soil.

Cultivation to bury seed to a depth deeper than one centimetre can be an effective tool to manage fleabane populations. Although this approach can dramatically reduce the number of fleabane which emerge, it also increases the longevity of the seed (ie. seed that is buried will not germinate but it will remain viable for a longer period).

Occasional cultivation can be a useful tool for seed bank management but this is not a technique to utilise frequently as it will simply return viable seeds to the soil surface.

Cultivation may also be a viable option for salvage management. Where 'blow outs' occur this may be the only economic option to effectively control large flowering plants.

Herbicide strategies

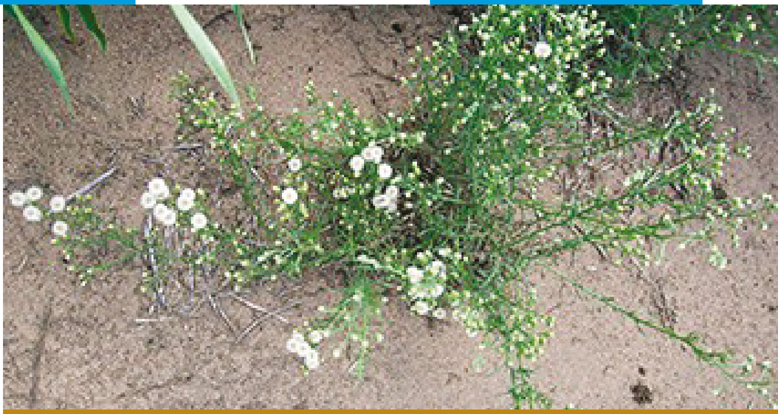
Fleabane management improved dramatically when growers switched from trying to control large plants in summer fallow to targeting small weeds still in the rosette stage during the winter crop phase.

There are three key stages where herbicides can be useful to manage fleabane populations:

- Pre-plant;
- In-crop; and,
- Post-harvest.

Germination of fleabane can occur all year round when wet conditions and temperatures of 10–25°C occur. This means fleabane often emerges with winter crops or during the winter fallow in the northern regions.

Due to its small seed size, fleabane will only emerge from the top one cm of soil.



There are three key stages where herbicides can be useful to manage fleabane populations – pre-plant, in-crop and post-harvest.

Residual herbicides (fallow and in-crop)

One of the most effective strategies to manage fleabane is the use of residual herbicides in fallow or in-crop. Trials have consistently shown good levels of efficacy from a range of residual herbicides commonly used in sorghum, cotton, chickpeas and winter cereals.

Residual control only

- Balance (750 g/kg isoxaflutole) at 100 g/ha.
- Terbyne Xtreme (875 g/kg terbuthylazine) at 0.86–1.2 kg/ha.

Residual (and knock-down) in fallow

- In Fallow, at least three months prior to planting sorghum: FallowBoss Tordon (300 g/L 2,4–D + 75 g/L picloram + 7.5 g/L aminopyralid) at 700 mL/ha + atrazine (600 g ai/L) at 3–5 L/ha.
- Trial work to date has indicated that increasing water volumes from 50–100 L/ha may help the consistency of residual control with application timing to ensure good herbicide/soil contact also important.

Knock-down herbicides in fallow

- Group I herbicides have been the key products for fallow management of fleabane with 2,4–D amine and picloram/2,4–D products the most consistent herbicides evaluated. Despite glyphosate alone generally giving poor control of fleabane, trial work has consistently shown a benefit from tank mixing glyphosate with 2,4–D and picloram/2,4–D products in the first application.
- Amicide Advance (700 g/L 2,4–D) at 0.65–1.1 L/ha + Weedmaster DST (470 g/L glyphosate) at a minimum of 1.4 L/ha. Follow with a double-knock of Nuquat (250 g/L paraquat) at 1.6–2.0 L/ha when weeds are from stem elongation to flowering.
- FallowBoss Tordon at 700 mL/ha + glyphosate (450 g/L) at 1.6–2.4 L/ha (can also be followed 5–7 days later with Spray.Seed at 1.6 L/ha as a double-knock) – prior to winter cereals or sorghum.
- Tordon 75 D (2,4–D + picloram) at 0.7 L/ha + glyphosate.
- Sharpen (700 g/kg saflufenacil) at 17–34 g/ha + 1 per cent Hasten spray oil.

Post emergent herbicides in winter cereals

- Amicide Advance at 1.5 L/ha.
- FallowBoss Tordon at 300 mL/ha.
- Hotshot (10 g/L aminopyralid + 140 g/L fluroxypyr) at 750 mL/ha + either metsulfuron (600 g ai/kg) at 5 g/ha or MCPA LVE (600 g ai/L) at 580 mL/ha (refer to label for appropriate growth stages).
- Lontrel Advanced (600 g/l clopyralid) at 150 mL/ha.
- Paradigm (200 g/kg halauxifen Group I + 200 g/kg florasulam Group B) at 25 g/ha + MCPA LVE (600 g ai/L) at 300–600 mL/ha.

Double-knock control

The use of a double-knock strategy is recommended for the control of fleabane in fallow systems as weed size increases and herbicide efficacy generally reduces. The most consistent and effective double-knock control of fleabane has involved including 2,4–D or picloram/2,4–D products + glyphosate in the first application followed by paraquat or Sharpen as the second. Glyphosate alone followed by paraquat will result in high levels of leaf desiccation but plants will generally recover.

Trial work conducted by the NGA has shown regrowth observed following the application of Sharpen as the second knock to be more consistent than other group G herbicides or paraquat when applied at the same timing.

Timing of the second application in fleabane is approximately 7–14 days after the first application. But the interval to the second knock appears quite flexible. Increased efficacy is obtained when fleabane is actively growing or if rosette stages can be targeted. Although complete control can be obtained in some situations, control levels frequently only reached approximately 70–80 per cent, particularly when targeting large flowering fleabane under moisture stressed conditions.

The high cost of fallow double-knock approaches, and inconsistency in the control level of large mature plants, is a key reason that proactive fleabane management should be focussed at earlier growth stages.

For more information contact Richard Daniel, NGA, mob: 0428 657 782, E: richard.daniel@nga.org.au

This research was presented at the July 2018 GRDC northern region Crop Updates

An old tractorman's recollections

By Ian M. Johnston

The 'good old days'

I have discovered it certainly is not 'cool' for an ageing tractorman to talk about 'the good old days'. To youngsters (and I mean anyone under 50 years of age) these distant halcyon times are as remote to their thinking as Victa lawnmowers, milk bottles and Bex powders.

I have observed that even my grown-up grandchildren exchange meaningful glances, accompanied by pained expressions, when I have the temerity to raise the subject of my glorious boyhood days in Scotland.

When I explain that when I arrived at age 17 in the Antipodes in 1952, Australia enjoyed the highest living standard, coupled to the lowest cost of living, in the western world, they exhibit only polite interest.

Sir Robert Menzies, possibly the last real statesman with which Australia has been blessed, is frequently lampooned by some of the more inane contemporary radio jocks as being an autocratic royalist hangover from the Colonial era. Yet we of The Bush who were around at the time, knew him to be an indulgent father figure under whose leadership we all prospered in a secure nation, boasting full employment and a sane selective, but

A 1951 International Farmall M in rowcrop configuration restored by the author. Note the tricycle wheels.

This International McCormick W6 is basically the same tractor as the Farmall M but classified as a general purpose unit and enjoyed volume sales.

This well presented Fordson E27N, was photographed during a parade at Morpeth NSW. In the late 1940s and early 1950s this was the top selling tractor in Australia, largely on account of its availability and price.

beneficial, migration policy. I feel privileged to have been able to experience these Golden Years.

Agriculture today is dominated by high tech machinery and scientifically determined chemicals and procedures. Whilst the benefits of these unprecedented developments are patently obvious, they have fast forwarded us into a less spiritual and meaningful lifestyle than was experienced on farms prior to the 1960s. Global warming, indecipherable punitive government legislation, and oft ill-considered one sided free trade agreements, plus alarming electricity charges, were thankfully unknown in these far off but sublime days.

The 1950s

Certainly, in the 1950s agriculture was more physically demanding. Bulk grain handling had not yet arrived. Consequently farmers were destined to the wearisome burden of lumping three bushel (54.4 kg) sacks of wheat on their shoulders which, if a crop yielded say 500 tonnes, would equate to a daunting number of individual sacks. (Phew!)

And, if you are still with me, fuel was routinely delivered to farms in 44 gallon (200 litre) drums, each of which weighed around 204 kg and had to be bodily handled. Hard work indeed.

Air conditioned tractor cabs had not been contemplated. Country roads, in the majority remained torturous gravel obstacles, guaranteed to destroy vehicle suspensions and loosen nuts and bolts.

If a bank manager was reluctant to approve a hire purchase deal on one of the new Holden utes, then a farmer was obliged to consider perhaps a totally unsuitable but cheaper Austin A40 ute, or battle on with his pre-war Chev.

But in the majority, farmers and graziers were a moderately prosperous lot. Largely due to the Korean conflict, wool was worth a pound per pound. Sales of beef and grain, mainly to Great Britain, earned good export currency. Farm inputs were reasonably low in relative terms and returns on the whole were adequate. Of course primary producers of the day would never have conceded this point. (Well after all, it is a farmer's undisputed time honoured rite to complain not only about the weather, but also about everything.)

Rural machinery dealers in the 1950s were on a roll. Draught horses had long since been pensioned off into the back paddock. There was a constant demand for new tractors, most makes of which were in very short supply. Frequently an impatient tractor buyer was obliged to wait for months until his new machine became available.

For example a grain grower who had placed an order for the popular International McCormick W6, would quite likely be encouraged by the tractor agent to instead accept delivery of the more readily available International Farmall M. Basically they were the same tractor except that the Farmall was configured as a row crop version. But if the Farmall was fitted with a full width front axle, it in fact, proved to be a superior ploughing and cultivating tractor compared to the W6.

Fordson Major tractors were the exception to the shortage situation, thanks to Britain's vigorous export policy. The Major was very much a no frills tractor incorporating a degree of outdated technology, but never the less was capable of performing capably alongside its more modern American counterparts. Plus its relatively low price rendered it the tractor of choice by the banks responsible for administering the Federal Government Soldier's Settlement Scheme – a program designed to assist war veterans in establishing themselves as primary producers.

In 1953–54 a new look Fordson Major was unveiled and proved to be an outstanding tractor for the period, evidenced by the number remaining in service today.

It had to happen!

Regrettably, but perhaps predictably, the demand for agricultural tractors encouraged the introduction into Australia of a range of questionably designed lightweight units, mainly originating from England.

These tractors had obviously been rushed onto the market by unprincipled manufacturers with little or no prior experience of farm mechanisation, in an endeavour to 'cash in' on the tractor shortage situation. These inept and potentially hazardous machines included such brands as Newman, OTA and President, and were offered as alternatives to the thoroughly proven and well engineered Ferguson, Fordson Dexta and David Brown tractors.

The manufacturers of tillage and harvesting machinery were also enjoying buoyant sales. The more powerful tractors streaming into the market resulted in the converted horse implements being abandoned and replaced by wider and more robust custom designed equipment.

Accordingly implement manufacturers such as David Shearer of Burwood, NSW; Mitchell and Co of West Footscray, Victoria;

The Fordson Farm Major replaced the E27N in 1953/4 and was a far superior all round tractor. The unit pictured, magnificently restored by John Grunow, is equipped with steel wheels, which were incorrectly assumed to obtain a better drawbar pull than conventional pneumatic tyres.

and, Rawling and Co of Coburg, Victoria were often compelled to work two shifts each day, in an endeavour to keep abreast of demands.

Machinery dealers in country towns were hard put to maintain the supply of electric lighting plants, fencing material, irrigation equipment, milking machines and cream separators, and of course the revolutionary Victa lawn mowers. Even traditional wool firms, including Farmers and Graziers, Grazcos, Dangar Gedye and Malloch, and Goldsbrough Mort diversified into farm machinery.

Tractor reps

Tractor company representatives were in their job primarily because of their interest and knowledge of farming and in particular – tractors. In my opinion (based on personal experience) it was a plumb job. We were trusted free agents and in my case, often away from head office for several weeks, while the various marketing and dealer support responsibilities were carried out capably, without being shackled to head office by that modern day umbilical cord – the mobile phone.

Then there were the perks, including an expense account, a company car, and the opportunity to travel around the Bush at a time before speed limits were introduced on country roads. This did not mean we all drove like maniacs, but we had the luxury of being able to concentrate upon what was through the windscreen rather than what was on the speedo. One knew intuitively what represented a safe and comfortable speed for our vehicle.

Should there be any young readers who have managed to stay the distance thus far, I ask them to note the following:

Way back in the prehistoric 1950s, at the Lanz Bulldog headquarters in Sydney, providing a spare parts order was received by letter, telegram or telephone by 4.30 pm, the requested part would be sourced from the shelf, packaged and delivered to Central Railway Station by 6 pm.

There it would be sorted and placed in the guard's van of the appropriate steam train (such as The Northwest Mail, The Riverina Express, and so on) which would thunder through the night to such distant places as Moombooldool, Gurley, Weethalle or perhaps Burren Junction. The train would pause at even the most isolated unmanned siding, enabling the guard to deposit the parcel on the platform.

Accordingly, the farmer who had suffered a breakdown with his tractor the previous afternoon, would be able to collect his spare part by breakfast the following day.

I question that in this stressful computer driven modern era, there would be a tractor firm and courier service capable of matching that efficiency. And that was in the days of steam trains!

My current observations – which I admit are unashamedly biased – are that tractor company reps (sorry, area supervisors) with their obligatory laptops, sales performance graphs and polished shoes, pale at the thought that one of their dealers might require them to actually visit an actual farm! I mean, farms are either terribly dusty places or horribly muddy places and, well, one has to think of one's shoes!

Okay, I know when to quit. They are waiting to put me back in my cage. But mark my words, back in the good old days… ■

IAN'S MYSTERY TRACTOR QUIZ

Question: Can you identify this extraordinary light weight tractor?

Clue: Better forgotten!

Degree of difficulty: Difficult!

Answer: See page 48.

Stripe rust pathotype discovery underlines need for vigilance

GRAIN growers are encouraged to closely monitor their wheat crops for stripe rust this season, following the detection of a new pathotype of the wheat stripe rust pathogen.

It is the first time since 2010 that a new pathotype of the wheat stripe rust pathogen, *Puccinia striiformis f. sp. tritici*, has been detected in Australia.

Australian Cereal Rust Control Program researchers at the University of Sydney's Plant Breeding Institute confirmed the new pathotype in samples received from Horsham (Wimmera) and Normanville (Mallee) in Victoria in late 2017 through the Australian Cereal Rust Survey, a Grains Research and Development Corporation (GRDC) investment.

They say the new pathotype is the first record of virulence for the Yr33 resistance gene in Australia and that its impact on wheat varieties will be better understood after the 2018 cropping season.

Dr Grant Hollaway, a Horsham-based senior plant pathologist with Agriculture Victoria, is encouraging growers and advisers to provide samples of stripe rust found in this year's crops to the Plant Breeding Institute for analysis.

"Stripe rust found on any variety of wheat should be submitted for pathotype analysis," Grant says.

"Having samples analysed will not only inform individual growers about the stripe rust pathotypes in their crops, which in turn assists with proactive disease management, but analysis enables the broader industry to be on the front foot with potential rust outbreaks and the detection of new pathotype mutations and incursions as soon as they occur."

Grant says early greenhouse data from the Plant Breeding Institute and data from the GRDC's National Variety Trials (NVT) at Horsham last year indicate that the varieties Coolah, LRPB Flanker, Axe, B53, Buchanan, Cobalt, EGA Gregory, Forrest, Gauntlet,

Dr Grant Hollaway, a Horsham-based senior plant pathologist with Agriculture Victoria, is encouraging growers and advisers to provide samples of stripe rust found in this year's crops to the Plant Breeding Institute for analysis. (PHOTO: GRDC)

Stripe rust in wheat.

Grenade CL Plus, Mitch, Steel, Trojan, Viking and Zen should be monitored closely for stripe rust.

Stripe rust first to appear

Of the three wheat rust diseases – stripe, stem and leaf – stripe rust is most suited to cooler temperatures that occur during late autumn and early spring. It is therefore usually the first rust disease to appear in a cropping cycle.

Stripe rust reproduces and spreads by spores, which are wind-blown and can travel hundreds of kilometres. The severity of stripe rust within a crop depends on varietal susceptibility, the nitrogen status of the crop, moisture and temperature.

Where very susceptible varieties of wheat are infected with stripe rust, resulting losses can be as high as 80 per cent.

Experts say the most powerful tool available to growers to minimise the impact of the disease is resistant varieties. Fungicides for controlling stripe rust should be regarded as a support and not a substitute for growing resistant varieties.

Where fungicides are used as part of a management strategy, growers are encouraged to employ effective fungicide resistance management practices. Knowing previous and anticipated fungicide modes of actions (MoA) used throughout the growing season is essential in resistance management.

Growers should monitor crops to detect infection at the earliest stage possible.

For more information on prevention and management of stripe rust, visit the GRDC-supported Rust Bust resource hub at *https://rustbust.com.au*.

The GRDC's Stripe Rust In Wheat Tips and Tactics publication, which can be viewed and downloaded via goo.gl/oKN1cE, also contains practical information for growers and advisers. ■

SEND IN YOUR SAMPLES

Infected plant samples can be mailed in paper envelopes (do not use plastic wrapping or plastic-lined packages) and if possible, include the latitude and longitude of the sample location. Direct samples to:

University of Sydney
Australian Cereal Rust Survey
Reply Paid 88076, NARELLAN NSW 2567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The power to predict sclerotinia before it appears.
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YOUR 24/7 FUNGAL DISEASE WARNING SYSTEM
Run CropAlert for Blackleg
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Postcode
Have you applied an effective blackleg fungicidal seed dressing?
Yes No
Have you applied Flutriafol?
Yes No
CropAlert is a free, online early warning system that takes the guesswork out of spray application timing for fungal diseases in canola.
Go to **cropalert.com.au** and enter your postcode to understand the potential risk of a sclerotinia outbreak based on your location and to determine the best fungicide application strategy.
LOW RISK
Current weather conditions are considered to create a low possibility of a sclerotinia outbreak.
MEDIUM RISK
Current weather conditions are considered to create a medium possibility of a sclerotinia outbreak - particularly in low-lying or slow drying areas of the paddock.
HIGH RISK
Current weather conditions are considered to create a high possibility of a sclerotinia outbreak - particularly in low-lying or slow drying areas of the paddock.
Aviator Xpro
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Technical Enquiries 1800 804 479. Prosaro®, Aviator® and Xpro® are registered trademarks of the Bayer Group.
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Yield gaps – how much yield potential is left behind?

By Zvi Hochman[1], Airong Zheng[2], Marta Monjardino[3], Heidi Horan[1], David Gobbett[3] and Franz Waldner[1]

AT A GLANCE…

- Average wheat yields between 2000 and 2014 for the Liverpool Plains (2.6 tonnes per hectare) are 2.3 tonnes per hectare below the water-limited yield potential for dryland wheat. On average, this is costing growers $575 per hectare.
- A national survey of 232 growers included 45 respondents from the Liverpool Plains. Of the 45 Liverpool Plains respondents, only three fell into the lower half of the national relative yield group, confirming the high standing of growers from the Liverpool Plains.
- At Quirindi, applying 45 kg N per hectare resulted in a 36 per cent yield gap. Failure to control weeds during the summer fallow could account for up to 14 per cent yield loss and low seedling density for a nine per cent yield loss. Even at 90 kg N per hectare, a 14 per cent yield gap remains.
- An emerging practice of sowing early (April 26) with a late maturing variety and flexible N fertiliser application is expected to have the potential to increase the yield frontier by 19 per cent.
- This emerging best practice has the potential to increase financial returns in the Liverpool Plains from about $1260 per hectare to about $1930 per hectare. While proven in other regions, this emerging practice defies local convention and deserves to be investigated in local fields by growers, consultants and researchers.

IT is well known that Australia's grain growers are among the best in the world. But there is a lot of variability between farms in terms of yields produced. This is the case even in the more favourable cropping areas such as the Liverpool Plains of NSW.

So why is the yield gap in the Liverpool Plains 47 per cent of the yield potential? Between 2000 and 2014 average annual wheat yield was 2.6 tonnes per hectare while the water–limited yield potential was 4.9 tonnes per hectare.

This means that there is a yield gap of 2.3 tonnes per hectare or $575 per hectare (at $250 per tonne) that is not realised.

We ask why such a substantial yield gap exists and why some growers achieve their yield potential while others do not. We examined this in three different ways:

- A grower survey that investigated how farms with large yield gaps differ from farms with low yield gaps by relating yield gaps to grower characteristics, farm characteristics and farm management practices.
- A simulation study that examined the impact of sub-optimal management practices at 50 weather stations spanning the Australian grain zone.
- An economic (risk-adjusted profit) analysis that explored the results from the simulation study.

National grower survey

The national survey aimed to comprehensively examine farm management practices as well as farm and farmer characteristics that may contribute to the wheat yield gaps in Australia. Using the GRDC customer relation database we conducted telephone interviews of 232 wheat producers from 14 contrasting local areas (roughly equivalent to a shire) in the Australian grain zone (Figure 1).

The relative yield of wheat (per cent of water-limited yield potential) is indicated by the red-yellow colour gradient. The white borders shows the GRDC sub-regions of the Australian grain zone The average participants' age was 51 years old (ranging from 20 to 89 years in age), with an average of 31 years of experience in growing crops. Among the participants, there were only 10 female producers (four per cent).

Seventeen participants (seven per cent) identified as corporate farms while the rest identified as family farms. Thirty-three participants (14 per cent) owned or managed other farms in locations more than 50 km apart. The average cropping land area was 2149 hectares.

The total area cropped by participants was 0.5 million hectares, or about two per cent of Australia's cropped area.

Each farm's yield gap was calculated by comparing their reported wheat yield in 2016 against the water-limited yield potential, simulated under best management practices for their three dominant soil types, using weather data from all stations in their postcode. All farms were ranked according to their relative yields.

The median relative yield was 64 per cent and this value was used as a cut-off for dividing the respondents into two equal sized groups – the high relative yield group and the low relative yield group.

An average yield gap of 49 per cent exists between these two groups.

FIGURE 1: Locations of surveyed local statistical areas with contrasting average relative yields

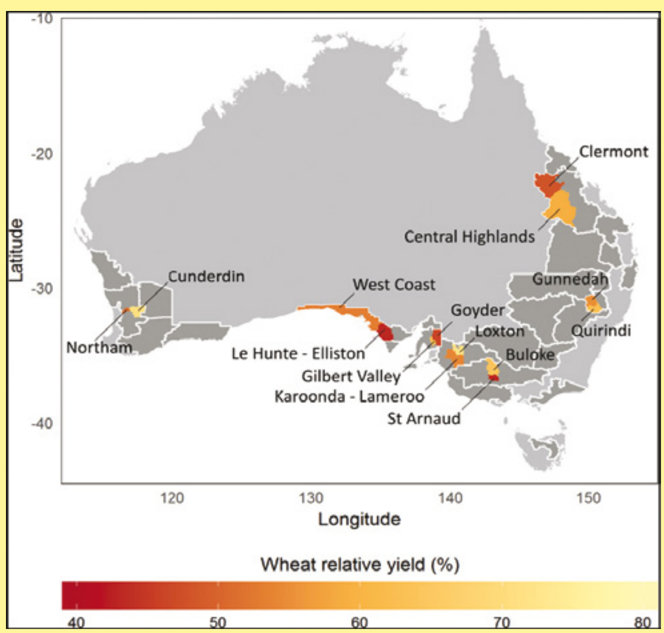
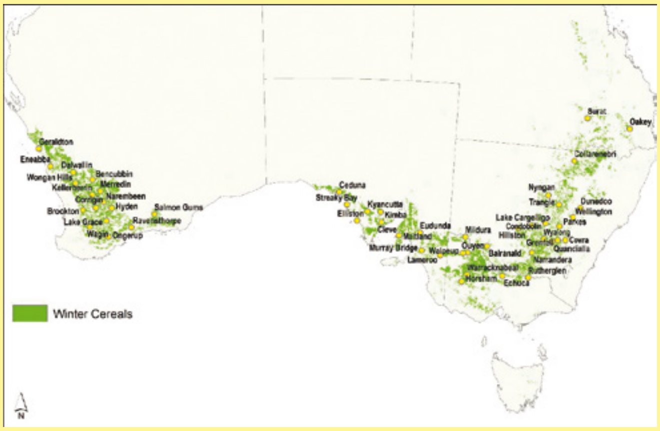


FIGURE 2: Fifty high quality weather stations and their distribution in Australia's cropping zone



All survey responses were analysed to determine if there were significant differences in how the high and low relative yield groups responded.

The results revealed significant differences between farms with smaller yield gaps and those with greater yield gaps in relation to farming management, farm characteristics, and grower characteristics.

Australian farms with smaller yield gaps (high relative yield) are more likely to be smaller holdings (mean size of 1886 hectares) growing less wheat on more favourable soil types.

These growers are more likely to apply considerably more N fertiliser to their wheat crop (Table 1), to grow a greater variety of crops, to soil-test a greater proportion of their fields, to have less area affected by herbicide-resistant weeds, and to be early adopters of new technology.

They are less likely to grow wheat following either cereal crops or a pasture (Table 1). They are more likely to use and trust a fee-for-service agronomist, and to have a university education.

TABLE 1: Preceding crops before wheat crop and average nitrogen applied

	% of farms		Nitrogen application	
	High relative yield group (%)	Low relative yield group (%)	High relative yield group M (SD) (kg N/ha)	Low relative yield group M (SD) (kg N/ha)
A cereal crop	37***	65***	79 (51)*	57 (42)*
A canola crop	44	48	116 (146)**	58 (45)**
A pulse crop	62	53	75 (61)***	42 (34)***
A pasture phase	22***	44***	64 (58)**	30 (33)**

Note: The asterisk symbol indicates the statistical significance level of the differences between high and low relative yield groups, * $p < .05$, ** $p < .01$, *** $p < .001$.
D = Standard Deviation.

Farms from the Liverpool Plains sub-region (Gunnedah and Quirindi) were massively overrepresented in the high relative yields group with only three of the 45 respondents falling into the low relative yield (high yield gap) group. But the large gap between highest and lowest yields reported for 2016 in the Liverpool Plains sub-region indicate that a significant yield gap still exists.

Even in relatively favourable regions, such as the Liverpool Plains, there are large gaps in crop yield potential.

Simulation study

We conducted a simulation study on the impact of sub-optimal management practices at 50 weather stations that span the whole grain zone (Figure 2). A benchmark "best management practice" was defined by:

- Zero tillage with clean fallows and stubble retained;
- A non-limiting supply of nitrogen to the crop; sowing at 150 plants/m² was activated between April 26 and July 15 when there were 30 mm of plant available water (PAW); and,
- A 15 mm cumulative rain event occurred over any three consecutive days.

Table 2 shows the average national impact, relative to water-

TABLE 2: Impacts of management factors (treatments 2 to 7) and of frost and heat stress (treatments 9 and 10) on water-limited yield potential (Yw)

Treatment number	Treatment	Mean (t/ha)	SD (t/ha)	CV (%)	Y% (%)
1	Yw (water-limited yield)	4.28	0.92	21	100
2	Seedling density (50 plants/m²)	3.78	1.10	29	88
3	Late sowing (2 week delay)	3.97	1.04	26	93
4	Summer weeds	3.18	1.17	37	74
5	Conventional tillage	2.86	1.08	38	67
6	N fertiliser (45 kg N/ha)	2.57	0.44	17	60
7	N Fertilizer (90 kg N/ha)	3.30	0.96	29	77
9	Frost and Heat	3.15	1.00	32	74
10	Frost and Heat 2 (moderate impact)	3.60	0.95	26	84

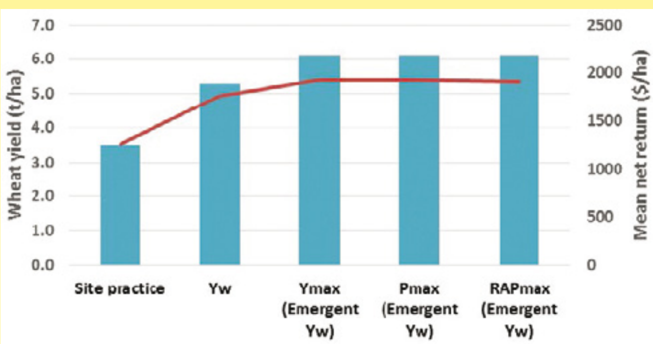
There is room for closing the yield gap by adopting non-limiting fertiliser management.

limited yield potential, of selected sub-optimal management practices.

Nationally, the average rate of N applied to grain crops is 45 kg N per hectare. This one practice is sufficient to account for a 40 per cent yield gap. Even at double that rate, a 23 per cent yield gap remains.

Frost and heat stress accounted for yield losses of between 16 and 25 per cent of water limited yield potential (Yw).

FIGURE 3: Wheat yield (tonnes per hectare) (blue bars) and net returns ($/ha) (red line) achieved by average site practice, water-limited yield potential (Yw) and yield-maximizing (Ymax), profit-maximizing (Pmax) and risk-adjusted profit maximizing (RAPmax) practices that are all emergent Yw treatments at a high yielding site (Dunedoo, NSW)



Failure to control weeds during the summer fallow could account for up to a 26 per cent yield loss; delayed sowing accounted for a seven per cent yield loss and low seedling density for an eight per cent yield loss.

Any grower who is still practising conventional tillage could be missing out on 33 per cent of their yield potential.

Other factors that contribute to the yield gap, not included in simulations, include biotic stresses such as plant diseases, insects and other pests, in-crop weeds and extreme weather events (eg. floods, strong winds and hail).

Despite the practice of late sowing in the Liverpool Plains, we found that the ideal sowing date was April 26 with a late maturing cultivar. This 'emergent Yw' treatment, with a 15 year average yield of 6.0 tonnes per hectare, had a 19 per cent advantage over Yw and should be considered as the new yield frontier.

While frost and heat stress reduce the yield potential of both Yw and the new simulated yield frontier, the advantage of the new treatment is slightly enhanced when frost and heat stress are taken into account.

The advantage of early sowing combined with later maturing (slower developing) varieties is consistent with recently published field and simulation work for sites from Dubbo south to Victoria, and west to SA and WA but will require flexible additional application of N fertiliser to meet N requirements of six to nine tonnes per hectare crops when seasonal conditions are right (for example, 2016).

Risk-adjusted profit

Growers generally do not seek to maximise yield but rather to maximise their profit. But growers are also generally averse to risk, meaning that profits should be adjusted for yield and price risk via a measure of certainty equivalent.

The certainty equivalent represents the smallest amount of certain money a farmer is willing to receive to forgo an uncertain profit, and can be calculated as the difference between average profit and a risk premium.

When typical costs were built in to allow profit and risk-adjusted profit to be calculated for a risk-neutral and a moderate risk-averse context, respectively (Figure 3), we found that, despite the higher costs, both maximum profit and maximum risk-adjusted profit were achieved by the emergent Yw treatment.

To sum up

While wheat growers in the Liverpool Plains are among the most efficient in Australia, there is still room for closing the yield gap by adopting non-limiting N fertiliser practices and controlling fallow weeds.

Simulation analysis suggests that, contrary to current practice, early sowing with slow maturing varieties has the potential to lift the production frontier by 19 per cent and significantly improve risk-adjusted profitability. This finding needs to be fully evaluated in local field experiments.

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

We gratefully acknowledge the expert advice provided by Jan Edwards and Alan Umbers of GRDC as well as by Pam Watson, CEO of Down To Earth Research who conducted the interviews. We wish to thank Dr Jeremy Whish who reviewed an earlier draft of this paper.

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■

Nuclear science helping to improve the efficiency of zinc fertilisers

WHEAT is one of Australia's top 10 exports, yet there are challenges as our nation's agricultural soils are known to be deficient in zinc and other micronutrients critical to the growth of wheat.

Nuclear science is helping us understand how to improve wheat crops by analysing the growth of 140 wheat plants flown from South Australia to Sydney's Lucas Heights in a specially-designed greenhouse laboratory.

Researchers from the Future Industries Institute at the University of South Australia are collaborating with a group of scientists at ANSTO to investigate a new class of micro and nano-scale zinc fertilisers for broadacre crops, such as wheat.

Dr Casey Doolette and PhD candidate Thea Lund Read from Prof Enzo Lombi's lab at the Future Industries Institute, are assessing if nano and micro zinc particles applied to leaves, can provide a more sustained supply of zinc to the crops.

What's the most efficient form of zinc?

The purpose of the study is to determine what form of zinc is the most efficient for supplying the nutrient to broadacre crops, with the ultimate aim of optimising crop management to increase crop yield and quality.

Nuclear science was used to understand how zinc is transported through the crop, and is based on the use of what are known as radiotracers to track the distribution of elements, in this case, zinc.

The tracer principle involves making a product slightly radioactive so that with certain equipment you can image it after it has arrived at a location in a plant or in a person. In this study, the zinc particles were made radioactive using the OPAL research reactor.

The imaging technique used by the team has allowed for single plants – grown in the greenhouse at ANSTO for this study – to be measured at multiple points of time without having to harvest them.

ANSTO biologist, Nicholas Howell, captured a series of x-ray like images called autoradiographic images of the plants, which show how the distribution of zinc changes in live leaves, over time.

ANSTO Environmental Research scientist Dr Tom Cresswell was also part of the study, and applied his expertise in using radioactive isotopes as tracers in marine organisms to the plants.

"We use this technique to study all manner of things at the atomic level. It is slightly different working with plants, but the concept and application is essentially the same," Tom said.

"By using zinc-65 as a radiotracer, it is possible to detect exactly where the zinc goes after it has been absorbed by the plant. We would also be interested in knowing how much zinc is not taken up by the plant, as that zinc would be released into the environment with rainfall, and from the perspective of an ecotoxicologist, it is important to know if the zinc is affecting freshwater runoff."

Casey said that ideally the applied zinc would accumulate in the grains of the plant, where it has the most nutritional benefit as food.

"By determining the most efficient form of zinc for direct foliar application, crop management strategies can be optimised to increase crop yield and quality," Casey said.

For more information on ANSTO, see *www.ansto.gov.au* ■

L–R: Dr Tom Cresswell (ANSTO), Dr Casey Doolette (FII) and PhD candidate, Thea Lund Read.

SOME BACKGROUND…

- The purpose of the study is to determine what form of zinc is the most efficient for supplying the nutrient to broadacre crops following its application to the leaves.
- Zinc is used by the plant for protein metabolism, synthesis of hormones and in the production of essential enzymes.
- Although zinc can also be delivered directly to the soil, there are some limitations due to soil conditions that affect its ability to address zinc deficiency in plants. When you deliver zinc to Australian agricultural soils, the zinc tends to get locked up, and is not readily available to the plants.
- This occurs because zinc is largely immobile in soil and only moves short distances from the point of where the fertiliser is placed.
- If the zinc can be released slowly into the leaf – such as the case when it is applied in nano form – there is likely to be less leaf scorch.
- The investigators are not focused on how the zinc, in the form of soluble zinc, is taken up but rather how much zinc is bioaccumulated. They are measuring zinc concentrations, as well as identifying where the zinc is transported in the plant, whether it be the new shoots, stems or grains.

How the study worked

Casey Doolette and Thea Lund Read are evaluating two commonly used agricultural formulations, soluble zinc and chelated zinc (Zn-EDTA). In order to make this evaluation, they needed to use a combination of tools to understand zinc transport and bioaccumulation.

Plants were imaged, after one day, 14 days and at maturity to evaluate the translocation and biodistribution of zinc.

Conventional analysis and imaging of zinc is limited because the naturally-occurring zinc in the leaves makes it difficult to identify newly-accumulated zinc. The nuclear techniques available at ANSTO enable this to be distinguished.

New test can determine nitrogen levels in soil

By Sharon Durham, Agricultural Research Service – USDA

NITROGEN is one of the main nutrients added to cereal crops which makes them grow faster and stronger. But too much of a good thing could sometimes have negative outcomes. Too much nitrogen can run off with rainwater or leach through to soil and contaminate groundwater. Now, a simple, rapid and reliable test can determine the nitrogen amount in soil.

For US corn growers, the current assumption is that corn grain requires 1.2 pounds (0.54 kg) of nitrogen applied for every bushel produced. This works for some soils, but not exactly for others, as the assumption doesn't factor in nitrogen from soil organic matter. Knowing the soil's potential to mineralise nitrogen from organic matter, making it available to plants, would help improve nitrogen fertiliser recommendations, according to US Department of Agriculture (USDA) ecologist Alan Franzluebbers, lead investigator of this research.

A series of experiments published in *Soil Science Society of America Journal* studied the effectiveness of this quick and inexpensive approach that can tell a farmer prior to the growing season how much nitrogen will be available by testing a soil sample.

Predicting mineralisation

In the first experiment, Alan, with Agricultural Research Service's (ARS) Plant Science Research Unit in Raleigh, North Carolina, and his colleagues illustrated how soil nitrogen mineralisation can be predicted with a three-day analysis of soil-test biological activity (STBA).

Soil is not an inert, dead plot of dirt – it contains many living organisms that enhance the soil's ability to make nutrients available to plants. Insects, bacteria and fungi play a part in making soil valuable for crop production. The STBA measures how much 'life' is contained in soil and how much usable nitrogen is in soil.

In the second experiment, Molly Pershing, a graduate student under Alan's guidance, conducted greenhouse trials to determine if higher levels of STBA actually equated to plant uptake of nitrogen from soil. The researchers found that indeed greater STBA was associated with greater plant nitrogen uptake.

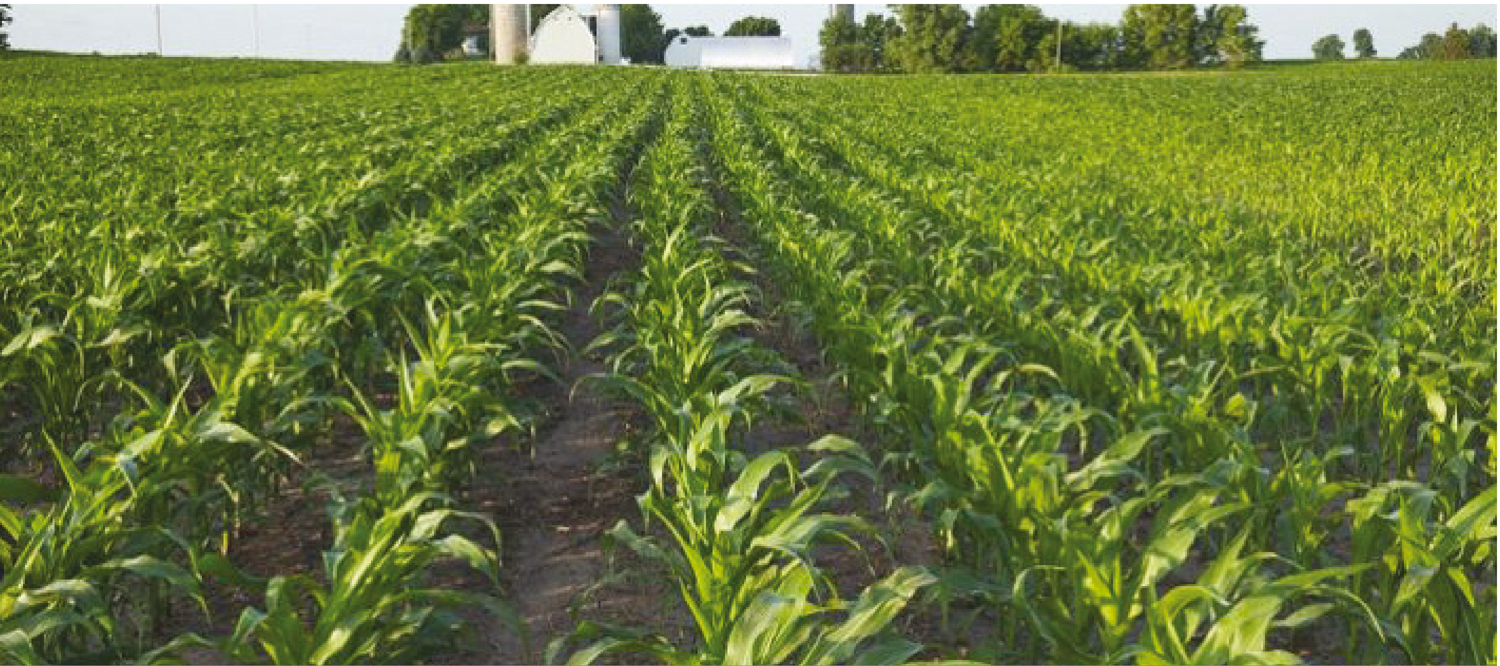
Greenhouse-grown plants were not supplied any nutrients other than what was present in soil. More than 75 per cent of the plant nitrogen uptake was from organic nitrogen that had to be mineralised, which was well predicted by the STBA level.

In the third experiment, Alan asked farmers to participate in the research. Forty-seven fields were sampled in the spring for STBA. On those fields, different rates of nitrogen fertiliser were applied to test which was most effective in optimising corn yield. The higher the STBA level – indicating a large amount of 'life' in the soil – the lower the need for additional nitrogen. The lower the STBA level, the greater the need for additional nitrogen.

Adding too little nitrogen can lead to a smaller harvest – costing farmers the opportunity to make more money. Adding too much nitrogen costs farmers money in unnecessary input to soil. Applying nitrogen at the correct levels can optimise yield and profit while keeping excess nutrients out of rivers, lakes and groundwater.

Using STBA, growers now have a preseason test that can more accurately determine the proper amount of nitrogen to apply for economically optimum yield.

The Agricultural Research Service is the US Department of Agriculture's chief scientific in-house research agency. Daily, ARS focuses on solutions to agricultural problems affecting America. Each dollar invested in agricultural research results in $20 of economic impact. ■



Soil nitrogen mineralisation can be predicted through analysis of soil biological activity.

Water extraction, use and fallow water in summer crops

By Lindsay Bell[1], Andrew Erbacher[2]

AT A GLANCE…

- Consider both soil water extraction as well as subsequent fallow accumulation when considering different summer crop options.
- Cotton and maize had higher water use than sorghum, but less efficient fallows.
- Mungbean water use and soil water extraction is often lower than summer cereal crops, but differences are often diminished after the subsequent fallow.
- Differences in soil water extraction under different sorghum configurations are small and seasonal, but impacts on subsequent fallow efficiency could be significant.

THE efficiency that soil water accumulates during fallows and a crop's ability to extract that water and convert into yield is a key driver of farming system productivity and profitability. While a large amount of work has been done on winter crops in farming systems, significantly less information is available on the relative water extraction of different summer crops and their impact on subsequent fallow water accumulation.

Cotton and maize had higher water use than sorghum, but less efficient fallows.

Some previous work was conducted in the western farming systems projects and in Central Queensland that examined the impact of different sorghum crop configurations on water extraction and fallow accumulation.

The current GRDC-funded farming systems projects have also gathered useful information on the soil water dynamics during and after different summer crop options in the farming system.

This article provides an update on some of this information and improves understanding of how crop choice and management might influence residual soil water at the end of the crop and accumulation during a subsequent fallow.

Differences in crop water extraction

Amongst the various summer crops grown across farming systems research sites, there are three cases where there are opportunities to draw comparisons of soil water dynamics during and after summer crops of different types.

Core farming systems site 2016–17

At the farming systems experiment at Pampas in 2016–17 a range of summer crops (maize, sorghum and cotton) were sown in the same season, with similar crop history and starting soil water (220 mm plant available water) (see Table 1). This allows a useful comparison of the extent of soil water extraction between these crops under the same conditions and the soil water accumulation during the subsequent fallow. Mungbean was also sown, but later in the same summer season.

In the 2016–17 season 136 mm of rain fell after soil sampling at the end of August and before sowing maize, sorghum and cotton on October 5. So the soil profile was full at sowing for each of these crops.

Similarly, 265 mm of rain, replenished the soil profile to over 200 mm before mungbean sowing on January 10, 2017. So all crops began with a full soil profile.

Soil sampling post-harvest in all these crops revealed only small differences in soil water – ranging from 130 mm in mungbean to 175 mm in sorghum.

Effective crop water use over this period, after estimated soil evaporation was subtracted, was similar in maize and cotton, about 30 mm lower in sorghum and about 80 mm lower in mungbean.

Despite relatively high crop water use, mungbean and maize yields (1.4 and 3.4 tonnes per hectare respectively) resulted in much lower returns per mm of crop water use ($0.70–0.80 per mm) compared to cotton (4.1 bales per hectare) and sorghum (6.8 tonnes per hectare) which produced higher returns per mm of crop water use ($1.80–2.00 per mm).

A dry winter followed these crops with little soil water accumulating. Soil water status after sorghum and maize was maintained, while this declined after cotton and mungbean – presumably due to lower ground cover following these crops.

So at the start of the next summer cropping season, soil water was 20 mm lower after cotton than it was after maize, and this was significantly lower than after sorghum (35 mm).

TABLE 1: Comparison of soil water extraction, crop water use efficiencies and subsequent fallow soil water status between summer crop options sown at the core farming systems experiment, Pampas during the summer of 2016–17

		Sorghum	Maize	Cotton	Mungbean
Crop water availability and use					
Plant available water pre-sowing (30 Aug 2016)		**220**	**221**	**223**	**117**
PAW post harvest (1 May 2017)		**175†**	**148**	**141**	**130**
In crop rainfall – 740 mm	Pre-sowing to sowing	136	136	136	265
	Sowing – maturity	287	337	347	280
	Maturity to post-harvest	317	267	257	9
Effective crop water use (30 Aug 2016 to 1 May 2017)[A]		**495**	**523**	**532**	**437**
Crop water use efficiency (kg product/mm water use)		**13.7**	**6.1**	**1.7**	**2.8**
Crop WUE ($/mm water use)		**2.02**	**0.74**	**1.82**	**0.83**
Fallow water accumulation					
Fallow rainfall (1 May to 20 Sept 2017)		78			
PAW at end of subsequent fallow (20 Sep 2017)		**180†**	**146**	**127**	**92**
Net change in soil water (30 Aug 2016 to 20 Sept 2017)		**-40**	**-75**	**-96**	**-25**

† – Calculated from soil samples taken earlier; A – Total rainfall + soil water extraction – APSIM predicted soil evaporation (290 mm)
Price assumptions used in calculations were 10 year median port prices less $40/t cartage costs. These were $221/t for sorghum, $667/t for mungbean, $281/t for maize and $1090/t for cotton ($537/bale plus seed).

TABLE 2: Comparison of soil water extraction, crop water use efficiencies and subsequent fallow soil water status between summer crop options sown at the Core Farming Systems experiment, Pampas during the summer of 2017–18

		Sorghum	Sorghum (high density)	Mungbean
Plant available water (PAW) (20 Sept 2017)		166	156	152
PAW post harvest (26 Mar 2018)		**58**	**40**	**42**
Change in soil water		**-108**	**-116**	**-110**
In crop rainfall – 362 mm	Pre-sowing to sowing	125	125	169
	Sowing – maturity	140	140	96
	Maturity to post-harvest	97	97	97
Effective crop water use (20 Sep 17 to 26 Mar 2018)[A]		**269**	**266**	**245**
Crop water use efficiency (WUE) (kg product/mm water use)		**18.9**	**18.5**	**4.2**
Crop WUE ($/mm water use)		**2.62**	**2.86**	**1.75**

A – Total rainfall + soil water extraction – APSIM predicted soil evaporation (200–220 mm)
Price assumptions used in calculations were 10 year median port prices less $40/t cartage costs. These were $221/t for sorghum and $667/t for mungbean.

Over the whole annual sequence (from August 30, 2016 to Sept ember 20, 2017) – including the crops water extraction and subsequent fallow accumulation – the relative change in soil water was 20 mm less for maize than cotton, 50 mm higher for sorghum than cotton and 65 mm higher for mungbean than cotton.

Core farming systems site 2017–18

In the subsequent summer cropping season, data from the core experimental site at Pampas allowed for comparisons of soil water extraction and crop water use between sorghum (solid plant one metre row spacing, 60,000 plants per hectare), high density sorghum (solid plant 0.5 m row spacing, 90, 000 plants per hectare) and mungbean (see Table 2).

The crops compared here had a common crop history (following maize in 2016), and soil nutrient status was also similar. This showed little difference in soil water extraction between these different crops, but effective crop water use was estimated to be 20 mm less in mungbean than sorghum in the same summer.

Interestingly there was no difference in sorghum crop water extraction, or crop water use efficiency between the standard or high density configurations.

Billa Billa farming systems site 2016–17

Two separate comparisons of summer crops are possible at the Billa Billa Farming systems site in summer 2016–17 (Table 3). The first, between spring sown sorghum crops with different starting soil waters (after a long-fallow after wheat, and after a short-fallow following mungbean).

Both sorghum crops finished with similar post-harvest soil water status, despite nearly 100 mm difference in starting soil water.

TABLE 3: Comparison of soil water extraction, crop water use efficiencies and subsequent fallow soil water status between summer crop options sown at the Billa Billa farming systems experiment during the summer of 2016–17

		Date	Comparison 1		Date	Comparison 2	
			Sorghum (long fallow)	Sorghum (short fallow)		Sorghum	Mungbean
Plant available water (mm)	Pre-sowing	1 Sep 2016	**237**	**142**	3 Oct 2016		
	Post-harvest	31 Jan 2017	51	44	12 July 2017	**78**	**188**
Change in soil water (mm)			**-186**	**-98**		**-103**	**+9**
Rainfall	Pre-sow to sowing		149	149		71	71
	Sowing – maturity		128	128		329	177
	Maturity – post-harvest		12	12		0	115
Total rainfall pre-sow to post-harvest			289	289		401	401
Estimated soil evaporation			195			274	
Effective crop water use (mm)[A]			**326**	**238**		**432**	**320**
Crop water use efficiency (WUE) (kg product/mm water use)			**4.6**	**3.69**		**3.71**	**1.58**
Crop WUE ($/mm water use)			**1.45**	**0.77**		**0.74**	**0.39**
Post-fallow plant available water (20 Mar 2018)			**223†**			**196**	172
Net change in soil water to 20 Sep 2017			**-14**			**+15**	**-9**

† — Calculated from soil samples taken earlier; A – Total rainfall + soil water extraction – APSIM predicted soil evaporation.
Price assumptions used in calculations were 10 year median port prices less $40/t cartage costs. These were $221/t for sorghum and $667/t for mungbean.

TABLE 4: Effect of sorghum configuration on soil water change, crop water use, yield and crop wateruse efficiency over four seasons and locations

Site and year (in-crop rain)	Sorghum configuration	Change in soil water (mm)	Crop water use (mm)	Yield (t/ha)	WUE (kg/ha/mm)
Croppa Creek 2000–01 (409 mm)	Solid (1 m)	+59	350	5.53	15.8
	Single-skip	+71	338	5.60	16.7
	Double-skip	+82	327	4.54	13.9
Billa Billa, 2000–01 (324 mm)	Solid (1 m)	+13	311	2.91	9.4
	Single-skip	+23	301	2.63	8.7
	Double-skip	+19	305	2.85	9.4
Bungunya 2001 (165 mm)	Solid (1 m)	-126	291	2.62	9.0
	Single-skip	-112	277	2.74	9.9
	Double-skip	-87	252	2.63	10.5
Billa Billa 2001–02 (253 mm)	Solid (1 m)	+17	236	2.57	10.9
	Double-skip	-2	255	2.81	11.0

Source: Routley, R., Broad, I., McLean, G., Whish, J., and Hammer, G. (2003). The effect of row configuration on yield reliability in grain sorghum: I. Yield, water use efficiency and soil water extraction. Proceedings of the Eleventh Australian Agronomy Conference, Geelong, Jan 2003.

Soil water status after sorghum and maize was maintained, while this declined after cotton and mungbeans.

The sorghum crop with the higher availability of water yielded significantly more and ended with a much higher crop grain WUE than the crop starting with more marginal soil water.

This translated into double the gross margin return per mm.

The second comparison can be made between sorghum and mungbean crops sown in January following a pulse crop the previous winter.

Both crops started with a similar soil water status, but soil water was about 100 mm lower following the sorghum crop compared to the mungbean crop in July after harvest. This was largely driven by the difference in maturity timing between the crops, with the sorghum crop having access to an additional 115 mm of in-crop rain that fell after the mungbean crop was mature.

So in the case of the mungbean crop, this 115 mm would have added to finishing soil PAW levels.

Despite these differences in post-harvest soil water at July 2017, differences in soil water were negated at the end of the subsequent fallow (in March 2018); with soil water similar at this time.

Over the whole annual cycle, there was only a marginal difference in the change in soil water, with sorghum extracting more soil water than mungbean but higher subsequent fallow efficiency after sorghum made up for this difference.

TABLE 5: Effects of sorghum row spacing on ground cover at the end of the subsequent fallow and fallow water accumulation, Emerald 2005–06

Sorghum row spacing (m)	Average ground cover at end of fallow (%)	Fallow water accumulation (29 Mar 2005–26 Apr 2006)
0.5	22	101
1.0	19	88
1.5	14	86
2.0	14	78

Source: Routley R, Lynch B, Conway M (2006) the effect of sorghum row spacing on fallow cover distribution and soil water accumulation in Central Queensland. In Proceedings of the 13th ASA Conference, 10-14 September 2006, Perth, Western Australia.

Impact of sorghum configuration

Little contemporary work has examined the effects that different sorghum crop configurations – such as solid planting, single-skip or double-skip – have on crop water use, crop water-use-efficiency and subsequent fallow accumulation.

The information presented here is from research conducted previously by others.

In the study of Routley *et al* 2003 (Table 4), few differences in soil water change and crop water use were statistically significant due to high site variability. But at three of the four experimental locations, double-skip sorghum crops extracted 20–40 mm less soil water than solid plant.

Single-skip sorghum was intermediate in soil water extraction and crop water use, with around 10 mm less soil water extraction but these small differences are hard to assess experimentally.

Interestingly in these data sets, the high rainfall year at Croppa Creek (over 400 mm in-crop rain) showed a significant yield penalty and lower crop WUE under the double-skip configuration compared to single-skip or solid plant.

In contrast, in the low rainfall season at Bungunya (165 mm in-crop rain), the single-skip and double-skip crops yielded similarly to solid plant crops but due to lower soil water extraction had higher crop WUE. Analysis over a wider range of environments and seasons has shown that double-skip or single-skip row sorghum crops only outperform solid-plant sorghum in dry growing seasons or when soil water at sowing is marginal (for example, under 60 per cent full profile).

Other locations have also shown marginal differences in total crop water use and soil water extraction between different sorghum row configurations.

Results in 10 experiments at Nebraska in the US show no significant difference in total crop water use or extraction between solid, single-skip or double-skip configurations.

The impact of the different row configurations on subsequent fallow water accumulation is also a critical factor to consider. It is expected that narrower rows with more even ground cover should improve soil water infiltration during a fallow after sorghum, while wide-row crops would be less efficient at accumulating water. But there is little information on this.

An experiment in Emerald conducted in 2006 (Table 5), showed that sorghum sown on narrow rows (0.5 m) had higher average ground cover at the end of the subsequent long fallow and had accumulated about 20 mm more soil water compared to sorghum on wide rows of 2.0 m. Other differences were not significant but intermediate row spacings accumulated soil water between these two extremes.

Further examination of the impact of narrow row (0.5 m) and higher density sorghum crops on subsequent fallow water accumulation is expected in the coming 12 months from farming systems experiments.

The research undertaken as part of this project is made possible by the significant contributions of growers through both trial cooperation and the support of the GRDC, the author would like to thank them for their continued support. We would like to thank the project teams and collaborators contributing to the management and implementation of the farming systems experiments across the northern region. Particular thanks and recognition must go to Richard Routley for reminding me of the past work on sorghum configuration effects on water extraction and fallow efficiency presented here.

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■

Impact of narrow row spacing in sorghum

■ By Trevor Philp – Pacific Seeds

AT A GLANCE…

- In a tough 2017–18 season, sorghum grown in narrow rows did not reduce the yield or increase lodging.
- Narrow row sorghum did reduce weed populations and has potential to increase fallow efficiency.

GRAIN sorghum is currently grown in three main row widths in the north eastern Australian grain belt – 150, 100 and 75 cm. Broadly, the higher the yield potential and the more reliable the environment, the narrower the row spacing.

There has been a renewed interest in narrow rows in field crops due to two main factors:

- Weeds with resistance to one or more herbicide mode of action groups; and,
- Improving ground cover to drive better efficiency of subsequent fallows.

Little data is available for Australia on the effect of narrow row spacing in grain sorghum on yield, grain quality, suppression of weeds and improvement in fallow efficiency. There is also no data on narrow row sorghum planted with precision planters.

Summary of recent trials

In the 2017–18 season nine grain sorghum trials were conducted to measure the effect of row spacing on yield grain quality and weed populations. Six trials compared 50, 75 and 100 cm rows, one trial compared 50 and 100 cm rows and two trials compared 50, 75 and 150 cm rows.

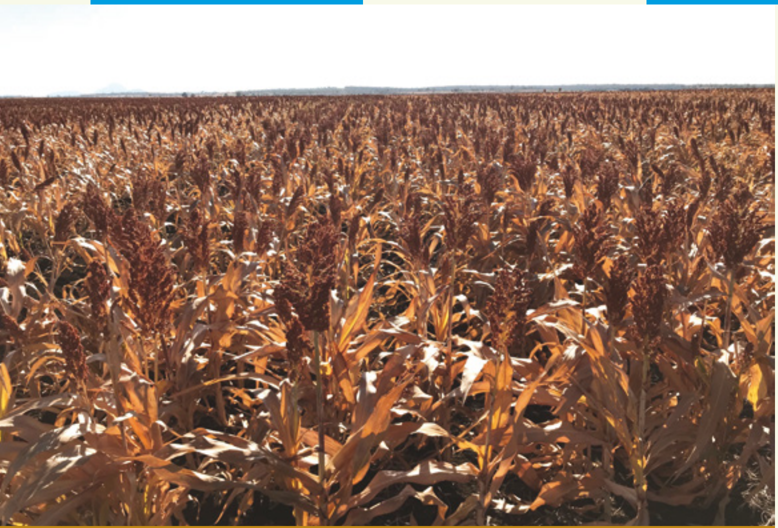
TABLE 1: Locations, row widths compared and sowing rate by 2017–18 trial site

Location	State	Row widths compared	Plant density/ha
Clifton	QLD	100, 75, 50 cm	85,000
Felton	QLD	100, 75, 50 cm	75,000
Brookstead	QLD	100, 75, 50 cm	85,000
Pampas	QLD	100, 75, 50 cm	85,000
Yelarbon	QLD	150, 75, 50 cm	65,000
Goondiwindi	QLD	150, 75, 50 cm	65,000
Yallaroi	NSW	100, 75, 50 cm	85,000
Tamworth	NSW	100, 75, 50 cm	75,000
Premer	NSW	100, 50 cm	85,000

TABLE 2: Individual 2017–18 trial results, grain yield by row width

Location	Row width	BLUP kg/ha	Rank	Relative mean %	Standard error
Goondiwindi	50 cm	3262	1	132.9	58
	75 cm	2214	2	90.2	58
	150 cm	1886	3	76.9	58
Premer	50 cm	7462	1	100.0	70
	100 cm	7462	1	100.0	70
Pampas	50 cm	3655	1	108.2	263
	75 cm	3173	3	94.0	263
	100 cm	3303	2	97.8	260
Brookstead	50 cm	3075	1	103.2	186
	75 cm	3039	2	102.0	186
	100 cm	2828	3	94.9	181
Yelarbon	50 cm	1947	2	94.8	177
	75 cm	1626	3	79.2	177
	150 cm	2588	1	126.0	177
Tamworth	50 cm	6469	3	97.0	52
	75 cm	6770	2	101.5	42
	100 cm	6771	1	101.5	42
Yallaroi	50 cm	4480	1	101.8	139
	75 cm	4321	3	98.2	149
	100 cm	4396	2	99.9	144
Clifton	50 cm	2972	3	100.0	26
	75 cm	2972	1	100.0	26
	100 cm	2972	2	100.0	26

Note: BLUP = Best linear unbiased prediction.



Narrow rows at Capella in a tough 2018 finish.

All configurations were sown at the same plant density using a single hybrid. Only eight trials were harvested, with the trial at Felton abandoned due to lodging. The Felton site was assessed for weed competition and was the only site that had significant weed populations to assess.

A significant difference in grain yield was measured at two of the eight sites, one at Tamworth and one at Goondiwindi, no significant difference between the row configurations was measured at any of the other sites.

Row width had a significant effect on weed population at the Felton Site, with weed population reducing with row width.

An across site analysis of the five sites comparing 100, 75 and 50 cm was conducted. No difference in grain yield was measured between row configurations.

The 2017–18 sorghum season was below average for yield, with grain size also reduced. Most spring planted crops suffered high levels of stress in the grain fill period, due to no rainfall in January.

Trial analysis description

The trait of yield (kg/ha) was analysed in two ways:

- Firstly with row width included as a fixed effect (model 1: Best linear unbiased estimate BLUE) otherwise known as least square mean. This gives an estimate of the mean yield of the each of the treatments; and secondly,
- With row width included as a random effect (model 2: Best linear unbiased prediction BLUP). The BLUP value is used to estimate/predict the difference between row widths.

Only the BLUPS are reported.

TABLE 3: Across site result, Clifton, Pampas, Brookstead, Yallaroi, Tamworth, and Premer

Treatment	Estimated BLUP	BLUP ranking	Relative BLUP
100 cm	4627	1	100
75 cm	4627	1	100
50 cm	4627	1	100

TABLE 4: Weed population by row spacing at harvest, Felton Site 2018

Row width	Subscript	Weed count BLUP	BLUP ranking	Relative %
100 cm	a	49.8	1	175.6
75 cm	b	23.5	2	82.8
50 cm	b	11.8	3	41.6

Trial results

Overall, these trials demonstrated no consistent significant difference in yield by row width, although only one hybrid was tested at a single planting rate.

Two sites showed significant difference in row spacing.

Goondiwindi showed a clear advantage in the 50 cm rows against the commercial standard row spacing of 150 cm. This advantage was created due to less lodging in the 50 cm, the 50 cm rows appeared to create more biomass early and ran into stress earlier than the 150 cm rows. The earlier stress resulted in less yield potential, and reduced height. No rainfall occurred in the grain fill period which caused in the higher yield potential treatment to lodge.

The Tamworth trial had a similar environment but stressed earlier and then was relieved by late rain, which favoured the 100 cm rows over the 75 and 50 cm rows.

In all sites row canopy closure occurred much earlier in the 50 cm row configuration, providing better ground cover. Water use and water use rate wasn't measured in these trials, but the 50 cm rows may use soil water at a faster rate in the vegetative phase and potentially increase the chance of stress prior to flowering.

The combination of an appropriate hybrid and plant density and the 50 cm row spacing has the potential to improve the sorghum crops' competition against weeds, reducing weed seed set and improving yields. This has potential to improve the fallow efficiency of the overall system, as well as lifting the sorghum yield and reliability in most seasons.

Further work to assess the impact on yield and quality is needed and work is needed to assess the effect on the fallow efficiency after the sorghum crop.

Detailed economic analysis is needed to determine the cost benefit of purchasing a narrow row precision planter.

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Narrow row sorghum at Tamworth in 2018.

Positive step into cotton for Dunedoo grower

A FIRST try at cotton as a crop has been a success for Brett Yeo, who farms at Dunedoo, in Central West New South Wales.

Dunedoo is not a traditional cotton growing area, but with good prices and advances in technology in recent years, Brett and his neighbour decided to grow the crop last season.

"The economics did attract me," he said. "But we were also running into weed problems with our cereal crops with shatter-cane and grass weeds that we didn't seem to be beating with rotations of beans."

Brett said growing Roundup Ready Flex cotton has helped him get on top of these weed problems.

The ability to be able to harvest the cotton crop was a concern for Brett but the area grown between him and a neighbour was enough to attract a cotton picker contractor to the area.

A larger combined area also meant they could get the relevant assistance from cotton agronomy experts and companies.

Brett said another concern was the potential for herbicide spray drift from other properties in the area.

Cotton is a sensitive plant to a number of products used in other cropping systems and the potential for spray drift was addressed with good communication leading up to Brett's decision to grow.

"I spoke to all the neighbours that I could," he said. "I also spoke to other irrigators in the area on the pros and cons and communicated as openly as we could. We conducted two grower meetings before we planted."

Brett had existing irrigation infrastructure although the switch to cotton did mean a closer look at his pivots to maximise their use.

"With water use, I think it probably made us switch on," he said. "We made sure we had good maintenance on our pivots."

He said ground preparation was similar to what he would do for corn.

Would we get enough heat units?

Dunedoo is located 100 kilometres east of the more established cotton growing areas and has traditionally been cooler in summer.

"We've been very concerned about that, whether we would get the heat units," Brett said. "This year we had a warm start to October and it allowed us to plant in mid-October. November cooled down, we were frost free but the plants were very slow."

As the season progressed, the cotton grew well and by early March the agronomist was quite comfortable with where the crop was at, even suggesting it was ahead of schedule.

The cotton variety planted was a shorter season variety than those used in more western areas.

Brett said it was really positive to connect with people throughout the cotton industry.

"I was told about the positive atmosphere in the cotton industry," he said. "It is marvellous connecting with other growers. It is much more forthcoming than most traditional areas of farming and I've really enjoyed that."

Brett's cotton crop needed just two insecticide sprays for sucking insects across the season with Bollgard 3 technology effectively controlling Helicoverpa caterpillars. ■

Brett Yeo, of Dunedoo, NSW, grew cotton for the first time in the 2017–18 season with excellent results.

SOUTHERN AUSTRALIA FOCUS

COVERING CROPPING SYSTEMS OF SOUTHERN NSW, VICTORIA, TASMANIA, SOUTH AUSTRALIA & WESTERN AUSTRALIA

Growers urged to monitor for crop mites

GROWERS in the southern region are being advised to monitor for redlegged earth mites (RLEM) this winter. Experts are warning environmental conditions have been ideal for mass hatchings, potentially putting winter crops at risk.

Dr Garry McDonald from cesar and the University of Melbourne said rain in some southern regions followed by cooler conditions in May had been conducive to population increases of the pest, which could affect canola, lupins, cereals and legume seedlings, as well as pastures.

"RLEM or *Halotydeus destructor*, only hatch in autumn under specific conditions, like those we had in May where areas received at least 5 mm of rain accumulated over five consecutive days or less, followed by 10 days of average daily temperatures below 16°C," he said.

"Our predictive modelling suggests the peak egg hatch would have occurred in mid-May in areas like Wagga Wagga and Albury. But as most growers would be aware, the juvenile mites are microscopic so we wouldn't expect them to have noticed much RLEM activity until early to mid June," Garry said.

Monitor and act early

"So the time to monitor crops, and where necessary enact management strategies for RLEM, is very early in the season."

RLEM is traditionally active from autumn until mid spring

Growers are advised to regularly monitor crops. RLEM are best detected feeding on the leaves in the morning or on overcast days. If mites are not observed on plant material, inspect soil.

across southern regions, with pest hatching often coinciding with crop emergence.

Garry said the pest feeds on the crop causing silvering or white discoloration of leaves and distortion or shriveling in severe infestations.

"Affected seedlings can die at emergence with high mite populations. Feeding symptoms can also be mistaken for frost damage. RLEM have been found to be directly responsible for a reduction in pasture palatability," he said.

Dr Garry McDonald said rain in some southern regions followed by cooler conditions in May had been conducive to population increases of red legged earth mites, which could affect canola, lupins, cereals and legume crops, as well as pastures.

RLEM are approximately 1 mm in length with a velvety black body and eight orange-red coloured legs. They can often be found on the leaf surface in feeding aggregations, of up to 30 individuals. In the warmer part of the day, they tend to gather at the base of plants, sheltering in leaf sheaths and under debris.

"Growers should be regularly monitoring crops. Mites are best detected feeding on the leaves in the morning or on overcast days. If mites are not observed on plant material, inspect soil for mites," Garry said.

He said the economic thresholds for mites were:

- Wheat/barley: 50 mites per 100 cm^2;
- Canola/linseed: 10 mites per 100 cm^2;
- Pulses: 50 mites per 100 cm^2; and,
- Establishing annual medic pastures: 20–30 mites per 100 cm^2.

"More recently, a threshold for canola of 10 mites per plant at the late cotyledon-first true leaf stage has been developed," he said.

Non-chemical options

Dr Paul Umina from cesar said RLEM were commonly controlled using insecticides, but non-chemical options were becoming increasingly important due to evidence of resistance and concerns about long-term sustainability.

"Insecticide resistance in the RLEM is now present in the southern cropping region, so chemical stewardship is vitally important."

He said for growers that meant not using the same chemical groups across successive spray windows (or across multiple generations of mites) and reserving co-formulations (or chemical mixtures) for situations where damaging levels of pests are present, and a single active ingredient was unlikely to provide adequate control.

"Border spraying can be an effective way to control mites, as mites will often move in from crop edges and roadside vegetation. During spring, carefully timed spraying using the *Timerite* strategy will reduce mite populations the following autumn, but could also exacerbate other mite problems."

Paul also encouraged growers to adopt an integrated approach to mite management such as leaving native vegetation shelterbelts or refuges between paddocks to maintain populations of natural enemies like snout predatory mites.

For more information about the resistance testing contact: Dr Paul Umina, (03) 9349 4723 or pumina@cesaraustralia.com

For more information go to: *http://cesaraustralia.com/sustainable-agriculture/pestnotes/insect/Redlegged-earth-mite* ■

RESISTANCE MANAGEMENT STRATEGY

An insecticide resistance management strategy has recently been developed for RLEM. Growers and advisors are encouraged to become familiar with the strategy, which is available for download at: *https://ipmguidelinesforgrains.com.au/ipm-information/resistance-management-strategies/*

Growers and advisers can also access a service to determine if RLEM populations within their paddocks are resistant to insecticides. This service is being made available through a GRDC investment. Knowing the resistance status will assist in implementing appropriate and effective management.

Omega-3 canola gets the green light

By Sarah Frazer, CSIRO

IN February this year, Australian regulators gave the green light for the world's first plant based and sustainable source of omega 3. Named Omega-3 canola, it's a type of canola that has been modified to contain long-chain omega 3 fatty acids. It is the first genetically modified crop wholly created by Australian scientists

This advancement is more than just a win for Australian science. For many years, nutritionists have recognised the health benefits of long-chain omega-3 fatty acids – in particular different types known as DHA and EPA. They are vital for early childhood growth and especially in brain and eye development, and cognition. They're not just good for kids, either.

In adults, omega-3 fatty acids can reduce blood pressure and the risk of coronary heart disease as well as stroke, type 2 diabetes, Alzheimer's disease, inflammatory disease and asthma.

Fish are friends, not food

The human body is incapable of producing its own omega-3, which means to meet our nutritional needs we need to get them from our food.

Currently, the most popular source of omega-3 oils is ocean-caught fish. Despite the old saying, there's only so many fish in the sea, and as the human population grows, so does our demand on fish stocks.

That's where omega-3 canola comes in – one hectare of the crop will provide the equivalent amount of DHA (one of the two main kinds of omega-3 fatty acids) as 10,000 kg of wild-caught fish.

Why don't we just farm fish?

Before omega-3 canola, trying to produce more omega-3 oils was a bit of a catch 22. Eating farm-grown fish seems like a good way to get your daily dose of omega-3 fatty acids without directly impacting ocean fish stocks.

The catch is that farmed fish require a substantial amount of omega-3 fatty acids in their diet – the main source of which is fish oil, often from ocean stocks.

Recent fish feeding trials conducted in Australia and Norway indicate that the omega-3 canola oil can be an excellent substitute for fish oil in aquaculture diets, breaking the fish-eat-fish cycle.

How did the CSIRO do it?

Omega 3 canola is the result of 12 years' work led by Surinder Singh, James Petrie and the team of scientists in the Plant Oils Engineering Group and involving many others from across our organisation (Agriculture & Food, Oceans & Atmosphere, Manufacturing, Health and Biosecurity and the Australian National Algae Culture Collection). The GRDC has supported this project since its beginning.

Using gene technology, our scientists transferred the ability to produce long chain omega-3 oils from the marine microalgae that fish consume into canola.

This involved introducing a set of eight transgenes which extended canola's short-chain omega-3 synthesis pathway all the way to marine-type EPA and DHA fatty acids.

It is the most complex piece of metabolic engineering so far achieved in plants.

When can I get some?

Just like *Game of Thrones*, sadly you're going to have wait for a bit for Omega-3 canola to hit the market. Omega-3 canola will be commercialised by Nuseed Pty Ltd, a subsidiary of Nufarm.

The first product that Nuseed plans to commercialise is an aquaculture feed, Aquaterra followed by Nutriterra for human nutrition. ■

One hectare of Omega-3 canola can produce the equivalent amount of omega-3 fatty acids as 10,000 kg of wild caught fish.

It's a gas! Crop trials that glimpse at future climate come to an end

AT A GLANCE…

- A 45,000 litre (35 tonne) gas cylinder has been removed from Agriculture Victoria's Plant Breeding Centre at Horsham.
- This marked the end of 11 years of field trials that were set up to help better understand the impacts of climate change and rising atmospheric carbon dioxide (CO_2) levels on dryland food production.

THE Horsham-based Australian Grains Free Air CO_2 Enrichment project (AGFACE) was established to allow researchers to examine how crops would respond under elevated CO_2.

It was the only facility of its kind in the world, having been built specifically to study the impact of elevated CO_2 on field crops grown in semi-arid conditions.

To mimic future atmospheric carbon dioxide levels – which over the next 35 years are predicted to rise from 405 ppm to 550 ppm – a gas cylinder was installed at the plant breeding centre which fed into pipes arranged into 12 metre wide octagonal rings around the field trials.

Plants grown inside these rings were exposed to 550 ppm levels of CO_2 during daylight hours.

Agriculture Victoria research scientist, Glenn Fitzgerald, led the AGFACE at Horsham. The project was also supported by a large team of researchers specialising in the fields of cereal chemistry, agronomy, soil sciences, farming systems, pests and diseases, microbiology, agricultural engineering and crop modelling ensuring crop effects were looked at from all angles.

Glenn said a decade of experiments using the AGFACE infrastructure has produced a number of results and has significantly contributed to the collective understanding about food production under elevated CO_2.

A 45,000 litre (35 tonne) gas cylinder is removed from Agriculture Victoria's Plant Breeding Centre at Horsham. (PHOTO: AGFACE)

Bigger, but hungrier crops

"A key finding was that crops grown under elevated CO_2 grow bigger but they will need more nitrogen and phosphorus to support them, and grain quality will decrease," Glenn said.

The research also showed that the impact elevated carbon dioxide had on crops varied according to cultivar, which suggests that adaptation to a changing climate is possible with targeted plant breeding.

Glenn listed other AGFACE key findings as follows:

- In the absence of increased moisture and heat stresses, the growth and yield of wheat, field peas, lentils and canola, on average will increase due to elevated CO_2. This is known as the 'CO_2 fertilisation effect'. On average, wheat and field peas grown under elevated CO_2, yielded 25 per cent higher than plants grown under current CO_2 levels.
- Bigger crops grown under higher CO_2 are likely to need more nitrogen and phosphorus to support them.
- Cereal grain protein, micronutrient levels and bread quality will decrease. Because protein decreases more under elevated CO_2 in semi-arid conditions – even with extra nitrogen fertiliser – Australia may be at a disadvantage in maintaining grain quality compared to other parts of the world.
- Diseases such as barley yellow dwarf virus and crown rot are likely to be more severe under elevated CO_2.

Glenn said there were a number of important other findings resulting from the extensive AGFACE research.

"Increasing temperatures and reduced rainfall in the future may tend to lower yields, counteracting the benefits of CO_2," he said.

"We also found that greater legume growth under elevated CO_2 could benefit future rotation systems by supplying more nitrogen to soils, but more phosphorus fertiliser will be required to maintain growth on deficient soils."

Computer modelling carried out as part of the project showed that the impacts of elevated CO_2 will vary across the landscape depending on rainfall, temperatures and soils.

Need to adapt crops to cope

"Models suggest that, over the coming decades, areas of Victoria best suited to cropping will effectively move further south because of less rainfall and heat stress in the northern districts, unless we can adapt crops to cope with changing climatic conditions," Glenn said.

"The ability to adapt to changing climate will depend on developing new cultivars and management systems that take advantage of the positive aspects of CO_2 and overcome the negatives."

AGFACE was a joint project of Agriculture Victoria and the University of Melbourne, with funding support from the Grains Research and Development Corporation, the federal Department of Agriculture and Water Resources and the Australian Research Council.

Results from research carried out as part of the AGFACE projects (DAV00109 and DAV00137) are available on the GRDC website at: *www.grdc.com.au* ■

Local crop trial data now even simpler to find

VALUABLE, timely and locally relevant information stemming from Australian crop research trials is now even easier and quicker to access following recent improvements to the popular Online Farm Trials (OFT) web portal.

This resource – available at *www.farmtrials.com.au* – is a GRDC investment that allows users to view, analyse and export the latest and historical grains research information.

Developed by the Centre for eResearch and Digital Innovation (CeRDI) at Federation University Australia in Ballarat (Victoria) and launched in 2014, it stores information provided by grower groups, research organisations, government bodies and other grain industry stakeholders.

Ben Wills, the project's Industry Engagement and Impact Research Lead, said the OFT website now featured streamlined searching capability for trials, was more 'intuitive' to use and highlighted – under 'Browse by Topic' – collections of trials relating to relevant seasonal issues.

"The aim of the recent improvements is to allow growers, agronomists, researchers and the wider grains industry to access, in the simplest and most efficient way, data and information that can help support grower decisions at a local level," he said.

Ben said the upgraded, faster underlying search functionality behind OFT allowed users to filter, sort and discover information that was most relevant to them.

"We welcome feedback about the new search functionality,

Professor David Lamb, from the Precision Agriculture Research Group at the University of New England, using the Online Farm Trials website at the GRDC Research Update event in Goondiwindi earlier this year.

The Online Farm Trials website now features streamlined searching capability for trials, is more 'intuitive' to use and highlights – under 'Browse by Topic' – collections of trials relating to relevant seasonal issues.

particularly about how relevant the results are from searches made, and specific examples of where refinements could be made," he said.

"Our team will use this feedback, which can be reported back to us through the website, to adjust and refine future results delivered by the new search engine."

Ben said additional trial results were continually being published on the OFT site, which now houses information for more than 6000 trials from 60 contributors across Australia, with more than 4330 trials publicly accessible.

Recently added research

Among the data available on OFT from Queensland and New South Wales research are some recently added findings from the Managing Profitable Farming Systems' retained stubble project.

The data is based on southern NSW research conducted by Tony Swan from CSIRO in collaboration with the Central West and the Riverine Plains farming systems groups. This work examined:

- Management options to deal with high stubble loads; and,
- The impact of various stubble treatments on nitrogen levels.

Other new data on the site includes Northern Grower Alliance (NGA) research:

- Evaluating the effectiveness of citric acid as an adjuvant for the control of summer grasses in fallow; and,
- Information assessing the mungbean response to phosphorus, potassium and nitrogen.

When adding results to the OFT website, organisations retain all intellectual property rights and manage their own data, allowing them to submit, update or remove trial information from the database.

The focus of the OFT resource is to include information derived from RD&E projects that have GRDC investment. But the website can host trial and research information from any researchers or organisations that seek to contribute to it. ■

Research uncovers new changes in barley fungicide resistance

RESEARCHERS from the Centre for Crop and Disease Management (CCDM), working closely with the Department of Primary Industries and Regional Development (DPIRD), have discovered a new case of demethylation inhibitor (DMI) Group 3 fungicide resistance affecting barley crops in Western Australia's southern grainbelt region.

The resistance was found in the pathogen responsible for the disease net form of net blotch (NFNB), caused by the fungus *Pyrenophora teres f. teres*.

It was uncovered in samples collected by DPIRD plant pathologists in the Scaddan area, near Esperance, and sent for testing to the Grains Research and Development Corporation (GRDC) and Curtin University-supported CCDM.

CCDM researchers first discovered NFNB isolates with reduced sensitivity to Group 3 fungicides in 2013 and mapped the occurrence between 2013 and 2016. Importantly, the newly discovered case in Scaddan has a higher resistance to Group 3 DMI fungicides than the previous identified cases.

According to CCDM Fungicide Research Group team leader Fran Lopez-Ruiz, the extent of this new type of fungicide resistance in WA is yet to be established and may not be limited to Scaddan.

"The populations collected from Scaddan are showing a higher resistance to the DMI fungicides tebuconazole and propiconazole, moderate levels of resistance to prothioconazole and low resistance to epoxiconazole," Fran said.

CCDM researcher Wesley Mair has been leading the disease testing in the laboratory and is currently investigating barley samples from other areas of the grainbelt to determine the distribution of this new resistance.

Quantifying resistance spread

"It is early days in our attempts to quantify the spread of this form of resistance, but the sampling process is well underway and, as analysis progresses, we will be able to report any further findings of resistance," Wesley said.

"Ongoing sampling and testing is crucial to helping the CCDM team identify not only new cases of fungicide resistance, but also which fungicides are effective in managing this problem.

"We can then assist growers, agronomists and advisers to make informed decisions when it comes to crop and disease management."

CCDM co-director Professor Mark Gibberd said this latest resistance discovery highlighted the importance of maintaining a high level of monitoring of disease pathogens in the landscape.

"The Australian agricultural production system is becoming increasingly dependent on both fungicides and improved crop varieties for pathogen control," Mark said.

"At the CCDM, research funded by GRDC and Curtin University focusses on the use and sustainability of fungicides, as well as genetic improvement of crops.

"Both approaches need to occur in concert and the recent findings highlight the rate of change that is occurring within the landscape and the need to consider implications for the long-term.

"It is now apparent that disease control measures for one pathogen may be potentially influencing the development of fungicide resistance in other pathogens."

Fran has advised growers to consider implementing integrated disease management strategies for the further protection of crops this season and in future seasons.

"We do know the over-use of fungicides is a key contributor to the problem of fungicide resistance, so users should adopt best practice methods of application," he said.

"Avoiding over-spraying and repeated use of the same fungicide group will help to ensure the longevity and effectiveness of the products we have at our disposal in the fight against crop disease."

The discovery of DMI-resistant NFNB populations in barley in WA follows the detection of two cases of DMI resistance in the pathogen responsible for another type of net blotch – spot form of net blotch (SFNB) – in WA's Esperance and South Stirling regions in 2016 and 2017.

Fran suggests growers consider some of the following fungicide strategies to assist with net blotch control during the current growing season.

Net blotch control strategies

- Choose mixtures with different modes of action (if available);
- Never apply the same Group 3 fungicide twice in a row;
- Apply fungicides from Groups 7 and 11 no more than once per season;
- Incorporate the use of seed dressing, in-furrow and foliar products containing fungicide mixtures from different chemical groups (such as 3 (DMI), 7 (SDHI) and 11 (QoI)) – in combination with limited use of propiconazole and no tebuconazole use;
- Avoid using tebuconazole as a stand-alone product in barley for any disease;
- Use other DMI-based mixtures (such as propiconazole, prothioconazole or epoxiconazole) only once, followed by mixtures containing other actives (preferably from the SDHI or QoI groups);
- If resistance is present, or suspected, avoid or minimise use of that mode of action – this will only further select for resistance; and,
- Do not exceed label rates.

It is also recommended growers consider implementing across-season tactics to reduce the risk of net blotch outbreaks and resistance selection.

These include rotating crops or managing stubble to reduce disease carry-over and selecting more disease-resistant barley varieties to reduce potential disease severity.

For more information about the work of the CCDM's Fungicide Resistance Group, visit *www.ccdm.com.au/frg* ■

GRDC and Curtin University's Centre for Crop and Disease Management Fungicide Resistance Group leader Fran Lopez-Ruiz is leading research into resistance in barley net type of net blotch. (PHOTO: CCDM)

Spot and stop barley blotch this winter

BARLEY crops in some high and medium rainfall areas may be exposed to damaging levels of spot form of net blotch (SFNB) this winter, but new research shows risks can be reduced with tactical fungicide use.

Crops most likely to suffer from this common disease, caused by the fungus *Pyrenophora teres f. maculata*, are barley planted consecutively after barley on high stubble loads and/or if there have been wet conditions after plant emergence. Production losses can be as much as 30–40 per cent, and there is potential for high screenings at harvest.

Signs to look out for in the paddock include small, solid brown oval lesions on leaves, surrounded by yellow edges. As infections progress, these may elongate and join – causing blotch symptoms.

Research carried out in WA with Grains Research and Development Corporation (GRDC) investment highlights the value of carefully planning the number and timing of fungicide applications to match seasonal conditions, in order to optimise SFNB control and economic returns.

Conducted by ConsultAg and the Department of Primary Industries and Regional Development (DPIRD) in 2015–17, the project – Best practice management of SFNB in barley and interaction with stubble management and head loss – found a potentially expensive fungicide strategy risked providing only marginal returns when early seasonal conditions were dry.

It also showed that when there is a dry start to the season and a slow build-up of disease, stubble management had only a minor impact on SFNB levels.

Crops most likely to suffer from spot form of net blotch are barley planted consecutively after barley on high stubble loads and/or if there have been wet conditions after plant emergence. **(PHOTO: Hugh Wallwork)**

ConsultAg advisor Trent Butcher said the trials found, in high rainfall areas where SFNB pressure was high, a double fungicide spray strategy could improve grain quality, yields and returns.

"If you see disease in the paddock in the next few weeks (late July early August) in these areas, a spray at Zadoks Growth Scale Z31-Z32 can reduce disease pressure and protect the canopy until a second application at Flag–1 stage," he said.

Trent said growers in low rainfall areas could typically get away with one spray application around the Flag–1 stage when growing barley-on-barley crops, as this would protect the top three leaves in the canopy.

Decisions more difficult in drier areas

But he said decision making was more difficult in medium rainfall zones, where fungicide use needed to be more tactical to make economic sense.

"The cost of a single fungicide treatment can be about $10 per hectare, including application, and two-spray strategies can cost up to $30 per hectare," he said.

"Our 2017 trials in medium rainfall zones found all fungicide treatments significantly reduced disease severity, compared with the untreated control, and boosted yields by about 10 per cent (175 kg per hectare) when a double spray strategy was used at Z31 and Z37.

"This led to a marginal economic response of about $20–40 per hectare under high disease pressure (retained stubble) in a low rainfall year.

"The second-best treatment to lower disease levels was a single late application at Z37. A single early application at Z31 did reduce leaf infection by about half compared with the untreated control, but disease was able to re-enter the canopy later in the season."

The GRDC and Curtin University-supported Centre for Crop and Disease Management (CCDM) says this year's discovery of fungicide resistance in the pathogen responsible for SFNB highlights the need for integrated disease control strategies to be used.

CCDM Fungicide Resistance Group leader Fran Lopez-Ruiz said the team's analysis of 2017 crop samples, collected by DPIRD from several paddocks in the Esperance and South Stirling regions, detected the resistance to some Group 3 DeMethylation Inhibitors (DMI) fungicides.

"For growers with DMI resistance or other suspected resistance in their paddocks, it is best to avoid doing two consecutive applications of the same Group 3 fungicide active (either as a foliar or seed dressing) in one season, unless these are used in mixture with a different mode of action (MOA)," he said.

"It is advised to always use fungicide mixtures with different MOA, adhering to label recommendations; to alternate fungicides where possible; and, to never apply the same fungicide or MOA consecutively."

More research with GRDC investment is being carried out into SFNB fungicide resistance and CCDM researchers will use crop samples to assist with this effort.

If growers suspect that fungicides have reduced efficacy in their crops, they can contact the CCDM's Fungicide Resistance Group at frg@curtin.edu.au ■

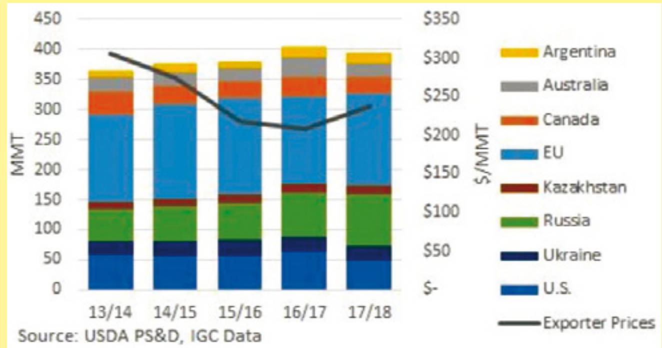
Strong demand pushes global wheat prices higher

By Stephanie Bryant-Erdmann, US Wheat Associates Market Analyst

WITH the world consuming more wheat than it produces for the first year since 2012–13, prices are also on the rise. According to Global Trade Atlas data, the average global wheat price increased four per cent year over year to $203 per tonne in 2017–18 (June 1 to May 31). Most of that price increase occurred in the last five months of the marketing year as the market digested lower Northern Hemisphere wheat production estimates and strong demand for 2018–19.

Here is a by-country look at production estimates in mid-July and the average wheat prices (noting that prices vary by class and quality) from major exporting countries and regions.

FIGURE 1: Exporter production and prices



Source: USDA PS&D, IGC Data

United States

According to the US Wheat Associates Price Report, the average price for US wheat rose an average $47 per tonne from one year ago. Hot, dry conditions in the US hard red winter (HRW) growing region decreased yield potential and pushed prices up for this largest US wheat class. USDA forecasts US 2018–19 wheat production at 49.7 million tonnes (mt), up five per cent year-over-year, but still 11 per cent below the five-year average. US beginning stocks are estimated at 29.4 mt, down eight per cent from 2017–18, but still 28 per cent above the five-year average. Increased US wheat production is expected to offset the lower US beginning stocks and total US supply is expected to remain stable year over year at 79.1 mt.

Canada

The International Grains Council (IGC) reported the average price for Canada Western Red Spring (CWRS) at 13.5 per cent protein (13.5 per cent moisture basis) from Vancouver rose to $255 per tonne in May. This is up $24 per tonne from May 2017 and reflects the tighter global supply and demand picture.

On June 21, Agriculture and Agri-Food Canada (AAFC) forecasted 2018–19 common wheat production (excluding durum) at 25.4 mt, up slightly from 2017–18. A 15 per cent bump in spring wheat planted area contrasts with an 11 per cent drop in winter wheat planted area. Predicted 2018–19 durum production will increase 15 per cent to 5.7 mt due to an 11 per cent year over year increase in planted area.

The global supply and demand situation for durum wheat is also supporting prices. Canadian durum prices at $282 per tonne are an average $7 per tonne above 2017 levels.

European Union (EU)

IGC reported the average French wheat price reached $205 per tonne in May, up from $187 per tonne the year prior. French production is expected to increase to 37.8 mt, up four per cent due to higher expected yield and larger planted area. 2018–19 EU wheat production is expected to fall 1.80 mt from 2017–18 to 140 mt according to Stratégie Grains, which is providing continued price support for exportable French supplies.

Australia

The current average price for Australian wheat of $239 per tonne is up 22 per cent year over year according to IGC data, which point to lower carry-in stocks and hot, dry conditions. In June ABARES forecasted 2018–19 Australian wheat production to rise three per cent from 2017–18 to 21.9 mt, despite a three per cent decrease in planted area to 29.5 million acres (12.0 million hectares).

Argentina

In May, the average price for Argentine wheat reached $261 per tonne according to IGC data. That is up 38 per cent year over year. This month (July) the Buenos Aires Grain Exchange reported Argentine farmers see higher revenue potential and expects them to plant seven per cent more area to wheat in 2018–19, reaching 15.1 million acres (6.1 million hectares). USDA's June estimate for 2018–19 Argentina's wheat production was 19.5 mt, up eight per cent from 2017–18 and 35 per cent greater than the five-year average.

Black Sea (Russia, Ukraine and Kazakhstan)

The average price for Russian 4th grade milling wheat (8.8 to 10.5 per cent protein on a 12 per cent moisture basis) reached $213 per tonne in May, up 14 per cent from the year prior according to IGC. Expectations for lower 2018–19 production in the Black Sea region are supporting export prices.

USDA projects combined 2018–19 output from Russia, Ukraine and Kazakhstan will drop 14 per cent to 109 mt based on an expected return to trendline yields. If realised, the combined harvest would still be greater than the five-year average.

At the end of May, the Russian Meteorological Service noted hot, dry conditions threatened winter wheat in Russia's southern regions, which have not received rain since April. Conversely, cold wet weather is delaying spring wheat planting in other regions.

To date, 23.3 million acres (9.43 million hectares) of spring wheat has been planted, compared to the 2017–18 total spring wheat area of 30.9 million acres (12.5 million hectares). Russian consultancy SovEcon forecasted Russian wheat production to decline to 77.0 mt, down 10 per cent from 2017–18.

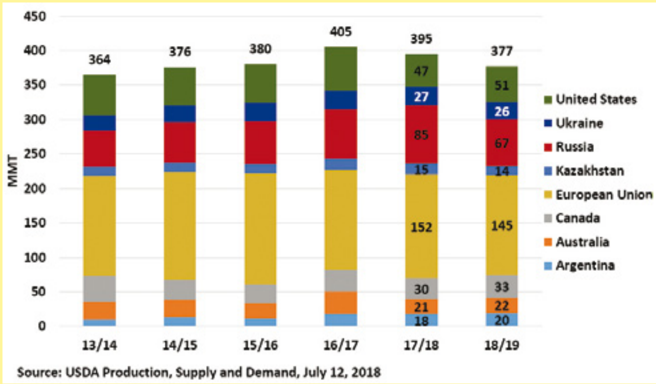
UkrAgroConsult reported Ukrainian wheat planted area increased two per cent year over year to 15.5 million acres (6.28 million hectares). The Ukrainian meteorological service expects wheat yields to fall eight per cent year over year to 3.80 tonnes per hectare. 2018–19 Ukrainian wheat production is forecast at 23.9 mt, compared to 25.4 mt in 2017–18.I GC expects yield declines and smaller planted area will lower Kazakhstan wheat production to 13.7 mt, down seven per cent from 2017–18, if realised. ■

Global grain conditions

By Stephanie Bryant-Erdmann, US Wheat Associates Market Analyst

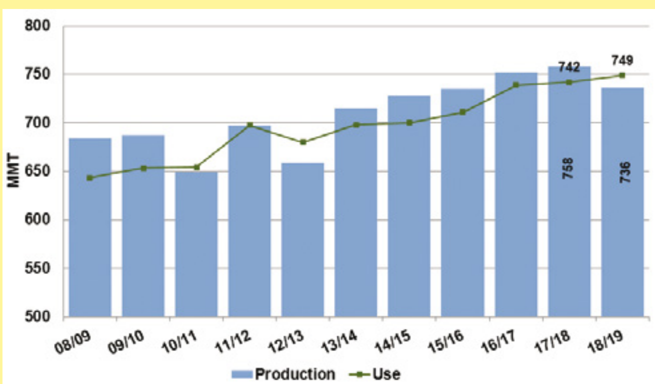
IN its July WASDE report, the USDA raised 2018–19 US wheat production to 51.2 million tonnes (mt), up eight per cent from 2017–18, if realised. Along with the increase, USDA also released its first US by-class forecast for US wheat. Increases in hard red spring (HRS), soft red winter (SRW) and soft white (SW) wheat are expected to more than offset a 12 per cent year over year reduction in hard red winter (HRW). US spring wheat production is expected to increase to 15.9 mt, up 52 per cent from the previous year when drought shriveled the crop.

FIGURE 1: Wheat production in the major exporting countries



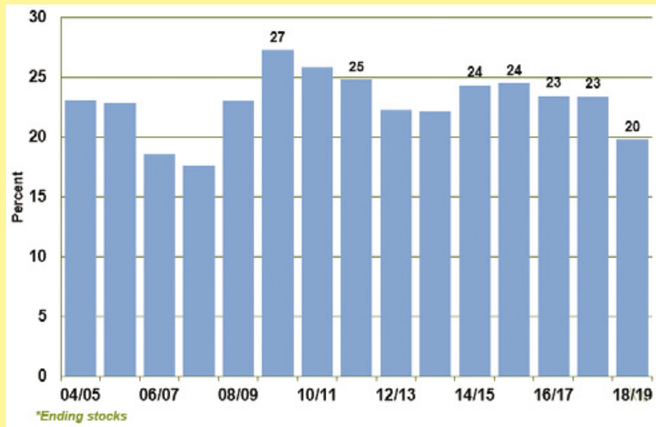
But while wheat production is expected to increase in the US, it is expected to fall globally in 2018–19. USDA forecast 2018–19 total world wheat production at 736 mt, down three per cent from the year prior, if realised. The largest decrease is expected in Russia, which is forecast to produce 67.0 mt, down 18.0 mt from 2017–18 due to poor growing conditions. Wheat production is also expected to fall in the European Union (EU) and Australia due to dry conditions.

FIGURE 2: World production and use



While 2018–19 world wheat production is expected to fall for the first time in five years, world wheat consumption is expected to grow 5.23 mt from the previous year to 749 mt. If realised, world wheat consumption will outpace world wheat production by 12.6 mt in 2018–19.

FIGURE 3: Global stocks-to-use ratio without China



With consumption outpacing production, world wheat ending stocks are expected to fall to 261 mt, down five per cent from 2017–18. The reduction in ending stocks puts the 2018–19 global stocks-to-use ratio (excluding China) just under 20 per cent, which is the lowest level since 2007–08. ■

A hard-earned Chinese thirst needs 138 billion big cold beers

AUSTRALIANS are known for a healthy love of beer, but we're being dwarfed by China when it comes to having a cold one (or a cold several billion).

China's thirst for beer – and the barley that helps make it – shows no signs of being quenched any time soon. China is Australia's largest market for barley by far, taking 4.2 million tonnes worth $1.2 billion each year. Australian barley is used in the premium brewing sector and is also increasingly in demand for animal feed.

To support this crucial market, AEGIC and Barley Australia hosted two Australian Barley Technical Workshops in Guangzhou and Beijing in May, in collaboration with Austrade, CSIRO, SeedNet, InterGrain and Australian grain grower Andrew Weidemann.

AEGIC Barley Markets Manager Mary Raynes said the workshops were attended by over 160 representatives of major brewing companies, members of the livestock industry, and maltsters and traders.

"There was an overwhelming response to the workshops with a range of diverse interests taking part," she said.

Important barley market

"Chinese brewing companies are campaigning heavily on beer promotion, with the total volume of beer sold in China reaching 45.6 billion litres in 2016. This equates to 138 billion 330 ml beers, so it's clear that this market is a very important one for Australia.

"Premium malting barley for brewing is where the best prices are, but feed barley has a larger export volume and this sector is showing strong growth.

"Increasing technical understanding of the production, accreditation and processing of Australian barley for malting and animal feed helps enhance the value of Australian barley. These events help maintain and enhance the relationship between the Australian barley industry and key players in the Chinese brewing industry."

At each of the two workshops, Mary gave attendees an overview of the Australian barley industry, followed by Barley Australia CEO Dr Megan Sheehy with an explanation of the Australian barley accreditation system.

New varieties

National Manager of SeedNet Simon Crane gave a technical overview of the benefits of new malting variety Compass, which was accredited this year along with Spartacus.

InterGrain Barley Breeder David Moody was on hand to explain the benefits of Spartacus and also introduced the upcoming variety, Banks.

The CSIRO's Dr Crispin Howitt gave an interesting presentation on gluten free barley, while grower Andrew Weidemann – who is also Chairman of Grain Producers Australia – presented a grower's perspective on farming malting barley for export markets.

AEGIC consultant Brenton Hosking gave attendees a technical overview of the benefits of using Australian barley in pig feed formulations.

Mary said the panel session gained the most interaction, with topics covering beer flavour, barley protein and barley varieties. ■

A celebratory tipple with Australian beers rounded out a very successful day.

Move over quinoa! We're bringing teff to the plate

By Pamela Tyers, CSIRO

WE'RE developing a range of snacks using teff. We've all heard of quinoa and its touted health benefits, but there's another ancient gluten-free grain that's about to make waves. It's called teff, and it's been a favourite in Ethiopian cooking for centuries.

Teff is the world's smallest grain, and research shows that its fibre content is several times higher than wheat or rice. It also contains resistant starch. Its protein content is similar to wheat and it's higher in iron than the more widely used grains. It's also a good source of calcium and other minerals. To top it off, it contains no allergens.

Riverina farmers, Fraser and Shane McNaul, started growing teff to diversify their cropping program so that it's more sustainable and innovative. Teff's growing season is short, from around December to March, and it fits neatly in between their usual crops of wheat, barley, corn and rice. By the time it's harvested, teff looks like tall grass and the grain is so small it's hard to hold it in your hand because it almost just runs through your fingers.

The McNauls started a company, Outback Harvest, and CSIRO is collaborating with Food Innovation Australia Ltd (FIAL) to help them develop teff-based snacks and baked goods for retail markets around Australia.

With our expertise in food science and new product development, we have developed prototype muffins, bread and dry cake mixes. We also produced extruded teff snacks in our world-class pilot-scale food innovation centre in Werribee, Victoria.

When it's milled, the brown teff produces a darker coloured flour that has a chocolate-like flavour, ideally suited to a product like muffins. The ivory teff produces lighter coloured flour with a nutty flavour, making it perfect for pancakes!

New teff based products are being developed offering a nutritious and allergen-free food option.

Fraser has moved to Melbourne to concentrate on developing packaging, marketing and distributing the first retail products, which have been endorsed as gluten-free by Coeliac Australia and Coeliac New Zealand.

He is considering expanding into other value-adding opportunities such as snack bars, tortillas and flat breads.

Look out for brown and ivory teff foods soon. ■

CSU research: Can coloured rice help people with obesity?

AT A GLANCE…

- Charles Sturt University (CSU) research is investigating the therapeutic effect of coloured rice for obesity and related diseases.
- The research is examining if the bioactive compounds in coloured rice can help reduce blood clotting, inflammation and chemical damage to cells.
- Preliminary studies have shown positive results and volunteers are needed for the next stage of the PhD research in Wagga Wagga.

VOLUNTEERS are needed for research at Charles Sturt University (CSU) in Wagga Wagga into the therapeutic effects of coloured rice for obesity and related diseases, like diabetes and cardiovascular disease.

CSU PhD student Ms Esther Callcott's research is focused on the bioactive compounds found in whole-grain coloured rice.

"Whole grain rice, especially purple and red varieties are rich in antioxidants," Esther said.

"My preliminary research, using stem cells in the laboratory and testing the compounds on blood samples, has shown the compounds may be helpful in reducing inflammation and free radicals.

"These positive results have given us the confidence to move ahead with the next stage of the research and we need volunteers to take part in a study in Wagga Wagga examining the impact of eating coloured rice."

Call for volunteers

- The researchers would like to hear from people who are obese (Body Mass Index of greater than 30).
- People need to be non-smokers, aged between 18 and 65, who are not pregnant and who don't suffer any chronic diseases.
- People will be required to take part in the study for one day each week, for four weeks.
- They'll be asked to eat some rice and give blood samples.
- More information about the study is available here *http://www.csu.edu.au/_data/assets/pdf_file/0019/3025531/Info-on-coloured-rice-research.pdf*

The research is through the Australian Research Council (ARC) Industrial Transformation Training Centre for Functional Grains (FGC) and is supervised by Dr Abishek Santhakumar and Professor Chris Blanchard from CSU's School of Biomedical Sciences *http://science.csu.edu.au/schools/biomed*

For more information or to take part in the study people can email Esther, ecallcott@csu.edu.au

Esther was awarded a scholarship by FGC. Funded by the Australian Government through the ARC's Industrial Transformation Training Centres scheme, the FGC is administered by Charles Sturt University and is an initiative of the Graham Centre for Agricultural Innovation *http://www.csu.edu.au/research/grahamcentre/home* ■

CSU PhD student Ms Esther Callcott is calling for volunteers to help her research into the impact of eating coloured rice.

Agriculture is widely recognised as one of northern Australia's key areas of possible growth and expansion. With its proximity to Asia, large land mass, high-rainfall and water resource developments, northern Australia's potential has been touted for many decades. This special report from ANZ Agribusiness delves deeper into this potential.

Beefing up northern agriculture

RISING demand from emerging economies, particularly in Asia, continues to create enormous opportunities, underpinning longer-term viability for northern Australian producers. But to achieve its full potential, broad-scale expansion of the region's agriculture industry is necessary but has been slow to materialise.

Capital investment and AgTech have been publicised as catalysts for the next wave in growth and expansion in the global agriculture sector. As northern Australian expands not only its existing agriculture sector, but also develops multiple greenfield developments – ranging from aquaculture, tropical fruits and horticulture – attracting new investment and utilising it well will be core to the success of northern Australian agriculture.

The face of northern Australian agriculture

Northern Australia agriculture was worth approximately $8.3 billion in 2016–17 – just under 14 per cent of total Australian agricultural production. Northern Australia's industry has been dominated by cattle production for many years, which continues to be the largest single commodity produced. But recent years has seen the rise of a number of alternative commodities, particularly horticulture.

While northern agriculture production largely reflects the distribution of soil and water resources, the promise of infrastructure spend has led to a renewed focus on sugar and a range of horticulture commodities, including bananas, mangoes, melons and avocados.

Irrigated production makes-up a considerable part of this production, totalling approximately $2.6 billion in 2016–17 with the majority of this production in Queensland.

The CSIRO has identified a potential increase of 50 per cent in the total value of Australian agricultural production stemming from around 90 water resource projects north of the Tropic of Capricorn.

Growth in the northern Australian agriculture sector has also been driven by federal and state government investment in water and transport infrastructure, thus enhancing the area available for intensive agriculture and reduce transport times to port.

Capital investment and AgTech have been publicised as catalysts for the next wave in growth and expansion in the global agriculture sector.

On current distribution of irrigated commodity production across northern Australia, an increase of 1.1 million hectares of irrigated land in northern Australia could see agricultural production grow by as much as $7.4 billion in 2016–17 figures, although this figure will be further influenced by the quality of soils and access to potential irrigation schemes.

The investment case for northern cattle

To attract investment and capital to northern Australia, it is important to highlight the region's growth potential and to demonstrate the advantages it has over its southern counterparts, where many fund and capital managers are based and focused.

The most obvious comparison between the northern and southern industries lies in cattle. Research has shown that northern Australia's cow/calf production system of selling into live export markets, typical of northern beef production, to be the most efficient and cost-effective cattle production system.

Data from the Australian Bureau of Agricultural and Resource Economics and Statistics (ABARES) compares the financial

Cattle production in the highest value single commodity in northern Australia, but in recent times there has been a rise in commodities such as horticulture.

TABLE 1: 2016–17 gross value of northern Australia agricultural production[1]

	Total (million)
Cattle and calves	$4,923.1
Sugar cane	$1,321.2
Bananas	$530.4
Pulses	$236.7
Tomatoes – *fresh market (outdoor & undercover)*	$109.1
Mangoes	$103.7
Cotton lint – *(irrigated & non-irrigated)*	$94.3
Wheat	$87.0
Avocados	$60.5
Poultry	$57.7
Hay	$55.2
Total northern agriculture	**$8,300.0**

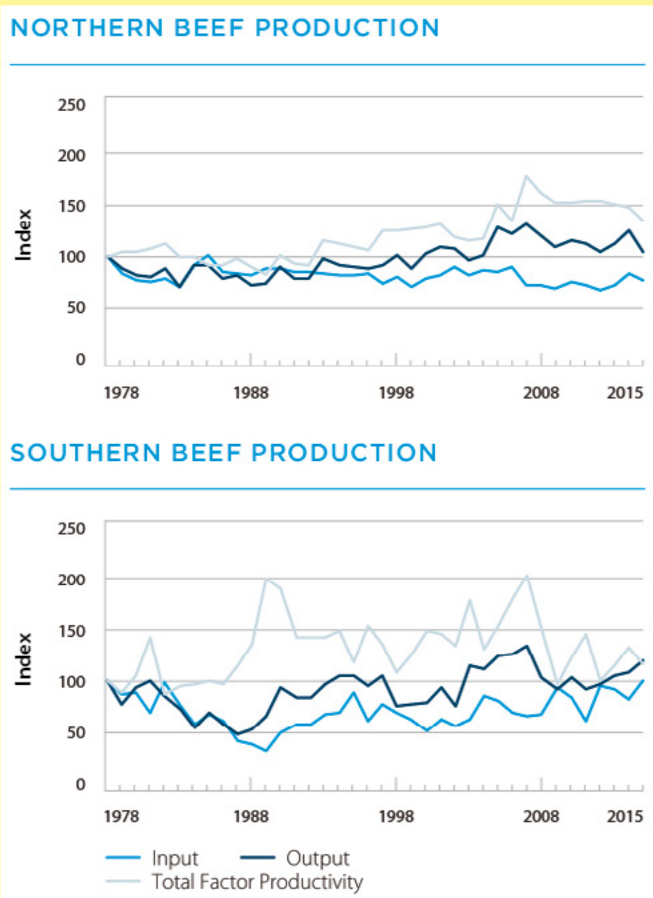
1 Production figures calculated on SA2 basis, and provide approximate figures only.
Source: ABS, ANZ

performance, production costs and productivity of the northern and southern beef production systems over a number of years.

ABARES data shows that since 2007–08 the northern beef production system has grown in productivity at a stronger rate than the southern system, reversing a 20-year trend (Figure 1).

Industry research, a more strategic approach to building and developing new markets, and the adoption of AgTech have all played a part in improving farm gate returns and, as a consequence, attracting new capital to the sector.

FIGURE 1: Northern Vs Southern beef production productivity



Source: ABARES, ANZ

Land and capital values in the northern and southern regions have followed similar trends, increasing 55 per cent from 2000–01 to 2015–16 in both regions, with a greater trend towards farm consolidation in the south than the north. But given the overall lower value of land per hectare in northern Australia and the push towards farm consolidation in the south, capital investment trends show that southern producers spent a greater proportion of investment on land while northern producers were able to utilise capital to invest in key drivers of cashflow, such as stock numbers and productivity improvements.

On these figures, northern Australia presents a strong case for investors looking for a relatively stable cost base, with greater ability to reap short-term gains on livestock investment compared with the sunken capital required for purchasing land and achieving scale in the south.

As a result, investors will turn their focus to the potential for income and productivity gains which come from further capital investment in northern Australian agriculture.

One answer to this lies in the potential of AgTech to lift productivity and output for northern Australian cattle, horticulture, aquaculture and cropping producers alike.

AgTech and growing northern Australian agriculture

A report by ANZ (2017) on the on the role of AgTech in Australian agriculture found that 62 per cent of the sector's productivity growth since 1995–96 was a result of technological advancements.

Furthermore, for every one per cent increase in capital investment in the agriculture industry, there is a 1.5 per cent increase in technology-based productivity gains.

While productivity in the northern Australian cattle industry is well discussed, the new wave of horticulture, fisheries and other non-broadacre farming will deliver new investment and capital into the industry. But how will this impact the industry's value?

Analysis of the northern agricultural sector, its capital base and potential growth scenarios highlight the need for additional capital investment and, most importantly, capital investment which increases productivity either by increasing outputs or lowering costs (Table 2).

For instance, attracting $15 billion of additional capital, which improves productivity growth to three per cent each year, would result in a 52 per cent increase in the size of the industry by 2030 – a cumulative increase in production of almost $73 billion.

In contrast, attracting just $4.7 billion, or capital growth of 0.5 per cent and productivity growth of one per cent per year, would result in a 16 per cent larger industry with cumulative growth of $57 billion.

These figures highlight not only the importance of attracting investment to the north, but also the need to attract the right investment, which increases the productivity of existing resources, including land, water, equipment and livestock. It also shows the potential that exists for investors and capital to invest in growing the size of northern Australia's agriculture industry.

But in addition to attracting capital there are a number of well-documented hurdles to achieving productivity growth. These include:

- **Transport and logistics infrastructure –** Large distances from production to port mean that investment in infrastructure is required to lower transport costs and ensure that produce can be exported in a timely manner, without a loss in quality;

TABLE 2: Impact of capital investment and productivity growth for northern Australian agriculture

	Base case	Moderate case	Aggressive case
Capital stock growth	0.5% p.a.	1.0% p.a.	1.5% p.a.
Productivity growth	1%	2%	3%
Impact of capital investment and technology on production			
Additional capital required by 2013	$4.7b	$9.7b	$15.0b
Size of northern Australian agriculture industry by 2030	$9.6b	$11.0b	$12.6b
% Growth in industry since 2017	15.7%	33.0%	52.1%
Cumulative growth in production between 2018 and 2030	$57.0b	$64.6b	$72.7b

- **Branding –** Differentiating and value-adding for northern Australian produce, as distinct from generic Australian produce, both for domestic and international markets;
- **Land titles –** Improving certainty around land tenure will increase investors' willingness to invest against land as a long-term asset; and,
- **Developing water resources –** Water remains one of northern Australian agriculture's key advantages, but it is currently underutilised, constraining growth, particularly in water-intensive industries such as horticulture.

For every one per cent increase in capital investment in the agriculture industry, there is a 1 .5 per cent increase in technology-based productivity gains.

To sum up

Despite many years of talking about the potential for growth and expansion in northern Australian agriculture, progress to date remains relatively subdued. Slow progress in the expansion of identified irrigation schemes and difficulties associated with turning government and industry intentions into concrete outcomes has meant that much potential is, as yet, unfulfilled.

This may, in part, be due to a range of risk factors that are unique to northern Australia and which any potential investor must also consider. These include the heavy exposure of the northern Australian cattle industry to the Indonesian live export market, unpredictable seasons and rainfall, and the need for direct air freight routes to improve the viability of the northern horticulture industry.

While there is clear potential for expansion in the northern Australian agriculture industry which supports the case for investment and capital from outside government, there remains a number of hurdles and risks facing the development of the industry.

As agriculture continues to boom across Australia, competition for investors' capital is also increasing. Taking advantage of capital and investment to improve productivity in northern Australian agriculture will rely on the industry's and producers' ability to underpin their own business and investment cases which mitigate those risks faced in northern Australia. ■

Helicoverpa in pulses and the new resistance management strategy

By Melina Miles, Adam Quade, Trevor Volp, DAF Queensland

AT A GLANCE…

- The *H. armigera* resistance management strategy is designed to prolong the useful life of the newer chemistry currently available to pulse growers. Familiarise yourself with the strategy and the full range of options available for Helicoverpa control in chickpeas, mungbeans and soybeans. Consider what products you will use if a second spray is required in these crops.

General rationale for the design of the strategy

Chickpeas and mungbeans are currently, and for the foreseeable future, the most valuable grains crops influenced by the *Helicoverpa armigera* Resistant Management Strategy (RMS). Therefore, the resistance management strategy is primarily focused on insecticide Modes of Action (MoA) rotation in these systems and is built around product windows for Altacor and Steward because:

- Altacor (chlorantraniliprole) is at risk from over-reliance in pulses, but resistance frequencies are currently low.
- Steward (indoxacarb) is at risk due to genetic predisposition (high level genetic dominance and metabolic mechanism) and pre-existing levels of resistance in NSW and QLD (with elevated levels in CQ during 2016–17). In addition, the use of indoxacarb in pulses may increase as generic products come on to the market.

There are two regions within the RMS, each with their own resistance management strategy designed to make the most effective products available when they are of greatest benefit, while minimising the risk of overuse:

1. Northern Grains Region: Belyando, Callide, Central Highlands and Dawson (Table 1); and,
2. Central Grains Region: Balonne, Bourke, Burnett, Darling Downs, Gwydir, Lachlan, Macintyre, Macquarie and Namoi (Table 2).

- The RMS provides windows-based recommendations common to these regions because *H. armigera* moths are highly mobile and have the capacity to move between these regions.

Helicoverpa armigera.

- No RMS is currently proposed for the Southern and Western grain regions (Victoria, South Australia and Western Australia) for winter crops. Biological indicators suggest that that the risk of *H. armigera* occurring in winter crops, at densities where control failures may occur, is presently considered low. Helicoverpa control in summer crops in these regions should use the Central Grains region RMS.

Use of broad-spectrum insecticides

The early use of synthetic pyrethroids (SPs) in winter pulses (August – early September) is adopted where the assumption is made that early infestations of Helicoverpa will be predominantly *H. punctigera* which are susceptible to SPs. Similarly, the use of carbamates to delay the application of Group 28 or Group 6 products, carries risks. If adopting this strategy, be aware of the following risks:

- Recent monitoring with pheromone traps has shown *H. armigera* to be present in all parts of the Northern Grains region from early August (*www.thebeatsheet.com.au*).
- Reduced efficacy of SPs and carbamates against *H. armigera* can be masked when treating very low population densities (less than three per m^2).
- If *H. armigera* are present, even at low levels in a population treated with SPs or carbamates, the treatment will select for further resistance. While initial applications may be effective, later treatments may be significantly less effective.

The number of uses in the RMS is more restrictive than stated on the Altacor label. Why?

To avoid repeated use of either Steward or Altacor within the use window, the number of allowable applications is one per crop. While this is currently inconsistent with the Altacor label (two applications per crop), we expect that there will be changes to the label to ensure consistency in these recommendations.

Does the RMS impact on recommendations for insecticide use in cotton and other crops?

The RMS is not intended to compromise the ability of the cotton industry to use any products registered for Helicoverpa in Bollgard cotton. This is because selection for insecticide resistance is considered low due to the high likelihood that survivors of

Chickpeas are one of Australia's most valuable winter pulses.

TABLE 1: Grains resistance management strategy for *Helicoverpa armigera* across Australia.
Best practice product windows and use restrictions to manage insecticide resistance in *H. armigera*.
Northern Region: Belyando, Central Highlands, Dawson and Callide.

SELECTIVITY (Increasing ↑ / Decreasing ↓)

Insecticide	June				July				Aug				Sept				Oct				Nov				Dec				Jan				Feb				Mar				Apr				May			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Bacillus thuringiensis																																																
Helicoverpa viruses																																																
Paraffinic oil (Note 1)																																																
Chlorantraniliprole (Note 2, 3)																																																
Indoxacarb (Note 4)																																																
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Emamectin benzoate (Note 2, 4, 5)																																																
Carbamates (Note 2, 4 6)																																																
Pyrethroids (Note 2, 4, 7)																																																

No restrictions	DO NOT USE during this period	No more than one application per crop per season	No more than two applications per crop per season

ADDITIONAL INFORMATION

Notes:

1. Some nC27 paraffinic spray oils can be used to suppress Helicoverpa populations and are best used as part of an IPM program.
2. Observe withholding periods (WHP). Products in this group have WHP 14 days or longer.
3. Maximum one spray of chlorantraniliprole alone or in mixtures per crop per season.
4. Refer to label for warning of insecticide risk to bee populations.
5. Maximum two consecutive sprays alone or in mixtures per crop per season.
6. MODERATE RESISTANCE IS PRESENT IN *H.ARMIGERA* POPULATIONS – FIELD FAILURES LIKELY.
7. HIGH RESISTANCE IS PRESENT IN *H.ARMIGERA* POPULATIONS – FIELD FAILURES EXPECTED!

TABLE 2: Grains resistance management strategy for Helicoverpa armigera across Australia.
Best practice product windows and use restrictions to manage insecticide resistance in *H. armigera*.
Southern QLD, Central and Northern NSW Regions: Balonne, Bourke, Burnett, Darling Downs, Gwydir, Lachlan, Macintyre, Macquarie and Namoi.

SELECTIVITY (Increasing ↑ / Decreasing ↓)

Insecticide	June				July				Aug				Sept				Oct				Nov				Dec				Jan				Feb				Mar				Apr				May			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
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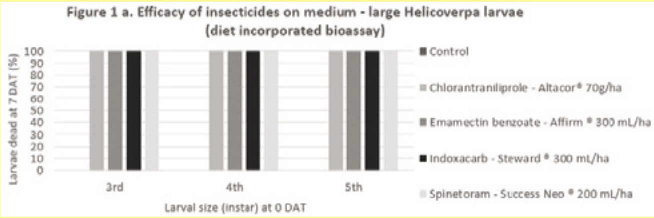
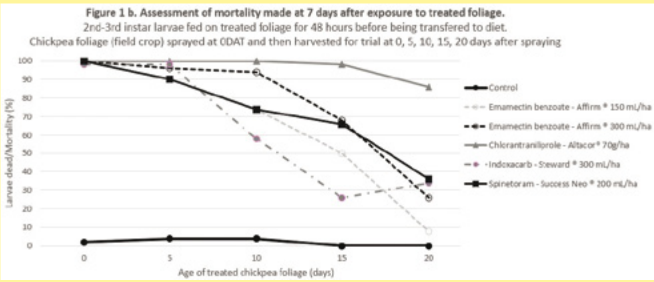
FIGURE 1: Relative efficacy (a) direct contact and (b) residual, of softer options for Helicoverpa control in chickpea and mungbean crops





conventional sprays used in Bollgard cotton would be killed by Bt toxins expressed in plants.

Similarly, the RMS does not attempt to align the use of the Group 28s in mungbeans and chickpeas with use in other grain crops or horticulture. To do so would add a level of complexity that would make the RMS impractical.

Shouldn't other modes of action (MoA) be windowed to prevent resistance?

There is little evidence to suggest that other products should be windowed now to slow the development of future resistance.

Both Affirm (emamectin benzoate) and Success Neo (spinetoram) show no sign of reduced susceptibility in testing. This result is consistent with the relatively limited use these products in the grains industry to date. If a shift in susceptibility is detected in future testing, it is the intention that the product/s will be windowed to limit selection pressure. The SPs and carbamates are not windowed because there is already well established, relatively stable moderate-high levels of resistance to these MoAs, and limiting their use will not change this situation.

By restricting the use of just the 'at risk' products, keeping the RMS as simple as possible, and allowing maximum choice of registered products we anticipate that the grains industry will be more inclined to use the RMS.

What is the relative efficacy of the 'softer' options for Helicoverpa control?

In 2017, QDAF entomology undertook a number of trials to compare the knockdown/contact efficacy, and residual efficacy (persistence in the crop) of Altacor, Steward, Affirm and Success Neo. The purpose of these trials was to provide agronomists and growers with information on how well each of the products worked, and to provide confidence to use another option, rather than relying solely on the Group 28 products.

The results show that these products are equally effective on 3rd, 4th or 5th instar larvae that receive a lethal dose of the product – as would be achieved with good spray coverage (Figure 1a).

But there is considerable benefit in products persisting in the crop to control larvae that may hatch after the spray, or emerge from flowers, buds or pods where they may have been protected from an earlier application. The long residual efficacy Altacor has been a major factor in its popularity.

The data in Figure 1b shows the relative efficacy of these products from 0–20 days after treatment in the field (at five day intervals).

For more information on the relative performance of these products in terms of feeding potential and recognising larvae affected by the different insecticides, see recent articles on the Beatsheet blog (*www.thebeatsheet.com.au*). ■

TABLE 3: Explanatory notes for product windows in all regions

Insecticide	Number of insecticide windows	Duration of insecticide windows	Maximum number of applications/crop/season
Chlorantraniliprole (Altacor®)	2	10 weeks	1
• 10 week windows restrict selection to a maximum of 2 consecutive generations of *H. armigera* (includes 2-3 weeks residual beyond the end of each window i.e. 12-13 weeks total exposure). • Start date of first window correlates well with historical data relating to average daily temperatures that result in early pod-set. • Exposure of 2 consecutive generations is off-set by long non-use periods (8 weeks in southern/central region and 18 weeks in northern region). • Use is not recommended in spring mung beans as there is less likelihood of both *H. armigera* and bean pod borer being present.			
Indoxacarb (e.g. Steward®)	Northern - 3 Central - 2	6 weeks	1
• 6 week windows restrict selection to a single generation of *H. armigera*. • Each window is followed by a non-use period of a minimum of 6 weeks. • Indoxacarb is an important early season rotation option for chickpeas and faba beans, and provides a robust selective alternative to Altacor® when Helicoverpa pressure is high.			
Bacillus thuringiensis	1	Season long	No restrictions
Helicoverpa viruses			No restrictions
Spinetoram (e.g. Success Neo®)*			2
• Low resistance risk and not widely used.			
Emamectin benzoate (e.g. Affirm®)*	1	Season long	2
• Very low resistance frequency and not used widely. • However, emamectin benzoate is a good option for rotation to spread resistance risk away from Altacor®. • BUT industry needs to become more confident with using this product for it to be of value in resistance management.			
Carbamates	1	Season long	1
Synthetic pyrethroids			
• *H. armigera* resistance is present at moderate to high levels, but one strategic application per season in regions where *H. punctigera* predominates in early spring may be effective. • Carbamates are a rotation tool for indoxacarb and Altacor® either early season in chickpeas or late season in mungbean.			

*Resistance monitoring for selective products is a key component of the RMS and changes in resistance frequencies will result in the introduction of product windows for those insecticides not currently windowed.

RUTHERGLEN BUG BUILD UP IN CANOLA

AT A GLANCE…

- Rutherglen bug adults are present in canola crops much earlier than was previously thought. Females are depositing eggs in the soil and leaf litter from early spring through to harvest. At this point, there is no obvious option for preventing the build-up of large populations of nymphs in canola stubble, but recent work is helping to understand how these populations develop.

In recent seasons, higher densities of Rutherglen bug (RGB) have been experienced. One of the challenges of this higher RGB pressure has been the movement of large numbers of nymphs from canola stubble into neighbouring summer crops. Through sheer weight of numbers, RGB nymphs can kill sorghum, cotton, soybean, corn and sunflower plants in the rows closest to canola. The movement of nymphs can occur over a period of weeks, and even regular spraying of the affected crops may not prevent significant crop loss.

Understanding how these enormous populations of nymphs develop is key to working out how they might be prevented, or managed, so that they don't affect neighbouring summer crops. Rather than focusing on controlling the nymphs, we were interested in whether there may be an opportunity to control the adults before they reproduce.

During the spring of 2017, QDAF entomology monitored a number of canola crops, from the Darling Downs to the Liverpool Plains. We assessed the density of adults in the canola, dissected females to determine if they were reproductive (laying eggs), and assessed the crops for nymphs.

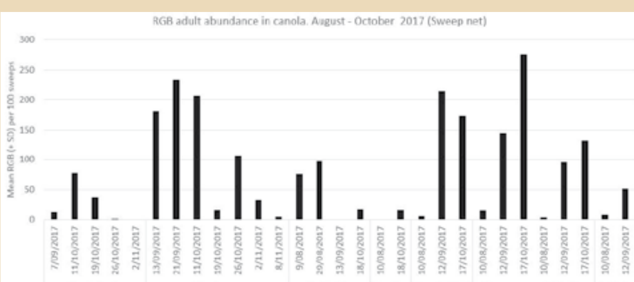
We also attempted to determine the timing of egg laying by assessing the density of eggs – but we were unable to do this effectively. Other than determining that eggs are deposited in the soil and on the leaf litter on the soil surface (not in the crop canopy), we could not reliably assess egg density.

While this is only one season of data, it is presented here to highlight the following key findings.

RGB adults were present in the canola crops much earlier than we expected (Figure 1). Even at the most southerly site (Curlewis, NSW), RGB adults were present in canola from early August. At most sites, numbers increased through September and October.

Female RGB were reproductive (had mature eggs in their ovaries ready to lay) from September onwards, and the percentage of the population that was reproductive increased from September through November.

FIGURE 1: RGB adults were present in canola from late winter (August–September)



(SD = standard deviation)

Rutherglen bugs.

Although the majority of female RGB were reproductive, and laying eggs, we did not see nymphs start to emerge until much later than expected based on the day degrees accumulated during this period (Figure 2).

It is possible that the development of eggs is slowed by the relatively cool temperatures experienced on the soil surface under the leaf litter and crop canopy. When the crop is harvested or windrowed, the temperature of the soil quickly rises, potentially resulting in synchronous hatching of eggs that have been laid over a period of two to three months.

More data is needed over additional sites and seasons to confirm our theory, and closer monitoring of soil temperature and RGB egg development is also needed to understand exactly what is happening.

The take home message from this RGB work is that there doesn't seem to be an easy fix to prevent the build-up of RGB nymphs in canola stubble. The long period of egg laying by the females, and the potential challenges with controlling nymphs on the ground under the crop canopy, means that there is no obvious opportunity to prevent the population build up.

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

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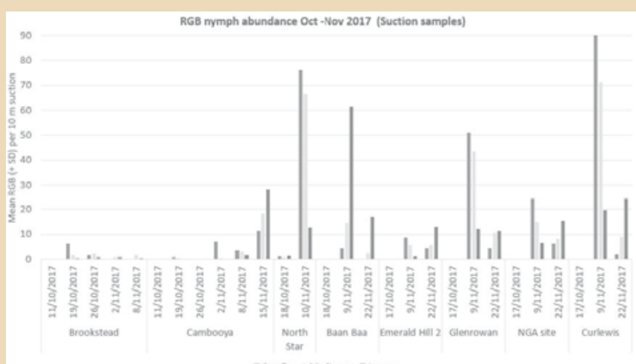
E: melina.miles@daf.qld.gov.au

FIGURE 2: Nymphs did not start to emerge until much later than expected based on the day degrees accumulated during this period, despite the majority of female RGB being reproductive and laying eggs



Harvest weed seed control – beyond windrow burning

By Greg Condon and Kirrily Condon – Grassroots Agronomy and Australian Herbicide Resistance Initiative

AT A GLANCE…

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

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

One of the most popular weed management tactics being adopted in recent years is harvest weed seed control (HWSC).

This process takes advantage of seed retention at maturity by collecting weed seeds as they pass through the harvester. Problematic weeds such as annual ryegrass, brome grass and wild radish retain 77–95 per cent of their seed above a harvest cut height of 15 cm at maturity, creating an ideal opportunity for seed collection.

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

The most successful weed management tactic to emerge in recent years is harvest weed seed control.

In the southern cropping region, low harvest height has been a barrier to adoption with growers not wanting to slow harvest down, incurring higher fuel costs and reducing harvester efficiency. Growers and researchers have since been looking at tactics that will enhance the efficacy of harvest weed seed control without slowing harvest.

One option being adopted is sowing crops at narrower row spacings or higher plant populations. Weeds are then forced to grow taller to compete for light, therefore producing seed higher in the crop canopy.

Stripper fronts are also being investigated to gauge any differences with weed seed capture and harvest efficiency, reducing the need to cut low whilst minimising fuel consumption.

Harvest weed seed control (HWSC) practices

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

Research by Walsh *et al*., 2014 highlighted that harvest weed seed control tactics are equally effective in reducing weed seed production. The use of chaff carts, narrow windrow burning or the Integrated Harrington Seed Destructor, were compared at 24 sites across Australia with an average reduction in ryegrass of 60 per cent germination the following autumn.

This was achieved by removing 70–80 per cent of the seed at harvest through either burning or destruction of weed seeds.

Research has recently commenced to gauge the impacts of chaff lining and chaff decks on the rotting of weed seeds under different crop types. Preliminary data suggests poor seed survival under canola or barley chaff because of an allelopathic effect. But in wheat there was high ryegrass seed survival underneath the chaff row which is unexplained.

Michael Walsh from Sydney University and John Broster from Charles Sturt University are currently working to quantify the value of rotting under chaff line and chaff deck systems.

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

Harvest weed seed control cannot be used in isolation for weed management; growers and advisers should implement

a range of diverse weed management practices to drive weed numbers down.

Defined as the 'Big six', these management practices include diverse rotations, mix and rotating herbicides, crop competition, double knocks, crop topping/hay to stop seed set and harvest weed seed control. The 'big six' complements best practice agronomy such as calendar sowing combined with effective pre-emergent herbicide packages.

Harvest weed seed control adoption

An online twitter survey was conducted in November 2017 by WeedSmart with 269 growers responding. The results indicated that harvest weed seed control practices are changing, with narrow windrow burning declining at the expense of chaff lining and chaff decks. 32 per cent of growers were planning to use narrow windrow burning in 2017 whilst 26 per cent would be chaff lining and 9 per cent using chaff decks. Chaff carts were stable at 13 per cent, mill technology at three per cent and 14 per cent would be doing nothing.

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

Narrow windrow burning (NWB)

Developed in the northern WA cropping zone, narrow windrow burning has been highly effective at reducing annual ryegrass and wild radish seed banks across the nation.

A chute is attached to the back of the harvester to concentrate straw and chaff into a 500–600 mm narrow windrow; these rows are then burnt the following autumn. The practice is low cost and highly effective with rows burning hotter for longer than a standard stubble burn. Up to 99 per cent of weeds seeds are controlled in a well managed hot burn where temperatures reach 400 to 500°C for at least 10 seconds.

Despite its simplicity and popularity, the practice is now in decline due to several factors.

- Burning is the major challenge, especially if fire escapes from the rows to burn the whole paddock or trees.
- Rows becoming wet after summer rains can create challenges waiting for the rows to dry out for the fire to burn hot enough and destroy weed seeds.
- Nutrient redistribution and ground cover loss are also key issues for growers using narrow window burning, particularly on lighter soil types.

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

Glenvar Bale Direct

Chaff and straw are collected during harvest then baled directly using a baler attached to the harvester. There is a moderate level of groundcover removal with straw and chaff

Narrow windrow burning is highly effective.

TABLE 1: Harvest weed seed control options

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

The straw residue is separated into chaff and weed seed fractions with the chaff dropped into a narrow line via a chute.

The harvest weed seed control tactic needs to be matched to the individual farming system.

removed, whilst weed seed removal is high. A large capacity harvester is needed to operate the baler but does not slow the harvesting operation down. Growers would require access to markets to utilise the bales for bedding or as a feed source.

Chaff carts

The first harvest weed seed control tactic tool introduced from Canada for the collection of chaff material for feeding to sheep. A cart is towed by the header which collects chaff and weed seeds then dumps it in piles for grazing or burning. The original blower delivery system was improved with a conveyor belt elevator which allows some small straw into the chaff fraction.

The increased oxygen levels in the chaff has resulted in a quicker, hotter burn. Burning of chaff piles has created similar issues to narrow windrow burning with chaff piles smouldering for long periods.

New research is proving the value of chaff dumps not only for weed seed reduction but also sheep feed. Chaff piles can be grazed by sheep directly or baled for sale into feedlots or other associated markets.

Ed Riggall is a sheep consultant from WA who has found that sheep grazing chaff piles gained 3kg/head more over three weeks than those without chaff piles. This was despite the sheep taking one week to get used to the chaff piles.

Chaff piles are reducing supplementary feeding costs and increasing scanning results while reducing weed seed numbers. Studies have shown that sheep do not spread weed seeds, with only three to six per cent of seed remaining viable after passing through the rumen.

Cattle are less effective at destroying ryegrass seed with 15–20 per cent of the seed remaining viable.

Chaff lining

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

Chaff lining is repeated on the same runs year after year to allow weeds to continually rot in a defined area. There is limited research data to quantify the full impacts of seed rotting but observations to date indicate the undisturbed chaff row is a hostile environment for weed seeds.

Growers don't need to be on a full controlled traffic farming system but ideally the header needs to run on the same lines each year.

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

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

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

Refinements to chaff lining are ongoing as growers work with each other and industry to achieve continuous improvement with the practice.

Chaff decks

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

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

Chaff decks systems have opened new opportunities for alternative forms of weed control not previously thought possible.

Weed seed collection has been so effective that very dense populations have emerged in defined rows on the tramlines in crop. Due to the nature of permanent control traffic farming tramlines, growers can use a range of alternative chemistry or cultural practices throughout the season and not affect the main crop.

For example, in a 12 metre control traffic farming system only eight per cent of the paddock is dedicated to wheel traffic therefore weeds in the chaff lines can be targeted using non-

chemical options such as microwave, baling or crimping as potential forms of site specific weed control.

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

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

Integrated Harrington Seed Destructor (iHSD)

Recognised as the ultimate form of harvest weed seed control tactic, the mill technology conceived by Ray Harrington is now reaching commercial reality for growers. The Integrated Harrington Seed Destructor (iHSD) has two hydraulically driven cage mills that are mounted within the back of the harvester (just below the sieves). The mills can destroy 93–99 per cent of the weed seeds and then spread the material back out on the paddock without any loss of stubble or nutrients.

Suitable for fitting onto all class eight, nine and ten harvesters the mill has been tested to destroy 96 per cent of annual ryegrass seeds, 99 per cent of wild oat seeds, 99 per cent of wild radish seeds and 98 per cent of brome grass seeds in the chaff.

Seed Terminator

Developed by Nick Berry and his group in South Australia the Seed Terminator uses a multi stage hammer mill on weed seeds in the chaff fraction. The mill uses a combination of processes to shear, crush, grind and high impact to destroy over 90 per cent of weed seeds. More research is under way to further quantify this weed seed kill.

The mill is mechanically driven with three stages of screen to sort material for size and can be operated at dual speeds of 2800 and 2950 RPM.

To sum up

Growers now have available a diverse range of harvest weed seed control tactics at their disposal depending on their farming system, location and scale. The options are becoming less labour intensive with a shift away from burning of windrows towards chaff lining or mill technology which leave crop residues and nutrients in place.

Although intensive croppers have previously been the major adopters of harvest weed seed control tactic, mixed farmers can also benefit through grazing chaff dumps or chaff lines while reducing weed seed banks.

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

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

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Formulation helps to increase nutrient uptake

THE division of Yara Crop Nutrition known as YaraVita has been developing foliar nutritional solutions for more than 50 years. The business started in 1967 as Phoysn, in the north east of England at Pocklington and has grown to become a supplier of high quality micronutrient products around the world.

The name Phosyn came from the word 'photosynthesis', as it could be seen that more than just NPK fertiliser was needed to allow photosynthesis to operate efficiently and maximise energy production for high yielding crops. Phosyn was acquired by Yara Crop Nutrition in 2006, signifying the important role that foliar nutrient contributes to crop production.

During the development of YaraVita liquids and Suspension Concentrate (SC) products, it has been clearly evident that high quality formulations are the key to enhanced safety and efficient delivery of foliar micronutrients. YaraVita products use many different raw materials but it is the properties of the finished formulated products that provides the benefits. Using unformulated raw materials to supply foliar micronutrients means you are missing out on the benefits, leading to reduced performance and increased potential crop damage.

YaraVita Glytrel ZnP and Glytrel MnP are great examples of the benefit of formulated foliar fertilisers. They are both compatible with glyphosate for co-application to glyphosate tolerant crops. But these products are made either with zinc sulphate or manganese sulphate, which is not compatible with glyphosate.

By simply comparing the actives listed on the label, the total value of YaraVita foliar fertilisers will be under estimated.

Benefits of formulated product

Benefits that formulated YaraVita products offer:

- YaraVita products contain their own wetting agents, sticking agents and adsorption agents. The combined effects of these agents helps to increase nutrient uptake.
- Products are easy to use; simple measurement, decant quickly out of drum or shuttle, disperse quickly in spray tank.
- Rainfast – once spray droplets are dry on the leaf surface the application is safe and will not wash off, keeping applied nutrients where they can be utilised by the developing crop.
- The purity of raw materials selected for this product makes it safe for application to the crop and helps ensure that harvested produce will not be rejected at any point in the supply chain – ISO 9001 accredited.
- A wide range of tank mix compatibilities makes it easy to co-apply with agrochemicals, saving both time and money – supported by TankmixIT (Free app available to download).
- Better nutrient value proposition for growers.

Tried and tested

Growers, agronomists and operators can be confident as YaraVita products have had many years of testing to confirm improved nutrient uptake, high level of crop safety and superior product performance over unformulated products, particularly after rainfall. ■

New National Grain and Fodder Innovation Awards

TWO new national innovation awards for the grain and fodder industries will be introduced at this year's Royal Adelaide Show.

The Nufarm National Grain Innovation Award and the Pasture Genetics National Fodder Innovation Award aim to recognise growers across Australia who have redeveloped their farming practices to adapt to change, increase production and/or demonstrate sustainability. Entries can be submitted in written or video form.

Nufarm ANZ Regional General Manager Peter O'Keefe said that as an Australian headquartered global company, focused on innovation that benefits local growers, they have great pleasure in sponsoring this Award.

"The Nufarm National Grain Innovation Award will recognise and reward a local grower who has brought innovative practises to the way they work, enabling them to be more successful," Peter said.

"Australian growers are some of the most progressive and resilient producers anywhere in the world and I am confident that the calibre of entries will be exceptional."

Pasture Genetics Research and Technical Services Manager Tom Damin said that Pasture Genetics is committed to researching, selecting, marketing and distributing the most innovative and productive forage seed technology.

"It is a natural fit for Pasture Genetics to partner with the Royal Adelaide Show to inaugurate the Pasture Genetics National Fodder Innovation Award," Tom said.

"As a family-founded and operated company built on Australian innovation, leadership and bold future thinking, we want to reward Australian farmers who are introducing new ideas and technologies, that can benefit not only their operations but the wider industry."

All entries will be assessed by an independent industry representative and representatives from the RA&HS Grains & Fodder Committee, Nufarm and Pasture Genetics.

The winner of the Nufarm National Grain Innovation Award will receive funding to the value of $5000 toward an overseas study tour to further the winner's knowledge of innovative farming practises. The winner of the Pasture Genetics National Fodder Innovation Award will receive proprietary seed product to the value of $3000 and a one-on-one on-farm agronomic consultation.

RA&HS Grain and Fodder Committee Deputy Chair Peter Smith, says the awards highlight the relevance of the Royal Adelaide Show's National Grain and Fodder competition.

"These Innovation Awards are an important recognition of young farmers who are developing progressive and sustainable improvement on their farms," Peter said.

Competition information can be found at www.theshow.com.au/grains-fodder. The awards will be announced on September 1 and 4 during the 2018 Royal Adelaide Show. ■

New track system, draper and mobile app

JOHN Deere has announced several updates to its grain harvesting solutions for 2019 that will significantly improve the performance, ride quality and small grain harvesting efficiency of its S-Series combines. These additions include a new suspension track system, flex draper header and harvest-specific enhancements to the MyOperations mobile app.

For model year 2019 S-Series combines, customers have the factory-installed option of a new suspension track system in 60.96, 76.2 or 91.4 cm belt widths. The redesigned John Deere track system for these combines incorporates changes to the track belts, integrated final drive, suspension cylinder and tandem bogie wheels that work together to improve flotation, ride quality, transport speed and durability.

"Combines with these tracks will be able to get into paddocks sooner and harvest longer, especially under less than ideal conditions, with less impact on the soil," says Matt Badding, product marketing manager for John Deere Harvest Solutions.

The new track system features a unique tread design with wider and taller tread bars that are angled to improve traction, balance and ride comfort while extending tread life. And unlike previous track systems, combines equipped with the new track systems can travel up to nearly 40 km per hour, reducing transport time between paddocks.

New HydraFlex Draper

In addition, Deere is launching the latest in its flex draper lineup – the 700FD HydraFlex Draper. This symmetrically designed draper has a dual V-guide belt and thicker, corrugated front edge for improved crop flow and four times longer belt life; dual position 40.6 and 45.7 cm centre-feed drum for greater harvesting versatility and better processing of bushy crops like canola; and a 45.7 cm Top Crop Auger for smooth feeding and fewer slugs under tough conditions.

"To improve ground sensing on uneven terrain and to automatically adjust header position accordingly, we've added a fourth sensor to the Automatic Header Height Control option on our 10.67, 12.19 and 13.71 metre models," Matt explains. "The new 700FD HydraFlex Draper has been built to deliver improved crop handling versatility, longer wear life and to feed and capture more grain."

Lastly, to help customers more easily monitor combine operations and adjust settings from remote locations, Deere offers Remote View as part of the MyOperations mobile app.

"This latest mobile app for combines gives customers immediate visual access to machine information from a single combine or an entire fleet to improve overall harvesting operations." Matt says.

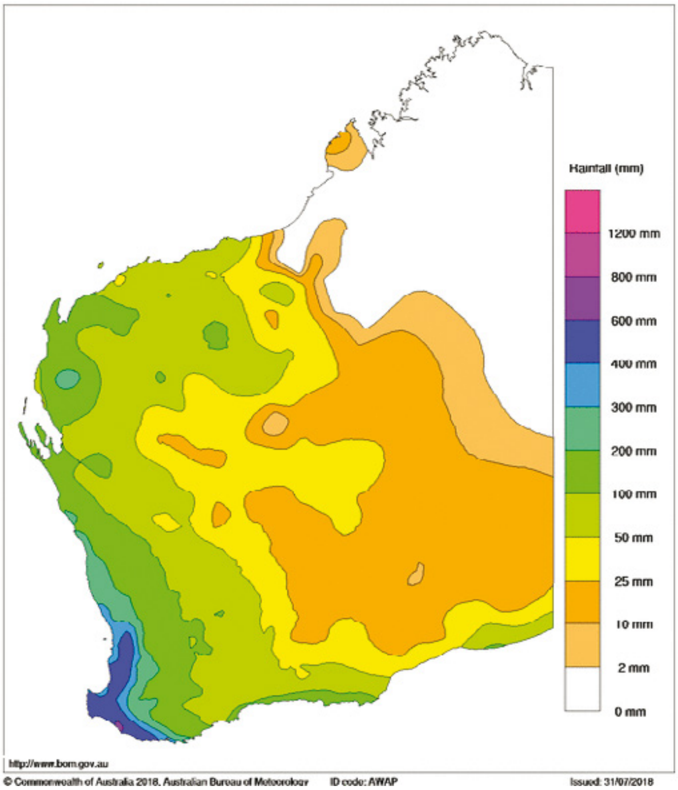
He notes that the app is a great way for managers to monitor less-experienced combine operators to ensure the combine is set and functioning properly.

For more information contact your local John Deere dealer or visit *www.JohnDeere.com.au*. ■

Western region

District Reports...

Western Australia rainfall totals (mm) April 1 to July 31, 2018
Australian Bureau of Meteorology



WESTERN AUSTRALIA SUMMARY

On balance, both promising and challenging seasonal conditions to date have the greater part of the Western Australian grainbelt in good shape, with crops making up ground over the past month following reasonable falls of rain and warm growing conditions. The exception to this are areas in the Great Southern down to the south coast and through to the Esperance port zone, and some areas north of Merredin, where the majority of rainfall events have been below 10 mm, with poor conditions compounded by significant wind damage.

The northern agricultural areas that were impacted by dry conditions in 2017 have cereal crops with above average grain yield potential. The canola and lupin crops in the northern region on the lighter soils which were damaged by strong winds at the start of the season have lower grain yield potential.

The central grain growing regions of the state have had one of the best starts to the season for many years and crops have above average potential if the season continues in a similar vein.

There has been less rainfall in the southern areas of the state, and crops that have emerged well will need good follow up rains and a soft finish to reach average grain yields. Crops that were impacted by the strong winds have low plant density, were slow to emerge and will need a good finish to reach average grain yield potential.

Wheat crops in the regions that received a good start will be a standout this year, and even average growing conditions from now on will see very good yields.

The barley area across the state is the largest in history although potential tonnage will be impacted by a poor start to the season in the major barley growing regions in the south of the state.

The canola area is significantly lower this year and most crops are later, with many having low plant density which will limit final grain yield.

Geraldton

Most of the Geraldton port zone has had between 100 mm and 140 mm of rain to date since the break in the season at the end of May. This together with pre-season rain has provided areas of the zone with an adequate soil moisture profile to finish crops without having to rely on significant rainfall events from now until the end of the season.

Whilst soil moisture is good, crops are a little behind in growth stage for this time of the year. Cereal crop grain yield potential is above average for most of the region although warm temperatures in spring can still bring current yield expectations down.

Wheat potential looks very good at the moment with crops well tillered and in the northern areas, starting to run up. There is an increase in the barley area in the region again this year and these crops look very good.

Lupin and canola crops were slow to get out of the ground and are behind for this time of the year. Grain yield potential is variable depending on location and soil type. Overall the expectation is that lupin and canola grain production will only be average at this stage of the season.

Crops on the deep ripped sand plain look really good and the well managed fallows from 2017 have above average yield potential.

The Midlands

The whole of the Midlands region is looking good and has benefited from the even break to the season and warm growing conditions.

Wheat crops are looking the best of all the crops and growth rate to date has put many crops in front of where they would normally be with a late May break. Barley crops also look good, but

2018 July WA crop area estimates (hectares)

Port zone	Wheat	Barley	Canola	Oats	Lupins	Field pea	State total
Kwinana	2,650,000	550,000	470,000	140,000	130,000	10,000	3,950,000
Albany	780,000	600,000	290,000	130,000	40,000	3,000	1,833,000
Esperance	510,000	350,000	210,000	10,000	10,000	20,000	1,110,000
Geraldton	920,000	110,000	130,000	10,000	180,000	1,000	1,351,000
Totals	**4,860,000**	**1,610,000**	**1,090,000**	**290,000**	**360,000**	**34,000**	**8,244,000**
% change from June 2018	0%	0%	0%	0%	0%	0%	0%

District Reports…

July–August 2018

as per most of the state this year, grass weeds have been a bit of a problem. There has also been some spot type net blotch starting to show up in crops where a fungicide was not used at seeding.

Lupins are a mixed bag in the area with some crops being damaged by wind resulting in low plant density. The same has occurred for canola, with crops slow to get out of the ground and wind damage limiting the potential grain yield.

Some growers are still hand feeding livestock, but some pasture growth is starting to get away now with pasture legume percentage better than for many years.

Kwinana West

All crops in the Kwinana West zone have above average yield potential at present. Crop growth stages are ahead from where they would normally be at this stage of the season. Most crops have been sprayed for weeds, and growers are topping up with nitrogen fertiliser to maintain crop health. Some leaf diseases are starting to show up although there are no major issues at the moment.

Kwinana East

Most of the zone except some of the areas north of Merredin around Bonnie Rock have average or above average grain yield potential at this stage of the season. Crops emerged evenly and have continued to grow without any setbacks. The majority of growers in the low rainfall areas from 2017, have crops up with good grain yield potential this year.

This region of the state has the potential to produce a lot of grain if the season continues as it has to date. There is not the same sub-soil moisture in the region compared with but year to finish crops so final grain yield potential will depend on average falls of rain from now until the end of the season.

Western Albany

The whole zone is looking at an above average yield potential at present. Crops have emerged well and have benefited from the lack of waterlogging and regular rainfall.

Pasture growth is behind, as it is for most of the southern areas of the state, with growers still handfeeding livestock. Grain reserves in the southern areas of the state are low and many oat and barley crops will go into silos on farm rather than be delivered to port.

Southern Albany

The majority of the Southern Albany zone across to Esperance has suffered badly from repeat wind events and a lack of rainfall to settle the country down and allow crops to emerge evenly. Many paddocks have been re-sown or parts of paddocks re-sown and these crops will struggle to reach average grain yield potential.

Most paddocks have low plant density and were slow to emerge. The season is going to have to be a soft finish for crops to achieve average yield potential. While average yields could still be achieved, low plant density and uncertainty of returning a profit is limiting fertiliser applications that are needed to make up the final grain yield.

Canola production in the region is going to be well down on last year due to wind damaged paddocks being re-sown to barley, and those not re-sown having low plant density and being well behind in their growth stage.

Eastern Albany (Lakes Region)

Most of the zone is looking similar to 2017 although if spring rainfall is low, there is not the sub soil moisture to assist in finishing crops at the end of the season. Cereal crop emergence is good and if it continues to rain, most cereals will have average or above average grain yield potential.

Canola plant density is lower than ideal, as per most of the state, due to difficult conditions at emergence and realistic grain yield potential is below average unless there is a very good finish to the season.

Pasture growth is still slow and many growers are still hand feeding livestock.

Esperance

The majority of crops in the Esperance port zone are a mixed bag. Crops generally have low plant density or staggered emergence and are at differing growth stages within paddocks. Most of the rainfall events have been below 10 mm, and combined with the wind and warm temperatures the region has experienced since the end of May, rainfall events have not been as effective as they normally would.

The cereals can still make average grain yields if the season has a good finish, although this is becoming less likely as the season progresses.

Canola grain yield potential is lower than average at this stage of the season due to crops being well behind in growth rates and density.

GIWA gratefully acknowledges the support of DPIRD, CBH and contributions from independent agricultural consultants and agronomists in the production of this report.

GIWA Crop Report – July 13, 2018

NORTHERN DISTRICT

Most of the region is looking very good at the moment. Widespread rain fell in all areas on May 23 and dry sown crops generally emerged well. Some non wetting sand and heavy soils were the exception and a few canola crops had very low stand density.

A number of growers had later crops emerging during July.

But cereal crops are mostly in the late tillering stage while lupins and canola will start to flower at the end of July and into August. There are some exceptions where significant summer rainfall and early sowing has put some crops already in the head and flowering stages.

Weed spraying will be completed on most farms in July. Then it will be fungicides and late N applications if conditions remain wet.

Rainfall has been very good across the region with most growers very happy with how crops and the season are progressing. There are a few areas in the west of the region that have had over 180 mm since May 23 and sand soils in these areas are somewhat washed out.

Generally our region is looking towards an above average harvest but we will need a wet and mild August to achieve this potential yield.

Let's hope August and September can deliver here and across all grain growing areas.

Peter Norris
Agronomy For Profit and Synergy Consulting, Geraldton
July 16, 2018

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District Reports…

July–August 2018

SOUTH COAST

Seasonal conditions on the South Coast have remained very dry, warm and windy, with one of the driest starts to a growing season on record.

But remarkably, the region still has some very good crops thanks to modern farming methods of full stubble retention, timely summer weed control, minimum till seeding, CTF, deep ripping and some frequent small but heavy 3 to 5 mm rainfall events.

Very strong north to north-west winds have been relentless and have caused some wind erosion issues. Thankfully these are quite minor compared to 30 years ago. This is once again, testament to the success of our modern farming methods.

Canola crops are the worst effected by the dry start with very staggered and late emergence. Most crops are now infested with green peach aphids as well as moderate to high levels of turnip yellows virus.

Most growers are not holding high expectations for good canola yields.

Cereal and pulse crops have established quite well and most emerged within or slightly later than the optimal window. Yield potential still looks OK with our stored soil moisture levels.

But we will need at least average rainfall from now on coupled with a mild spring!

The non wetting sands have been very difficult soils in which to establish crops. This is particularly the case when compared to those soils that have been previously ameliorated by claying, delving or spading.

Neridup farmer Tony Meiklejohn is very happy with his Flinders barley crop. The Neridup region is one the better performing areas on the South Coast this season.

Seasonal rainfall across the grain regions – 25 year averages and year to date

Brought to you in association with	25yr Annual Average (mm)	2018 rainfall to date (mm)	Summer		Autumn		Winter		Spring	
			25yr Annual Average (mm)	2017–18	25yr Annual Average (mm)	2018	25yr Annual Average (mm)	2018 to date	25yr Annual Average (mm)	2017
Emerald Qld	561	291	251	330	105	21	69	23	127	190
Toowoomba Qld	675	305	269	302	138	82	88	25	179	177
Roma Qld	581	240	251	208	116	94	78	21	135	163
Goondiwindi Qld	623	134	254	113	122	62	102	10	145	191
Narrabri NSW	631	133	220	95	118	67	130	8	164	126
Gunnedah NSW	634	92	217	118	108	35	129	5	183	185
Dubbo NSW	604	74	190	85	127	24	133	19	157	124
West Wyalong NSW	454	128	119	156	80	40	124	50	131	66
Wagga Wagga NSW	540	172	133	177	111	47	150	50	140	111
Swan Hill Vic	317	91	71	69	65	28	87	48	95	91
Bendigo Vic	504	159	109	60	106	70	159	66	135	106
Horsham Vic	374	128	79	43	71	54	122	57	104	116
Lake Bolac Vic	515	217	114	66	101	103	153	95	148	179
Murray Bridge SA	364	98	70	64	79	39	121	44	97	75
Kadina SA	336	69	63	60	78	18	112	32	85	60
Cummins SA	388	165	55	49	88	55	170	86	78	75
Esperance WA	614	220	88	75	141	68	248	86	138	128
Wagin WA	397	229	50	62	97	50	163	133	87	79
Northam WA	401	276	47	97	88	40	185	155	80	64
Mingenew WA	347	141	30	75	89	50	170	19	58	44
Moora WA	382	290	43	88	85	51	185	167	69	63
Mullewa WA	321	212	53	88	93	47	130	103	45	34

Last rainfall reading July 24, 2018.

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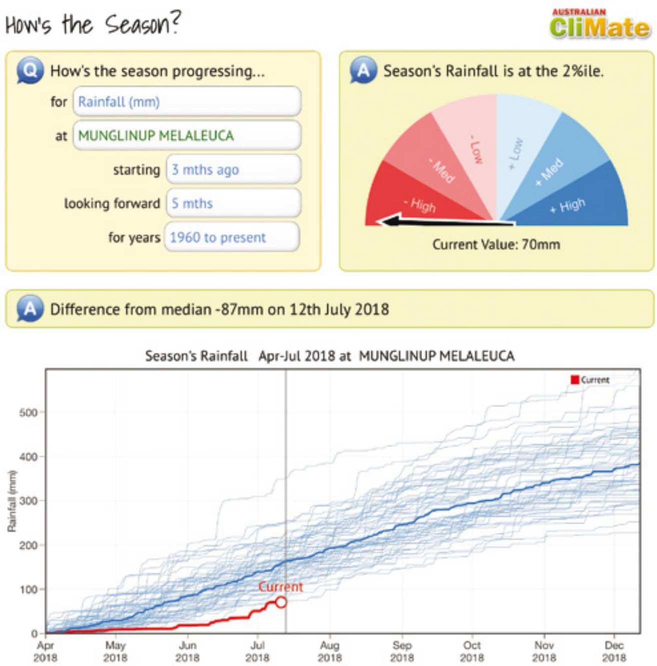
July–August 2018



This image from Australian Climate shows how dry the growing season has been at Munglinupon WA's South Coast.

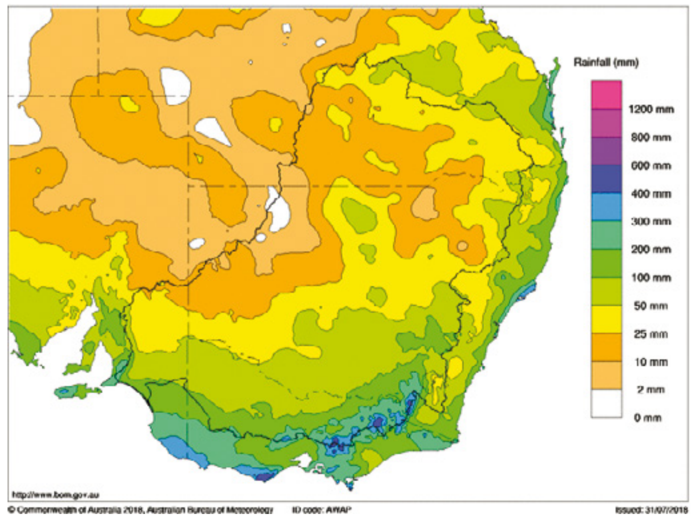
This will encourage most growers to embark on even more soil amelioration into the future.

While the season has been a challenge, growers are optimistic and marvel at how robust our modern farming systems perform in tough conditions.

Quenten Knight
Agronomist, Agronomy Focus
July 13, 2018

Southern region

Murray–Darling Basin rainfall totals (mm) April 1 to July 31, 2018
Australian Bureau of Meteorology



VICTORIAN MALLEE

The Mallee region is looking good although crops are getting thirsty for a decent rainfall event. Crop growth has been stalled, and crops have been dealt some tough conditions with frosts, some warm temperatures, windy days and limited rainfall.

The late break to the season and ad-hoc showers means there was patchy germination, especially in canola.

This slow growth made for some tough control of weeds, especially using chemicals with different label rates for the various growth stages of weeds and crop.

As we approach/pass GS30 the chemical options differ again, and ester restrictions will come in to effect in coming weeks.

At this point in the season, most growers would normally have top-dressed by now but in many locations, there seems to be a conservative approach to nitrogen given the seasonal outlook.

The potential of an El Niño developing in late winter and/or spring is not what growers particularly want to contemplate.

Wheat crops in the Mallee will most likely have sufficient nitrogen to see them through to the end of the season.

Enough N to get us through?

According to most reports, there is sufficient nitrogen in the subsoils in the region to get growers through the season.

This information is supported by using a *Yield Prophet Lite* scenario on July 17 and inputting the following parameters for a wheat crop in Sea Lake:

- A water use efficiency of 15 kg per mm;
- An organic carbon level of 1%;
- 20 mm of stored soil water and 50 mm of growing season rainfall to date,
- 60 kg N per hectare stored and 5 kg N per hectare applied at sowing.

With the above parameters, *Yield Prophet Lite* predicts there is enough nitrogen to achieve a 1.7 tonne per hectare crop with a decile 3 finish.

Supporting this, the Poama/Access forecast probability predicts there is a greater than average (79 per cent) chance of a decile 3 finish to the season.

Conversely, the positives that come with a low rainfall season include low weed, pest and disease pressure.

A healthy looking wheat crop in the Mallee.

Weed control has been a challenge in the Mallee due to patchy germination, differing growth stages and frosty conditions.

Crop pests

Earlier in the season there were reports of some red-legged earth mites, bryobia mites and Lucerne flea however, these were/are being managed with minimal concern. But growers are being encouraged to not be complacent and should continue to monitor for Russian wheat aphids in cereals and green peach aphid in canola, as well as potential disease threats.

The late break has also highlighted the soil type differences across the region as well as where poor weed control practices were demonstrated during summer. Incorrect seeding rate and depth and the benefits of retained stubble have also been emphasised.

Thanks to a grain and hay price rise there has been a lot of hay from 2016 – and even 2017 – being sold which is improving cash flow at this time of the year.

For those with sheep, there is still a lot of feeding out happening due to limited biomass production and/or crops not being anchored and able to withstand grazing. Sheep and wool prices remain excellent so mixed farming enterprises will be in a better position if the forecast season eventuates.

Ciara Cullen
Birchip Cropping Group
July 22, 2018

Northern region

LIVERPOOL PLAINS

Unfortunately, not much has changed since the last report in June – conditions are still dry and cold.

In mid July there is still time in many areas to plant wheat, including durum. But the lack of rain in the forecast would suggest that many growers will miss out on planting a winter crop for the first time on record.

Going back over the farming years on the Liverpool Plains, it has been more common for wet weather being the cause of no planting opportunity.

District Reports…

July–August 2018

With the solid summer crop prices being offered and the increased area available, there are a large number of farmers turning their attention to making sure they have summer crop planters set up and ready to go when the rain comes.

The quantity and timing of rain will be the main driver of the sorghum or cotton decision for most with both crops looking like a reasonable option.

But in recent years there has been a solid swing towards dryland cotton in the area at the expense of sorghum. The flexibility of Bollgard 3 cotton helps the no-till farmers stay relatively no till.

On our farm we plan to sow a crop of sorghum with our variable rate multi hybrid planter. But we will have to wait on how much rain we receive before we can decide which sorghum will be planted on which soil types.

There have been a number of our customers taking advantage of a trip we have offered to the US revolving around precision planting, farm visits and new technologies in the US.

David McGavin
Precision Seeding Solutions, Premer
July 18, 2018

DARLING DOWNS

"Not good" is the comment on weather conditions in the region. There has been no widespread rain since last October, and for many the first six months of 2018 are sitting at 40 per cent of the average rainfall with the last three months at just 15 per cent.

This has not only curtailed winter crop planting, but has decimated pasture growth and it is so dry on the ridges that there are trees dying.

Winter crop

The major area of winter crop planting has been to the west of Dalby and in the Chinchilla region, where there were more patches of reasonable rainfall. The Western Downs has about 40 per cent of the expected winter crop planted, Central Downs around 20 per cent and the Eastern Downs under 10 per cent.

Barley planted early is approaching the flag leaf stage, whilst other paddocks are still being planted. Some chickpeas were deep planted – and where the moisture was enough – have emerged and are growing well.

There has been little disease in any crops, but there are high numbers of aphids in the barley.

Many of the crops planted in the Central and Eastern Downs are on marginal moisture, and are facing increasing mouse activity, so their potential is unknown at this stage.

There will be demand for silage and hay from the barley crop, and although growers are prepared to plant wheat to the end of July, there is no sign of a planting rain at all.

Summer outlook

First we still need rain to plant, but it is a wide planting window from September to January. And the main crop is in no doubt – sorghum.

There will be a large plant of both grain and forage sorghum, as hay and silage supplies are very low and grain sorghum demands are high.

Cotton is at a very attractive price and irrigated farmers will find it hard to go past the returns from this crop.

If it rains enough, there should be a strong planting of dryland cotton as well.

Growers are still trying to maintain rotations, and so summer planted mungbeans may be an attractive option.

But all the crops appear to have attractive prices this summer, which should lead to all crops having at least some area planted.

Hugh Reardon-Smith
Agronomist, Landmark Pittsworth
July 17, 2018

A typical drought vista on Queensland's Darling Downs this 2018 winter season.

ANSWER TO IAN'S MYSTERY TRACTOR QUIZ

It is an OTA Monarch three wheeler, powered by a Ford Prefect engine and cable steered! An absurd tractor, but owing to its rarity, it is very collectable. Beautifully restored by Warren Harris.

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