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Grain Yearbook published in April

FRONT COVER

Key characteristics northern NSW farmer Andrew Rogers wants in his sorghum crops are standability, good seasonal vigour and grain size – all of these traits adding up



to better yield potential.

A lot of the boxes on his wish list were answered this past summer crop season with a new hybrid sorghum.

See article page viii *Northern Focus*.

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NOT wanting to incur the wrath of *Hughie*, it's got to be said that the winter crop season is ticking along pretty nicely in most regions. There are a few areas that could do with another inch or two in the rain gauges in early August – while growers in the southern reaches of the national grain belt are generally keen to see a few weeks of sun to dry things out a bit. Leaf disease and insect pests are loving the favourable conditions while some crops are looking for nutrient top-ups. These issues will be addressed at the earliest possible opportunity so crops can enter the critical spring period full of yield potential.



Our official government forecaster (ABARES) estimates that, after a reasonably prolonged planting window, around 22.3 million hectares is under winter crop. This is a small increase (1 per cent) in total area compared to last year, but the crop mix has changed substantially.

Declines in wheat and barley area have been more than offset by increases in the area planted to canola, oats and pulses. This is a reflection of the more attractive prices on offer this season for oilseeds and pulses compared to cereals. The national wheat and barley areas are estimated to have declined 1 per cent to 12.7 and 4.1 million hectares respectively.

But here's what a potentially above average season across the country can do for the national accounts: Total winter crop production is tipped to increase by 7 per cent on last year to 42.3 million tonnes. The production of wheat and barley are both forecast to be up 5 per cent and canola up 10 per cent. The real bolters are oats (up 19 per cent) and chickpeas (8 per cent).

And these official forecasts were issued in mid June – the seasonal prospects have only improved since then.

A healthy report card

These numbers sound encouraging and GrainGrowers have joined in the enthusiasm with the release of the *State of the Australian Grains Industry: 2016* report at the recent Australian Grains Industry Conference (AGIC) in Melbourne.

In what is essentially an industry report card on the previous five years, a key finding was the strong financial position of most grain farm businesses. Although there were state-based variations due to seasonal conditions, grain farm businesses lead the way in farm business cash income when compared to other commodities. In 2014–15 broadacre cropping directly contributed \$13.9 billion to Australia's national economy – and that's just farm gate value.

Innovative farm management has helped export grain values to grow exponentially. In 2010, grain exports were worth an average of \$6 billion – in the following five years this almost doubled to an annual average of \$11.5 billion.

As someone said recently: "There's never been a more exciting time to be a grain farmer."

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In this issue...

New wheat rusts and their management

Many people who have an interest in cereal production would have heard the term 'pathotype' (or 'races' and 'strains'). Pathotypes are variants within a pathogen that differ in their ability to overcome rust resistance genes in cultivars.

See article Page 8



Safety last

I recently had occasion to be at the premises of a tractor dealership and observed the hot tap in the kitchen had a sign above it stating Danger – hot water! Another sign stated Danger – floor may be wet! Yet another sign alerting everyone to the fact that they should Beware of Tractors! Gosh!

See article Page 13



The Russian wheat aphid is here

The GRDC is encouraging grain growers to adopt a simple four-point plan in dealing with Russian wheat aphid. A multi-faceted research, development and extension approach is encouraging growers to scout fields, report any concerns and where necessary implement a considered management strategy.

See article Page 18



Killing storage pests without mercy

There are very few options available to growers to control storage pests when an insect infestation has been detected. Phosphine is by far the most common disinfestation treatment for stored grain.

See article Page 32



Chickpea Ascochyta – the latest on variability and management

In 2015, 243 chickpea crop inspections were conducted. Ascochyta blight was detected in 60 crops. Inoculum had carried over from the 2014 season and wet conditions during June–July favoured infection and disease development. High chickpea prices tempted some growers to break best practice and plant back to back chickpeas resulting in severe disease.

See article Page 35





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New wheat leaf rusts: Impacts, plant resistance and management

■ By Robert Park, Plant Breeding Institute, Cobbitty

AT A GLANCE...

- Rust pathogens spread freely and rapidly through the Australasian region. While this is predominantly in a west-to-east direction, recent years have seen two examples of east-to-west transport.
- Monitor for the presence of the green bridge, and if present, make sure it is destroyed at least four weeks before crops are sown, either by heavy grazing or herbicides.
- Warm, moist autumn conditions favour the development of leaf rust.
- Monitor crops of vulnerable varieties for leaf rust in 2016 and send samples for pathotype analysis to the Australian Rust Survey. This service is free to all, and is funded by the grower levy paid to the Grains Research and Development Corporation.
- The identification of rust pathotypes involves greenhouse tests in which seedlings of indicator varieties are infected, and takes about three weeks. These tests are increasingly being supplemented with DNA-tests that are much quicker (less than 48 hours). The DNA tests provide useful basic information but are nowhere near powerful enough to identify pathotypes.
- Genetic resistance to rust in cereals delivers significant benefit to Australian grain growers, estimated at \$1.1 billion annually with wheat alone, and remains the basis of rust control.
- Minimum disease standards remain important for industry-wide benefit from genetic resistance.

MANY people who have an interest in cereal production would have heard the term 'pathotype' (or 'races' and 'strains'). Pathotypes are variants within a pathogen that differ in their ability to overcome rust resistance genes in cultivars.

A good recent example of this concerns stripe rust and the wheat cultivar Mace. Like many current wheat varieties grown in Western Australia, Mace carries the stripe rust resistance gene Yr17, a gene that is expressed at all growth stages (often referred to as seedling resistance genes, major resistance genes or all stage resistance genes).

While Mace is resistant to the "WA stripe rust pathotype", first detected in 2002, the resistance provided by Yr17 was overcome in eastern Australia by a new pathotype, 134 E16 A+ Yr17+, first detected in 2006. To date, the latter Mace-virulent pathotype has not been detected in WA.

For this reason Mace is regarded as susceptible to stripe rust in eastern Australia, and resistant to stripe rust in WA.

Rust pathotype surveillance

The existence of rust pathotypes was first shown in the early 1900s in the US. Not long after, Australian annual rust surveys were initiated at the University of Sydney, and continue to this day at the University's Plant Breeding Institute (PBI).

WHEAT RUST PATHOGENS

Australian wheat crops are infected by three different rust pathogens:

- Stem rust (caused by *Puccinia graminis* f. sp. *tritici*);
- Stripe rust (caused by *Puccinia striiformis* f. sp. *tritici*); and,
- Leaf rust (caused by *Puccinia triticina*).

The identification of rust pathotypes at the PBI is a free service that is open to anyone who would like to submit a sample for analysis (directions on how to do so are provided on page 10). Following this procedure is vital if the viability of a rust isolate is to be ensured.

The sample will be analysed and the sender will be notified of the results.

The success in establishing the distribution and occurrence of known rust pathotypes – and in detecting new rust pathotypes – depends entirely on the collection and submission of samples.

Pathotype identification involves infecting seedlings of a set of cereal varieties, each carrying a different rust resistance gene, with a field collected sample of rust. The ability or inability of the rust isolate to overcome the resistance gene in each variety allows the pathotype or pathotypes present to be identified. These tests take about three to four weeks to complete, and if a new pathotype is suspected, often a longer time is needed to confirm this. The pathotype identification work at PBI is increasingly being supplemented by DNA profiling, which is comparatively quicker and may only take several days.

But while providing important information and a means by which exotic rust incursions can be recognised rapidly, as yet,



Australian wheat varieties are infected by three different rust pathogens – stem (pictured), stripe and leaf rust.

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DNA profiling is nowhere near powerful enough to identify individual pathotypes.

The long-term studies of pathogenic variability of rust pathogens conducted at PBI have clearly established that Australia and New Zealand comprise a single rust epidemiological unit, within which rusts migrate freely and rapidly. This is why a nationally coordinated approach to the genetic control of cereal rusts (ie. the Australian Cereal Rust Control Program) is fundamental to success.

The annual surveys of rust variability carried out at PBI have, and continue to form, the basis of all gene-based rust control efforts. They:

- Monitor the effectiveness of rust resistance genes in commercial cultivars;
- Determine the implications of new rust pathotypes in the rust responses of current cereal cultivars;
- Facilitate the discovery and introduction of new resistance genes into locally adapted germplasm; and,
- Allow pre-emptive resistance breeding.

Recent changes in the wheat leaf rust pathogen

A new pathotype of the wheat leaf rust pathogen, *Puccinia triticina*, was detected in a sample of leaf rust collected from a crop of the wheat cultivar SQP Revenue at South Bool Lagoon (South Australia) in mid-August 2014.

The new pathotype – 104-1,3,4,6,7,8,10,12 +Lr37 – was considered to be an exotic incursion based on its unique virulence profile and SSR fingerprint. This pathotype is the twelfth documented incursion of an exotic wheat rust pathogen since Australia-wide cereal rust surveys conducted by University of Sydney staff began in 1922.

Following its initial detection in South Australia, pt. 104-

SEND IN YOUR RUST SAMPLES

Suspected rusted cereal plant samples can be mailed in paper envelopes to:

University of Sydney – Australian Rust Survey
Reply Paid 88076, Narellan NSW 2567.

PLEASE NOTE: Do not use plastic wrapping or plastic-lined packages.

If possible, include the latitude and longitude of the sample location.

1,3,4,6,7,8,10,12 +Lr37 spread rapidly throughout much of the eastern Australian wheat belt and in late September 2015 it was identified in samples of leaf rusted wheat collected from four separate locations in the northern region of the WA wheat belt.

Pt. 104-1,3,4,6,7,8,10,12 +Lr37 carries virulence for the resistance genes Lr27+Lr31, and the adult plant resistance (APR) gene Lr12, and combines this with virulence for Lr13 and Lr37.

All four resistances occur in Australian wheat varieties, and consequently this pathotype has resulted in increased leaf rust susceptibility in some varieties.

Pathotype surveys and rust control

To have maximum impact in disease control, surveys of pathogenic variability in rust pathogens must be closely integrated with the development and management of new wheat cultivars.

Where this has been practiced, surveys have provided both information and pathogen isolates that have underpinned rust control efforts, from gene discovery to post-release management of resistance resources.

Information generated by pathotype surveys has been used to devise breeding strategies, inform selection of the most relevant isolates for use in screening and breeding, define the distribution of virulence and virulence combinations. This allows predictions of the effectiveness/ineffectiveness of resistance genes, and the issue advance warning to growers by identifying new pathotypes that overcome the resistance of cultivars before they reach levels likely to cause significant economic damage.

Maintaining and improving current levels of rust control

It has been estimated that 50 per cent of the cost of plant improvement involves breeding to maintain current yield and quality levels to meet the challenges of degrading growing environments and evolving pathotypes of major pathogens – in other words, maintenance breeding.

Resistance breeding, and reducing the current impact of rust diseases, is estimated to have saved the industry in the order of \$1 billion annually. A continuation of these savings will only be possible if resistance remains a priority in breeding programs, and if the wheat industry as a whole continues to support genetic approaches to rust control.

Adult plant resistance and rust management decision making

Many people in the cereals industry would be familiar with the expression that a variety's disease resistance has 'broken down'. This expression can be misleading because it suggests that the variety itself has changed in some way. But the shift in a variety's response to rust is actually caused by a change in the pathogen that causes the disease.

This is why monitoring rust populations for new pathotypes

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is critical to increase our knowledge of how a variety's resistance stacks up.

The emergence of a new rust pathotype can result in a resistant variety becoming more susceptible to rust. Because this shift is often subtle, describing the change in a variety to a new rust pathotype accurately, can be difficult.

Changes in a variety's response to new pathotypes are influenced by the nature and number of genes that confer resistance to the disease.

Such resistance genes protect against the disease either at all growth stages, which is called all stage resistance (ASR; also referred to as 'seedling' or 'major' resistance), or at adult plant growth stages only, which is called adult plant resistance (APR; also referred to as minor gene resistance).

Genes that confer ASR usually provide very high levels of protection against rust, while those conferring APR usually provide moderate levels of protection. A variety may carry one or both gene types, resulting in different effects on resistance levels.

Where a variety only carries an ASR gene – and this is overcome by a new rust pathotype – its resistance rating may change from highly resistant to highly susceptible.

The boom and bust cycle

There are many examples of such changes in a variety's resistance levels – the 'bust' part of what is known as the 'boom and bust cycle'.

One of the first examples of this shift was recorded in the Eureka wheat variety's resistance to stem rust. Eureka was highly resistant to stem rust when it was released in 1938. But because this variety only has one ASR gene (Sr6) to protect it against stem rust, it became highly susceptible to the disease when this

single gene was overcome by a new rust pathotype in 1942.

Similarly, the stripe rust resistance rating of Mace was downgraded from highly resistant to very susceptible because it only has one ASR gene (Yr17), which was overcome by a new pathotype in eastern Australia.

But in other grain growing regions such as Western Australia, Mace remains highly resistant to stripe rust because its single ASR gene has not been overcome.

Adding another dimension of complexity are the many wheat varieties that carry a combination of ASR and APR genes. Having both these genes means a pathotypic change can result in a slight increase in susceptibility that occurs when the ASR gene is overcome by a new pathotype, but the APR gene is still effective in providing 'back-up' resistance.

Field testing is the only reliable way to determine the levels of back-up resistance provided by the APR gene.

For example, the full impact of the new wheat leaf rust pt. 104-1,3,4,6,7,8,10,12 +Lr37 will not be known until further field tests are completed this year.

While many years of painstaking genetic research has led to a sound understanding of ASR genes, intensive genetic analyses of APR genes began only about 20 years ago. Consequently, information about the APR genes in Australian wheat varieties is incomplete, and varietal information on rust response has partial information only.

This article is based on a presentation at the GRDC Research Updates, Narrabri 2016. The research undertaken 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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Be on the lookout for yellow spot

ALMOST half the yellow spot disease samples received in a national survey last year were collected from wheat varieties which were rated as having resistance, highlighting the need for continued industry vigilance against the costly disease.

Conducted as part of the Curtin University (WA) and Grains Research and Development Corporation (GRDC) *Stop the Spot* initiative, the survey found that yellow leaf spot (*Pyrenophora tritici-repentis*) – also known as tan spot – is nationally widespread.

Researchers analysed 145 diseased-leaf samples sent from a range of locations across Australia's grain growing regions and 56 per cent of the samples were confirmed as being infected with yellow spot.

Pao Theen See, of the yellow spot program at the Curtin University-based Centre for Crop and Disease Management (CCDM), said 46 per cent of the confirmed yellow spot samples were from varieties rated moderately resistant or moderately resistant/moderately susceptible.

"Yellow spot was found in varieties such as Mace, Magenta and Wyalkatchem, which indicates that even putatively-resistant varieties can be susceptible to the disease," she said.

"This also highlights how vital it is that yellow spot is continually monitored so we can respond to any changes in the pathogen population.

"These varieties are not damaged by 'ToxA' – the most potent of known effectors (disease-causing toxins) within the yellow spot pathogen – as the wheat gene that interacts with ToxA was bred out of them.

"The reason they still get infected is because there are other damaging effectors in Australia including ToxC and others that are so far unknown," Pao said.

Continue to choose insensitive varieties

Pao said it was still recommended that growers chose varieties 'insensitive' to ToxA such as Mace, Magenta and Wyalkatchem as ToxA was the most potent of the identified effectors.

"Growers who choose resistant varieties may get some yellow spot infection in their crops but not as much if they grow susceptible varieties," she said.

Pao said one of the positive outcomes from the latest *Stop the Spot* survey was no variation in the ToxA gene was detected compared with previous years' samples.

"This implies that the major gene within yellow spot that causes necrosis (cell death) has not mutated into a different or stronger form," she said.

"This is good news for breeding yellow spot resistant wheat because fewer pathotypes makes it easier to develop the genetic tools to reduce yellow spot infections on wheat."

Pao said that for the second year ToxB – which is found in overseas yellow spot pathogens – was not detected in *Stop the Spot* samples.

"But as a major biosecurity risk to Australian wheat crops, it is extremely important that we continue to monitor the yellow spot pathogen for this effector," she said.

"If ToxB-containing strains invaded Australia, yellow spot disease virulence would increase."

Stop the Spot, which aims to significantly reduce the economic impact of yellow spot, is continuing in 2016 and growers and advisers are encouraged to send in leaf samples of the disease to the CCDM.

"The more samples we receive, the better we can keep track of the disease to develop solutions for improved yellow spot resistance in wheat," Pao said.

For more information, including how to submit samples for this year's campaign, visit www.ccdm.com.au/farm-management-resources/stop-the-spot.

The CCDM conducts cutting-edge crop disease research into genetics, breeding and fungicides, and the improvement of agronomic practices.

The GRDC has committed \$30 million over five years to the \$100 million CCDM as part of its long-term bilateral agreement with Curtin University.

Information about yellow spot management in wheat is available at www.grdc.com.au/grownotes or www.grdc.com.au/HT-YellowspotInWheat ■



Centre for Crop and Disease Management (CCDM) yellow spot program researchers, from left, Pao Theen See, Kalai Marathamuthu and Elyce Lagallo. (Photo: CCDM)

Safety last

■ By Ian M. Johnston

I recently had occasion to be at the premises of a tractor dealership and observed the hot tap in the kitchen had a sign above it stating **Danger – hot water!** Another sign stated **Danger – floor may be wet!** Yet another sign, this time near the workshop exit, alerted everyone to the fact that they should **Beware of Tractors!** Gosh!

I happen to know that all the employees at this particular establishment are normal intelligent human beings, exhibiting no signs of suicidal or maniacal tendencies. I also believe that some of the modern governmental industrial safety guidelines border on the absurd. Still, I guess it is better to err on the side of caution rather than on the alternative.

Indeed, when I reminisce and ponder over the many alarmingly perilous tractors I have encountered over the years, I tend to appreciate the imperatives of the current safety legislations, particularly relating to tractors.

A brief description of some of the offending tractors will assist in emphasising my point.

Farmall F12

One of a range of International Harvester's row crop tractors of the 1930s. I would have used the term 'excellent', except for the fact that the mudguards (or fenders in Yankee parlance)

were not fitted as standard equipment. This resulted in the tall narrowly spaced skinny steel wheels – with their potentially lethal extending spud grips – were likely to grab the sleeve of a less



A 1932 International Farmall F12, restored by the author. Note the narrow rear wheel settings and the dangerously close lugs. (PHOTO: IMJ)

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A 1925 Fordson F, complete with an Athens mid-mounted disc plough, restored by Mal Brinkman. Note the extended rear mudguards designed to prevent the tractor rearing over rearwards!! (PHOTO: IMJ)

than attentive operator and haul him off his iron pan seat into a veritable meat grinder!

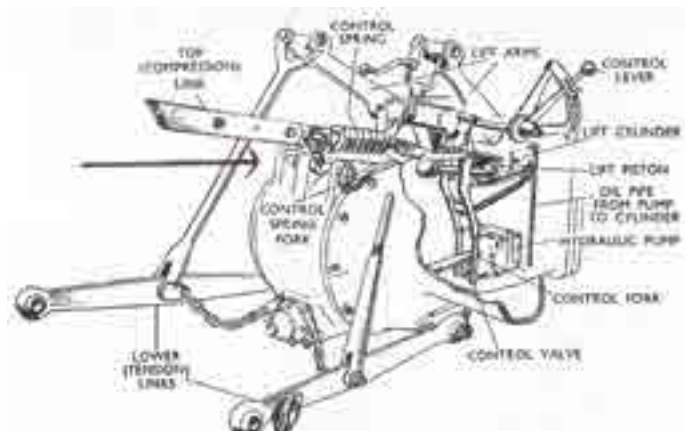
But there is more! Two short levers – unreachable unless you possessed the arms of an orangutan – were positioned near the clutch pedal, and these were the sole controls of the alleged brakes, one for each wheel. So an emergency stop resulted in taking one's hands off the steering wheel, stretching forward and hauling back on the two stumpy levers, all coinciding with the utterance of a prayer!

Fordson F

Despite enjoying 70 per cent of the world's tractor sales in the 1920s, the Model F also represented guaranteed brisk business for morticians. You see they were fitted with a worm drive differential final drive, the design of which resulted in the alarming habit of the tractor winding itself around the differential, if the implement being dragged behind encountered an immovable obstruction, such as a stump. So, an unsuspecting



This Model P Lanz Bulldog is shown with the steering wheel and shaft fitted to the end of the crankshaft, ready for starting. But in this instance it must be a spare steering wheel because the original is still in its rightful place. (Photographed at Swan Hill Pioneer settlement by IMJ)



A diagram of the Ferguson rear diff. housing and the hydraulic linkage system. The arrow points to the 'grandfather pin' located high on the housing. (IMJ archives)

operator would suddenly experience his tractor rearing, in the manner of a startled horse. Unless with lightning reflexes he could jump on the clutch and thus counter the physics involved, the thing would land upside down on top of the unpropitious now sadly deceased operator!

Henry Ford stubbornly insisted there was no design fault involved. Yet in later versions the mudguards were lengthened rearwards, extending to within inches of the ground, in a feeble attempt to prevent the tractors from turning completely over!

Lanz and KL Bulldogs

The excellent reputation of these legendary two-stroke broadacre tractors was earned on account of their fuel frugality, reliability and simplicity of design. But the inherent juddering vibration of the single cylinder engine resulted in scores of Bulldog operators in later life, limping to the doors of chiropractors.

It goes without saying that the intimidating blow lamp, required to pre-heat the combustion chamber prior to starting the engine, was a hazardous affair that tested the courage of all but the most red-necked of operators. In fact, a Bulldog at harvest time had to be parked in a safe fire-proof area, often out



A Ferguson TEA 20 restored by Alan Latimore. Legions of these outstanding tractors remain in Australia, often regrettably in the hands of hobby farmers, having dangerously inadequate tractor knowledge. (PHOTO: IMJ)



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A Field Marshall Model 3A owned by Canadian collector Stan Kick. The breech pin handle is located on the bonnet nose just ahead of the radiator grill. (PHOTO: IMJ)

on an adjacent gravel road, for fear of the blow lamp setting fire to the tinder dry crop.

Once heated, it was necessary to remove the steering wheel and shaft from its rightful place and insert it into the end of the crankshaft. The wheel was grasped firmly and half turned in each direction, with a pendulum motion, thus moving the piston back and fro. Eventually the engine would literally explode into life accompanied by the steering wheel dangerously instantly spinning at several 100 revs per minute. Wow! If you were not adept at pulling it out of the crankshaft the instant it fired – then stand well back, because the shaft and wheel would rapidly dislodge itself and fly off in any direction like a demented missile!

Also a Bulldog was of a devious nature. The engine frequently started in reverse cycle! So just picture an early morning scenario – a sleepy operator engages reverse gear in order to back the tractor out of its shed, lets in the clutch and – the machine shoots forward and likely punches a hole in the wall of the shed.

Little Grey Fergy

Yes, we all love little grey Fergusons, so why is it being classed as a “Safety Last” tractor? Well, in actual fact it is not the little tractor that is dangerous. It is the inexperienced operator. Permit me to explain a typical example of what is an all too often occurrence.

A city accountant type is fed up wrestling with ‘bottom lines’ and questionable balance sheets and decides to exchange his squillion dollar unit at Double Bay for a retreat in the bush. So he buys a vast five acre block, close to a fashionable coastal town, and bundles his family into the Range Rover and heads north.

He hasn’t a clue about farming but high on the priority is being able to display a tractor (plus of course an outboard runabout) at the front of his newly acquired house – to impress his yuppie city cousins when they come to visit.

He knows nothing at all about tractors, but remembers that simply everybody knows that the grey Ferguson is a brilliant tractor (ignoring the fact that this might have been the case half a century ago)! So he buys a Fergy from a local dealer who has been trying to quit the thing for nigh on three years. Our ex-accountant is also convinced by the dealer that he requires a slasher to tame his vast acres.

Before long he realises that there are umpteen wattles and other unidentifiable scrubby things that need pulling out. No problem – he has a Fergy. Trouble is, like most remaining Fergusons, his one is OK for 3-point linkage implements but is minus a drawbar, which some previous owner forgot to hand over

when he traded in the tractor. Again – no problem, because he notes there is a fitting for a pin near the top of the diff housing.

This was known to we old tractor blokes as the grandfather pin – for some obscure reason I have never been able to work out. But its purpose was for attaching two stabiliser links which extended down to a drawbar, when one was fitted (see diagram page 14). Its high location most definitely was NOT for attaching a snig chain to pull out wattles! Never tow from any point that is not below the level of the axles!

The chain is wrapped round an offending wattle and hooked to the grandfather pin and our injudicious ex-accountant charges off and, well as you can guess, when the chain takes up the slack the poor wee tractor is hauled over backwards ending up on top of the operator. A seriously broken tractor and an even more seriously broken ex-accountant!

Unfortunately, because most of today’s owners of grey Fergusons are inexperienced hobby farmers, the blameless tractor accounts for nearly half of all tractor operator fatalities in Australia.

Field Marshall

Like the Lanz and KL Bulldogs, the post war Field Marshall tractors featured a single cylinder 2-stroke engine. But unlike the Bulldogs, the Marshall engine was a full compression diesel (ie. 15.5 to 1 compression ratio). Accordingly there was no requirement to use a blowlamp to pre-heat the combustion chamber prior to starting.

Instead, Marshall equipped their tractors with a shot gun cartridge start! Seems weird today, but cartridge starting early diesel engines was not uncommon, particularly in relation to stationary and marine diesels.

Marshall incorporated a 12 bore cartridge breech on the front nearside of the engine, immediately ahead of the side mounted radiator. The operator was obliged to unscrew the breech cap and insert the cartridge. (I suppose it helped if he was an ex artillery guy). The next step was crucial! The breech plug had to be re-inserted and screwed in tightly! A hammer was then used to give a whack to the striking pin, located in the end of the cap. WHAM! The energy released was channelled to the head of the piston which immediately reacted by commencing its downward and first stroke of its cycle.

But, if the operator’s mind was elsewhere, such as speculating on the conviviality of the farmer’s daughter, and the breech cap was not correctly fitted, then again WHAM. But this time, instead of the energy going to the piston head, it would aim the breech cap at the operator’s head with grievous results, necessitating an advertisement having to be urgently placed in the local newspaper, seeking the services of a replacement but experienced tractor driver!

Brockhouse President

A modern day safety officer would likely suffer an immediate nervous breakdown if he was asked to assess a President! Operator safety was definitely not foremost in the designer’s priority. Apart from that, powered by a tiny Morris side valve engine, the one and only task it was capable of performing with a semblance of dignity, was to drive to the front gate to collect the mail!

The unfortunate operator’s position was ridiculous, in that he was perched high on a wobbly inadequate pan seat, the dimensions of which could not realistically accommodate a posterior of a typically rotund farmer. Plus, climbing onto the seat was a challenging exercise in athleticism. But wait, there is more! The loose wobbly seat was designed to swivel. Accordingly, when the operator put pressure on his foot to engage the clutch, he was rotated and the clutch remained disengaged!



A 1950 Brockhouse President. A close scrutiny will reveal the chrome governor control extending down from the centre of the steering wheel. (Photographed in New Zealand by IMJ)

But the most dangerous feature of the Brockhouse President was the engine throttle control. It was in the form of a long chrome lever which protruded from the centre of the steering column. So just visualise an operator carefully manoeuvring the tractor at low engine revs into a shed. Then when turning the steering wheel, the throttle control catches his jacket sleeve and suddenly the vehicle rockets forward at full revs! Scary stuff indeed!

Or imagine, when powering the President up a steep hill with a laden trailer behind and upon entering a curve the lever is caught in the sleeve of the operator's coat, causing the revs to be instantly reduced to idle and the Morris engine to stall – panic stations, as the singularly inadequate brakes are hastily applied.

Conclusion

We country folk enjoying the benefits of rural lifestyles, are free to whinge about such matters as fuel prices, dodgy politicians, the weather and so forth. But let us never whinge about modern safety regulations. They are designed to save lives! ■

IAN'S MYSTERY TRACTOR QUIZ

Question: Can you identify this old tractor from the remains, rotting away in the jungle of weeds?

Clue: It has a 6 cylinder petrol/kero engine.

Degree of difficulty: Moderate, to anyone who knows his or her tractors.

Answer: See page 48.



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'Gloves are up' ready to FITE Russian wheat aphid

THE Grains Research and Development Corporation (GRDC) is encouraging grain growers to adopt a simple four-point plan in dealing with Russian wheat aphid (RWA).

As the GRDC implements a multi-faceted research, development and extension approach to better inform future control of the pest – detected in Australia for the first time in May – growers are being encouraged to continue to scout fields, report any concerns and where necessary implement a considered management strategy.

Any suspected sightings of RWA should be reported to the Exotic Plant Pest Hotline (1800 084 881).

GRDC grower services manager north, Sharon O'Keeffe, says with RWA now established in South Australia and Victoria, the focus is on surveillance and management focussed on a four-point plan known as the "FITE" strategy:

- Find (look for characteristic leaf streaking or rolling symptoms on cereal crops and grasses);
- Identify (positively identify RWA in consultation with an industry specialist);
- Threshold approach (consider international thresholds for control, factoring crop growth stage and potential yield losses); and,
- Enact an appropriate management strategy that where possible encourages beneficial insects.

Sharon encouraged growers and agronomists – and



Russian wheat aphid (*Diuraphis noxia*) is approximately 2 mm long and is a pale yellowish green in colour, with a fine waxy coating. It is spread by wind, humans, animals and farm machinery. RWA is a global pest which attacks all cereal crops including wheat, barley, oats and rice. The aphid injects toxins into the plant during feeding, which affects growth. Heavy infestations kill plants completely. Affected plants display whitish, yellow and red leaf markings, as well as distinctive, rolling leaves. (Photo: Michael Nash, SARDI)

particularly those in southern New South Wales – to be on alert for signs of the pest but to consult state-based authorities before undertaking any control measures to avoid unnecessary spray applications.

Lots of unknowns

"Because this pest is new to Australia, there are still lots of unknowns around basic population dynamics, developmental and reproductive processes and what the triggers are for long distance movement under local conditions," Sharon said.

"The GRDC, its research partners and other agencies are working hard to improve our understanding about how this pest behaves, its impact and suitable approaches to management under our environment and cropping systems.

"One of the leading priorities is to generate a better understanding of the relative effectiveness of the insecticides currently registered for control of other aphid species in Australian cereals.

"While an Australian Pesticides and Veterinary Medicines Authority (APVMA) permit currently exists for the use of chlorpyrifos and pirimicarb (APVMA 82792), we need to compare these active ingredients with other chemistry including neonicotinoid and synthetic pyrethroid insecticides."

Sharon said in addition, the economic thresholds for control have not yet been validated locally which is critical to provide increased confidence in grower decision making around when to spray.

"While we do have indicative thresholds to guide growers based on international experience, it's important to understand that the economic threshold for control will vary with different situations," she said.

"Potential yield loss in our environment, crop yield potential and cost of the chosen control measure must be considered when weighing up spray decisions."



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Resistant varieties?

The GRDC has previously invested in pre-emptive pre-breeding activities associated with varietal resistance to RWA in a partnership led by Murdoch University and involving national and international collaborators.

While no resistance to RWA was identified in a screen of major Australian wheat and barley cultivars several years ago, encouragingly the project did develop some material where resistance genes were introgressed into Australian cereal backgrounds.

The GRDC continues to work with research partners and plant breeding companies in Australia to make germplasm available for commercial breeding.

Sharon said that in the meantime, it was important that growers and their advisers scouted crops, report suspected sightings to the relevant authorities and speak with their local district agronomist in relation to an appropriate control strategy, if necessary.

"It's a similar situation to that of any other insect pest in crops – assess what the level of infestation is and determine if/what treatment is necessary," she said.

"The FITE strategy is a simple way to assist growers in the decision-making process: Firstly, scout cereal crops and grasses and if you find typical symptoms of damage (such as leaf streaks and rolling of leaves) then the second step is to positively identify the aphid species present – consult your local adviser if unsure.

"The third step is to consider economic thresholds for control before getting the sprayer filled and ready to go. International advice supports an economic threshold of 20 per cent of plants infested up to the start of tillering and 10 per cent of plants infested thereafter. But it is important to understand that these

thresholds have yet to be validated under Australian conditions. The main point here is to avoid prophylactic sprays where the pest is either not present or is present in very low numbers within a field.

"The fourth step is enacting an appropriate management strategy – one that factors in the importance of encouraging beneficial insects which may act as natural predators, as well as the potential impact on honeybees."

The GRDC has just released a comprehensive Paddock Practices article on RWA, available from the GRDC website www.grdc.com.au

More information:

NSW Department of Primary Industries website.

Queensland Department of Agriculture and Fisheries (DAF) Beatsheet Blog.

Plant Health Australia website.

GRDC website – www.grdc.com.au

Call the Exotic Plant Pest Hotline (1800 084 881).



Typical Russian wheat aphid damage showing curled leaf and white streaking.

MURDOCH HELPING TO FIGHT RWA INVASION

Researchers at Murdoch University in Western Australia could hold the key to stopping the exotic pest which is threatening Australia's \$8 billion cereal crop industry.

Russian wheat aphid (RWA) has been detected in South Australia and Victoria – the first time it has been reported in Australia.

The Federal Government has issued an alert to farmers of the threat the aphid poses to crops.

If untreated, the pest could cause a 70 per cent loss to wheat crops and completely destroy barley yield, costing Australian agriculture billions of dollars.

But researchers at Murdoch University, funded by the Grains Research Development Corporation (GRDC), have developed plant resistance to the pest.

Breeding for RWA resistance

The discovery came from a pre-emptive, pre-breeding project which was originally led by former Murdoch Associate Professor Mehmet Cakir, funded by the GRDC from 2008 to 2013.

Surendran Selladurai is a PhD student at the School of Veterinary and Life Science, working in the Western Australian State Agricultural Biotechnology Centre (SABC) at the University. He completed the project and his thesis is now under examination by international experts.

Surendran's research contributed to successfully breeding plant resistance against three aphid biotypes which occur in other countries. Testing of the aphids found in South Australia is underway to determine biotype.

Surendran said: "Developing host plant resistance via

pre-emptive plant breeding is critical to ensuring Australian biosecurity. It's the most economical and practical means of control."

RWA resistance has been demonstrated in studies carried out in Morocco, Turkey and South Africa.

Surendran identified molecular markers used in screening germplasm – a plant's genetic code – for RWA resistance.

If the aphids found in South Australia are similar to those screened by Surendran's study, Murdoch University could hold the key to protecting Australia's cereal crops.

David Morrison is Deputy Vice Chancellor Research & Innovation at Murdoch University. He said: "Surendran's research could protect Australian grains from RWA.

"This is a perfect example of the translational nature of research at Murdoch, which aims to provide solutions to the challenges facing the world.

"Crop production, agricultural biotechnology and biosecurity are at the core of our research."

Murdoch University, GRDC and plant breeding companies are working together to ensure the benefits of this research are available to industry.

Work continues at Murdoch's Plant Biotechnology Research Group to develop other ways of controlling aphid pests and protecting crop plants.

Researchers are using a technique known as gene silencing to generate genetically modified plants with genes making them resistant to the green peach aphid.

Surendran's PhD thesis was funded by a Murdoch University scholarship, using a new mapping technique.



ASK AN EXPERT – CAN ‘SURVIVOR’ WEEDS STILL BE SUSCEPTIBLE TO GLYPHOSATE?

■ With Peter Boutsalis

ANNUAL ryegrass was the first cab-off-the-rank with resistance to glyphosate first recorded in Australia in 1996. In the past 20 years several other weed species have been added to the glyphosate resistant list but annual ryegrass remains the leader by far with over 600 resistant populations confirmed.

Dr Peter Boutsalis, Plant Science Consulting director and weeds researcher at Adelaide University has been in the thick of this unfolding dilemma, taking a leading role in testing for herbicide resistance and conducting random surveys across southern Australia to monitor the spread and evolution of resistance.

“We now know that 15 years of consistent use of glyphosate, without alternative weed control measures, will invariably lead to glyphosate resistance in ryegrass,” he says. “There are confirmed cases of resistant populations under many land management systems but we see the largest number of cases in winter cropping paddocks, along fencelines and beside roads.”

One area of particular interest to Peter is the fact that even if resistance is confirmed at a particular rate, sometimes the resistant plants will be effectively controlled with a higher rate.

“This doesn’t mean that we can keep increasing the rate



Dr Peter Boutsalis conducts random weed surveys across the southern states testing weeds for herbicide resistance under a range of management and land use conditions

indefinitely,” he says. “It just means that if the population is susceptible to a higher rate, this information can be used to form part of an integrated management response to escalating resistance.”

How can a resistant plant still be susceptible?

Short answer: The resistance mechanism must work hard to ‘protect’ the plant but it can be overloaded.

Longer answer: The target site mechanism in annual ryegrass works by pumping the herbicide to the leaf tips and restricting translocation. A plant may be able to sustain this pump at one rate but at a higher rate there may be sufficient ‘leakage’ to kill the plant and stop it setting seed.

What is a good first response to confirmed glyphosate resistance?

Short answer: Glyphosate resistant weeds are often not good competitors when glyphosate is not used. Research has shown many instances of a ‘fitness penalty’ that makes these ‘weak survivors’ less competitive and so they set less seed.

Longer answer: If it is necessary to continue using glyphosate, apply a higher rate of glyphosate initially to reduce plant numbers and then use a different herbicide MOA to further reduce the number of potentially resistant plants setting seed. For best results with this double-knock, apply the second mode of action herbicide, e.g. paraquat, within three days of applying glyphosate.

What’s the best way to manage hot spots like fencelines to avoid glyphosate resistance taking hold?

Short answer: Don’t leave spraying fencelines until spring – try to get in early and treat weeds when they are small.

Longer answer: Resistant ryegrass is more sensitive to glyphosate when the conditions are optimal – aim for small, unstressed weeds, optimal spray coverage, including sufficient adjuvant, and spray in the cooler part of the day (below 30°C). Resistant pollen can quickly spread at least 50 m into the paddock. Ryegrass cross-pollinates and there is a low, but increasing, incidence of populations possessing both target site and translocation resistance mechanisms. ■



The 2015 random weed survey revealed an incidence of nine per cent glyphosate resistance in annual ryegrass in the Wimmera region of Victoria. It is not possible to diagnose herbicide resistance in weeds in the field. The only way to know what herbicides particular weeds are susceptible to is to undertake scientific testing. The ‘Quick Test’ can be done on living plants and provides timely feedback on suitable herbicide options.

HOW TO ASK A WEEDSMART QUESTION

Ask your questions about managing herbicide resistant crop plants that establish in non-crop areas on the WeedSmart Innovations Facebook page <https://www.facebook.com/pages/WeedSmart-Innovations/354441941389122>, Twitter @WeedSmartAU or the WeedSmart website <http://www.weedsmart.org.au/category/ask-a-weedsmart-expert/>

‘Weedsmart’ is an industry-led initiative that aims to enhance on-farm practices and promote the long term, sustainable use of herbicides in Australian agriculture.

What's the point of cake if you don't eat it?

■ By the Australian Herbicide Resistance Initiative (AHRI)

You can't have your cake and eat it.

But what's the point of cake if you don't eat it?

Ok, we've (deliberately) misinterpreted the saying here, but you get the drift.

What is the point of doing research if you don't tell anyone about it?



A LOT of money is spent on agricultural research, and we need this research to reach the farmer – otherwise, what's the point?

Everyone's time poor and, these days, we're all bombarded with more info than ever. This means that good communication of this info is more important than ever.

There's more to communication than scientific papers and presentations. There's a raft of activities going on behind the scenes to ensure that messages aren't only heard, they're understood and (hopefully) adopted!

For this edition of AHRI insight, we're going to take you behind the scenes of our approach to communication and show you why we do things the way we do.

- Why we start AHRI insight with quirky anecdotes.
- Why we layer info.
- Why we use social media.
- And why we believe research projects deserve their own communication program.

Once upon a time, we had the telephone and face-to-face meetings. Now we have a whole raft of communication channels. This is great because there are more ways to send and receive info, but it also means we're all bombarded with a (seemingly) constant

stream of information. So how do we cut through the clutter and succeed in a crowded space?

The quirky anecdote

People want to be entertained. Do you have an email newsletter that you always open, as soon as it comes in? Why do you open it? Chances are it's entertaining and/or makes you think.

The quirky anecdote to start the AHRI insight newsletter does a few things:

- It entertains (we hope!);
- It makes the content memorable; and,
- It links the story that you're about to tell to the reader's current knowledge.

The bible of the AHRI communications team is the book 'Made to Stick' by Chip and Dan Heath. This book explores why some ideas thrive while others die. They came up with the SUCCES formula to make ideas stick.

Simple
Unexpected
Concrete
Credible
Emootional
Stories

The quirky anecdote is unexpected, and when done well, it also contains some of the other elements of the SUCCES formula. It's also great fun to write.

Head, heart, gut

Cam Nicholson is an agricultural consultant who specialises in extension theory. In his paper, *Making good decisions great*,



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Cam talks about how decision making is about more than facts and figures. He says that there are three broad influencers of decisions:

- **The Head:** Logic/facts and figures;
- **The Heart:** Emotion – value based and include goals/beliefs. These are acquired early in life; and,
- **The Gut:** Intuition – intuitive decisions are usually right if they ‘feel’ right.

Lots of communication of ag research starts and finishes with logic. This is a flawed approach because it forgets that we all make decisions based on emotion, and then justify them with rational arguments.

Think back to a big life decision that you have made in recent years. What was it that finally tipped you over the edge to make the decision? Was it the logic or did it just feel right and the logic helped you rationalise it?

Does it feel right to have narrower row spacing to compete with your weeds because whenever you have seen a blocked row the weeds grow like Trifids? Good, because the data says the same thing. Don’t ignore the heart and the gut.

Champion growers

Part of our communication process includes champion growers sharing their stories. This began when Dr Michael Walsh took Ray Harrington, Lance Turner and Rod Messina on the road to speak about their experiences with the HSD, chaff carts and narrow windrow burning. They didn’t know it at the time, but these growers spoke from the heart and the gut and told stories of their experiences and WHY they do things.

We’re forever grateful for the help from these growers and others like them. They help many growers make the right decision for them.

Bill Long, another extension expert

Bill Long is another ag consultant who knows a thing or two about ag extension theory (in fact, he did his masters on it). Bill has a lot of good theories, but the one that has stuck with us is the role of the ‘significant other’.

For example, we know that not too many growers walk out of a workshop about, for instance, chaff carts, and go straight to the machinery dealer and buy a chaff cart.

Bill believes that there’s another (very important) link in the ‘chain’. After the chaff cart workshop, if growers like the sound of what they’ve heard, they have a chat with a ‘significant other’ (or two) to help them make a decision.

This means that the information we deliver needs to reach people sitting at various points along this chain. So how do we do this?

Layer upon layer upon layer

Because our audience is so varied (from grain growers, to agronomists to research scientists), we layer our info so each layer is targeted at a certain portion of that audience.

We know that grain growers have a lot on their mind, which is why they outsource some thinking to experts such as agronomists, consultants, grain marketers etc. An agronomist, who specialises in weed control, is likely to want a deeper understanding of herbicide technology than most grain growers (since it helps them understand what they see in the field).

We layer information so people can dig as far as they like. For example, for AHRI insight the first layer is the email, the second layer with a bit more science/detail is the website content or *Australian Grain* article (what you’re reading now), and the third layer is (usually) the scientific paper.

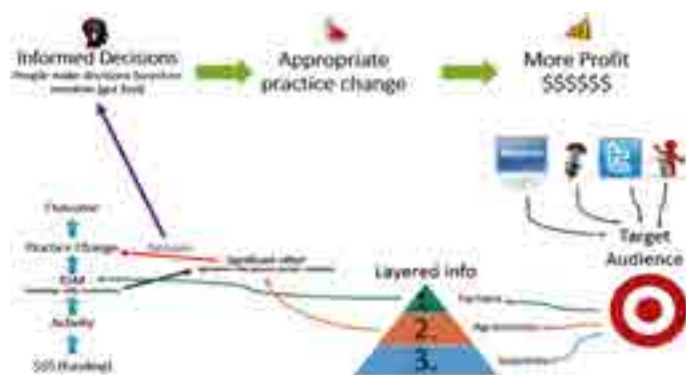
Stay native to the platform

There are so many ways we communicate these days (for us, it’s email, website, twitter, presentations, WeedSmart, webinars, video, media) so it’s important to know which platforms to use and how to use them. It’s not just about sharing info... it’s about deciding the BEST way to share it.

The term “stay native to the platform” is one that AHRI communicator, Brogan Micallef, uses often. By this she means that we need to remember which platform we’re using when we choose the language/style and so on of the information.

For example, Twitter should be treated as a cocktail party where you move from group to group talking to people about stuff. If all you do on Twitter is post links and never discuss things with people, this is like walking up to a group at a cocktail party, making a statement and then walking off. There are names for people like this! We also have names for people who only talk about themselves – remember the ‘social’ in social media!

We need a reason to use all of these platforms and we need to use them in the appropriate way (and not just for the sake of it). Some are used to gather more subscribers, some to discuss concepts, and others to act as a repository for information. They’re all important and they’re all linked. The image below best describes how it’s all linked for AHRI communication.



We use events such as presentations, *Australian Grain* articles, radio interviews, Twitter and webinars not only to give out information but also to capture subscribers. To these subscribers we send layered information, using the SUCCE formula to ensure that both farmers and their significant others are informed so that the best decisions can be made.

If we get all of this right, then we’re on the way to facilitating practice change that delivers more profit to grain growers, sustainably.

To sum up

There are a few key words that sum up the information above.

Filter: It’s our job to filter all of the information out there and then deliver it in a way that makes sense to the audience. We must give the audience what they need, not just what we have!

Linked: Everything is linked. We need to join the dots between communication platforms and between people.

Focus: By focusing our efforts on communication we can do it justice. Our communication is not tacked onto a research program – it is a program.

SUCCE: When we use the SUCCE formula developed by Chip and Dan Heath, we appeal to the heart and the gut rather than just the head and we create stories that stick.

If ag research is to have an impact it must be communicated. We believe we’ve developed a winning formula and we would love to see other research programs invest in the art of communication. It’s well worth the effort.

Have your cake and eat it.

Managing spray drift with a new decision-support tool

■ By Andrew Hewitt, Chris O'Donnell, Gary Dorr, Jason Ferguson and Rodolfo Chechetto, University of Queensland

TAKE HOME MESSAGE...

The Australian Ground Spray Calculator is a decision-support tool that provides spray applicators with information on droplet size, target coverage and drift potential specific to particular nozzles and tank mixes. Spray applicators now have a unified tool that provides science-based reliable information to help with their drift management strategies.

JUST because a spray is classified as 'coarse', it can still include up to 10 or more out of every 100 L in 'fines'. In other words, for an application rate of 100 L per hectare, 10 of those 100 L could potentially be available to drift off-target in unfavourable conditions.

In a relatively high wind speed in an unstable atmosphere, this driftable part of the spray could move relatively large distances, but is likely to disperse more than under conditions of little or no wind in a local surface temperature inversion where the total drift loss and distance may be similar to that of the high wind scenario. But the concentrations of droplets on the ground at any one distance can be hard to predict. In some places there may be no droplets, while in other places there could be relatively high concentrations of this deposition drift under stable air conditions.

The above hypothetical cases of unstable and stable air may have involved the same amount of airborne drift but very different patterns of deposition drift.

Managing drift

Pesticide exposure risk assessors usually assume that the air is unstable because applications under conditions of local surface temperature inversions are forbidden on labels and in most pesticide application regulations. When stable air scenarios are

ignored in risk assessment, the normal trend for exposure is that airborne and deposition drift increase with higher wind speeds. But the label tends to focus on spray quality for alerting the applicator how to avoid drift with a particular product.

For example, phenoxy herbicides are usually labelled for requiring a spray that is at least coarse in spray quality.

Improvements to regulations

But through the work of UQ and others, regulations could soon become more flexible to allow an applicator to manage drift in other ways than just droplet size – and even to reduce the size of any required no-spray buffer zones by using a suitable Drift Reduction Technology (DRT) as well as the standard nozzle options.

DRTs may include novel designs of hardware options (eg. better nozzles, atomisers or shields, shrouds, air-assistance, etc), or formulation chemistries (eg. some emulsion and other chemistries).

In some cases, landscape features such as hedges or netting may be allowed as DRT shields or barriers to intercept drift and protect sensitive areas downwind and beyond their locations.

Spray Performance Calculator

One aim of the Spray Performance Calculator is to be ready to show DRTs once the Australian Pesticide and Veterinary Medicines Authority (APVMA) announces and launches its DRT scheme for Australia (this is expected late in 2016, at which time the Spray Performance Calculator will be updated accordingly). The Calculator already includes an output called 'drift potential'.

This indicates the relative drift potential of the spray. In the example shown in Figure 1, the spray selected by the end-user was classified as 'coarse' for Spray Quality, but had a relatively low drift profile and exposure level. Note that the percent 'fines' in this case is almost 80 per cent lower than the default of about 13 per cent for the reference category of 'coarse' sprays. This is important because if an applicator can select a spray quality that is finer than

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the drift potential then they can often increase the potential spray coverage at targets without needing to increase their application volume rate.

Factors influencing spray performance

It has been known for many years that the choice of nozzle, spray pressure and tank mix composition – including active

ingredient and adjuvant products – can have a large effect on the performance of a pesticide spray for efficacy and targeting. In general, the coarser the spray, the lower its drift potential but the lower the potential coverage on target surfaces, plants and pests.

This is where factors like increasing the water volume rate can help boost droplet numbers, but how does an applicator know how to get the balance between the spray coverage and avoidance of drift when faced with so many variables?

In particular, adjuvant effects are often non-intuitive with some adjuvants increasing the fine droplets in a spray and others reducing these ‘fines’. To make things more complicated, one trend may be seen with one nozzle but a completely different trend with a different nozzle.

To help take the guesswork out of spray performance and also help comply with new spray drift management requirements, researchers at The University of Queensland (UQ) have measured the performance of over a thousand combinations of nozzle x pressure x tank mix that cover most Australian grain crop spraying scenarios. They have assembled these data into a new Australian Spray Performance Calculator that can help show the key performances of a spray in relative terms:

- Coverage in number of droplets per cm²;
- Coverage after droplets wet a leaf;
- Spray quality in terms of droplet size classification; and,
- Drift potential.

This calculator differs from previous spray performance tools in Australia and the US which tended to only state the spray quality.

Additional information in the Calculator shows the droplet size spectrum and where it sits relative to the American Society for Agricultural and Biological Engineers (ASABE, formerly ASAE) S572 reference spray boundary curves. ASABE S572 “Spray Nozzle Classification by Droplet Spectra” is a system that allows sprays and nozzles to be classified by Spray Quality into categories of relative size.

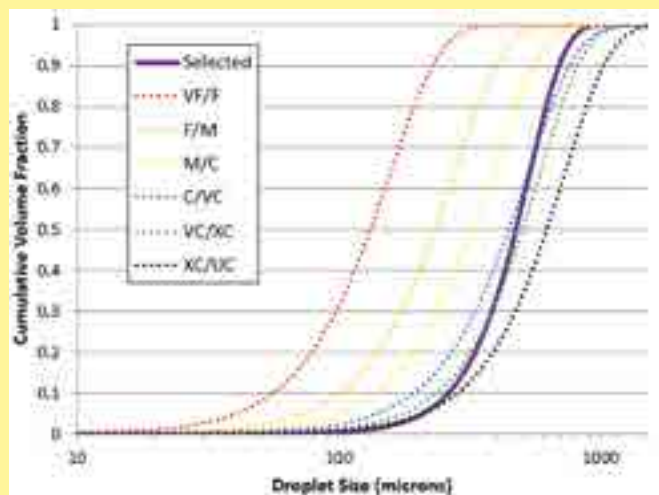
In the Figure 2 example, the volumetric droplet size spectrum curve (solid purple line) crosses between different size classes depending on the volume fraction/droplet size region. The ASABE S572 scheme requires the classification be assigned to the finest category in this distribution which resulted in a coarse spray designation.

The authors gratefully acknowledge the financial support of the GRDC and their grower base which helped develop the core database used in the spray calculator.

Contact details Chris O'Donnell, The University of Queensland Gatton, Qld, 4343 Email: c.odonnell@uq.edu.au

FIGURE 1: Spray Performance Calculator

FIGURE 2: Droplet size spectrum for the example scenario (Figure 1) generated by the calculator (solid line) compared to ASABE S572 reference curves which are (from L to R) VF/F, F/M, M/C, C/V, VC/XC, XC/UC



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Benefits of planting mungbeans on narrow rows

■ By Bhagirath Singh Chauhan¹

AT A GLANCE...

- Mungbeans are generally grown in wide rows of up to 1 m.
- Wide row spacing makes the crop more prone to heavy weed infestation.
- Narrowing the row spacing may increase weed suppression and grain yield.

MUNGBEANS, a nutritionally important food and feed legume crop, are grown in spring and summer seasons in subtropical areas in Australia – mostly in Queensland and northern New South Wales. It is grown mainly as a rotation

crop with cotton or cereals. About 95 per cent of the total mungbeans produced in Australia are exported. But in addition to drought and disease, the yield and product quality of this crop are affected by weeds.

In general, mungbeans are grown in wide rows of up to one metre. This means they are prone to heavy weed infestation. Weeds can be



Mungbean researcher, Bhagirath Chauhan.

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FIGURE 1: Weed biomass reduction in mungbeans grown at 25 and 50 cm rows compared to that at 75 cm – there were three weed infestation periods

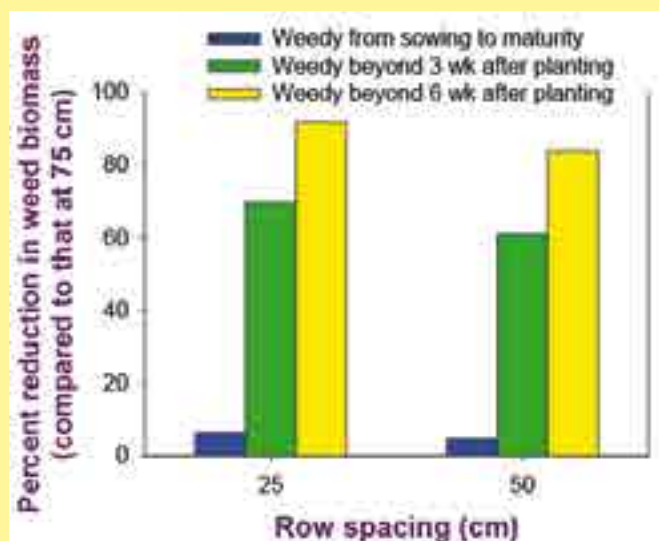
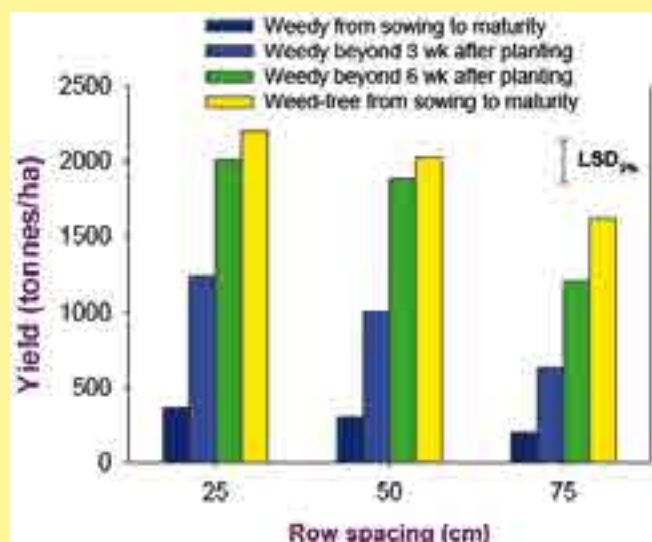


FIGURE 2: Impact of row spacing and weed infestation period on yield of mungbeans



controlled using herbicides – but continuous use of herbicides with similar modes of action may result in the evolution of resistance in weeds.

In the northern region of Australia, many weed species have already developed resistance against several commonly used herbicides. Weed management tactics, which can make crops more competitive against weeds, are required.

One tactic is to reduce row spacing to improve crop competitiveness with weeds. But there has been limited information on the impact of row spacing on weed suppression in mungbeans grown under Australian conditions.

The research outlined here – supported by the Department of Agriculture and Fisheries (DAF) and QAAFI weed research team in Toowoomba – aims to provide more information on row spacing options for Australian growers.

How we did the trial

A trial was conducted in the summer season of 2014–15 at the research farm of the University of Queensland (Gatton), to evaluate the impact of row spacing (25, 50, and 75 cm rows) and various weed infestation scenarios on weed suppression and mungbean yield.

The weed infestations scenarios were:

- No weeds (weed-free);
- Weedy beyond three and six weeks after crop planting (WAP); and,
- Weedy from crop sowing to maturity.

The cultivar 'Jade-AU' was planted at a seeding rate of 30 kg per hectare across all the row spacings.

The experiment was arranged in a split-plot design with row spacing assigned in the main plots and weed-infestation period in the sub-plots. There were three replicates of each treatment.

Weed competition was created by spreading Rhodes grass at 300 seeds per m² at crop planting (in weedy plots from sowing to maturity), three WAP (in weedy plots beyond three WAP), and six WAP (in weedy plots beyond six WAP).

These weedy treatments were selected to reflect different levels of weed infestation. No weeds were allowed to grow in the weed-free plots.

What we found

When weeds were allowed to grow from crop sowing to maturity, row spacing did not influence weed biomass. But narrow rows (both 25 cm and 50 cm) suppressed weeds more effectively than the widest rows (75 cm) when weeds were allowed to grow beyond three WAP (Figure 1).

There was 61 to 70 per cent less weed biomass in 25 to 50 cm rows compared to 75 cm rows for the weeds grown beyond three WAP. Similarly, there was 84 to 92 per cent less weed biomass in 25 to 50 cm rows compared to 75 cm rows when weeds were allowed to grow beyond six WAP.

In the completely weedy condition, grain yield was not affected by the row spacing and it ranged from 0.20 to 0.36 tonnes per hectare (Figure 2).

In the other three weed treatments, grain yield was always lower for the crop grown at 75 cm rows and there was no difference in yield between the crops grown on 25 and 50 cm spacings.

Maximum grain yield (2.2 tonnes per hectare) was produced in the weed-free plots of the crop grown at 25 cm rows.

To sum up

This trial suggests that weeds – emerging beyond three WAP – can be suppressed more effectively by planting mungbeans in narrower rows (25 to 50 cm), compared to wider rows (75 cm).

The narrower rows provided higher grain yield of mungbeans compared to the widest rows. This also occurred where there was a total absence of weeds.

The current trial was conducted using 'artificial' weeds (ie. Rhodes grass). Weeds in natural conditions may behave differently because of their non-uniform density and less tolerance to shading.

In addition, different mungbean genotypes, depending on their growth habit, may compete with weeds differently in different management scenarios.

Given these variables, there is a need to conduct this trial in different genotype x environment x management situations.

¹The Centre for Plant Science, Queensland Alliance for Agriculture and Food Innovation (QAAFI), Gatton/Toowoomba.
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Experts 'beetle away' on scarab research

GRAINS Research and Development Corporation (GRDC) funded research is paving the way for more effective control of scarabs across the northern cropping belt.

Scarab damage to establishing crops has previously been reported from Queensland's Darling Downs to the Liverpool Plains, affecting both summer crops and winter cereals including sorghum, maize, sunflower, mungbean and wheat.

While reports of scarab damage have tended to be sporadic and associated with wetter seasons, in certain areas, persistently affected paddocks have suffered up to 80 per cent loss in sorghum crops prompting on-going research into a variety of potential control methods.

Scarabs feed on roots, impacting on plant growth and the plant's ability to tolerate moisture stress. This is visible as slowed crop growth, plant death (often in patches), delayed maturing and lodging.

Scarabs generally have a one to two-year lifecycle which can be longer if growing conditions are unsuitable such as if it is too dry or food sources are inadequate. This means larvae can be present in fields for 12 months of the year.

In-field trials

Recent in-field trials have focussed on cultivation, comparing the impact of a single offset disc and chisel plough on scarab larvae densities, as well as insecticide treatments at sowing, both in-furrow treatments and seed treatments.

Queensland Department of Agriculture and Fisheries (DAF) principal entomologist Dr Melina Miles said both the disc and chisel plough cultivation trials resulted in a significant reduction in larvae numbers but also resulted in a full disturbance of the soil surface and correspondingly high reductions in soil moisture.

"The impact of cultivation on soil moisture is a major impediment to the potential uptake of cultivation to manage high density infestations," Melina said.

"But it may be possible to be more targeted with cultivation and achieve the same outcome. Examination of the distribution of larvae across the plant row and inter-row shows a concentration of larvae on the plant row in the majority of fields.

"This pattern of distribution opens up the possibility of more targeted tillage with reduced disturbance."

In-furrow and seed treatment trials

Trials assessing the efficacy of in-furrow and seed treatments have also been undertaken given that there is little information on the impact of these treatments on the scarab larvae that are causing damage to establishing crops.

Melina said although preliminary results suggested that insecticide treatments at sowing could potentially provide some crop protection, it was also probable that the insecticides would deter larvae from the zone in which they are active – but as roots grow out of the treated zone they could then be damaged by larvae.

"It is also possible that the use of seed or in-furrow treatments will have little longer term effect on the density of the population, essentially locking growers into a program of using these treatments to ensure a crop," she said.

"Techniques for evaluating the efficacy of seed dressings, in-furrow treatments – and possibly side-dressed insecticides – are

under development which will allow for evaluation at different times post-application to test the longevity of the treatments and their potential toxicity to scarab larvae."

Larvae identification and thresholds

Work is also continuing into the definitive identification of larvae species – at least four species have been collected from fields in the northern region and it's believed that the most common species is *Othnonius batseii* – the black soil scarab.

At the same time, research teams are undertaking additional investigation into the within-field distribution of scarab larvae which will be critical to developing a reliable monitoring technique for growers and agronomists.

"In the absence of a defined threshold, observations of crop loss and infestations indicate that densities above 15 larvae per square metre (to 15 cm depth) are associated with significant crop loss," Melina said.

Melina encouraged growers and advisors to monitor for scarab larvae during the growing season and if larvae are found, contact her at DAF Toowoomba on 13 25 23 or melina.miles@daf.qld.gov.au. ■



Scarab larvae under a sorghum stand. (PHOTO: Melina Miles DAF)

MANAGING HELICOVERPA

Controlling *Helicoverpa armigera* and *Helicoverpa punctigera* in pre-podding chickpeas is often considered unwarranted due to the plant's ability to compensate for *Helicoverpa* damage and the low likelihood of incurring yield or quality losses during vegetative and early flowering stages.

The economic threshold calculator developed by Queensland DAFF is based on this principle, with an emphasis on controlling the most damaging larval stages between pod set and maturity.

However, strategic use of nucleopolyhedrovirus (NPV) such as Vivus Max during chickpea flowering has been used for many years by many growers to manage *Helicoverpa* leading into the critical podding stage.

Using Vivus Max early shows significant value in certain crops (such as soybeans) when used during flowering against pre-threshold populations of *Helicoverpa*. This technique relies on larvae dying from NPV infection and releasing huge amounts of the virus. In this way a single, low rate Vivus Max application can be used to "inoculate the crop" with NPV, and establish a natural virus infection cycle for many weeks or months.

AgBiTech, in collaboration with consultants and growers throughout the northern grain belt, undertook a trial program over several seasons to evaluate the early (pre-podding, sub-threshold) use of Vivus Max in chickpeas. The key questions to answer about this use pattern were:

1. Can it provide useful suppression of *Helicoverpa* during pod-fill?
2. Does the suppression delay the onset of economic threshold populations of *Helicoverpa*?

3. Is this sufficient to delay the need for threshold applications of insecticides or reduce the likelihood of needing a clean-up spray close to harvest?
4. Can early NPV reduce the level of pod damage compared to a conventional management strategy (i.e. threshold application of insecticides)?
5. Does a half rate of Vivus Max (75 mL/ha) provide an effective "inoculation dose"?

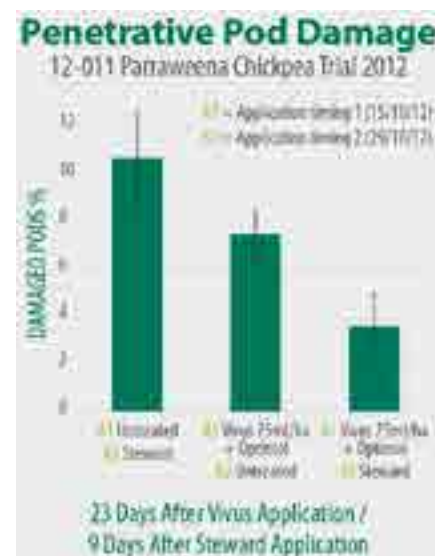
Trial Program

Large-scale trials were conducted from Quirindi, NSW to Emerald, Qld using commercial / grower spray equipment. The trials were laid out in single fields that were initially split into two. One half was managed using the normal commercial insecticide regime and the other half was treated with a pre-threshold application of Vivus Max. Each section was managed individually, and in some cases each section was further split as the season progressed to allow for different treatment regimes.

Damage Reduction

The key benefit of using NPV early is that the presence of the virus minimises the number of larvae that develop beyond 3rd instar and into the most damaging stages. This greatly reduces the "sub-threshold" damage that occurs prior to the application of a knockdown insecticide, and will also minimise damage from larvae that may survive an insecticide spray.

This graph shows that under high insect pressure, a single application of Vivus Max (applied two weeks before the crop reached economic threshold, when it was sprayed with Steward) provided greater damage reduction than the threshold spray of Steward. This



IN CHICKPEAS WITH NPV

exceptional level of performance from NPV is not usual, but shows that when applied early and under good conditions, Vivus Max can be very effective in chickpeas. The combination of the early Vivus Max with a threshold Steward spray was the best performing treatment and provided over 60% damage reduction compared to Steward alone.

Delayed/Fewer Insecticides

It is often reported that early applications of Vivus Max in chickpeas delays larval numbers reaching economic threshold. Results from the trial program confirmed this effect in the majority of situations – an example can be seen in the graph [below] where threshold levels were delayed by 10 days due to the use of Vivus Max. In addition, the number of 4th and 5th instar larvae remained low in the Vivus Max treated area. Depending on the season, delaying the first chemical insecticide can have the effect of eliminating the need for a “clean-up” spray close to harvest.

Why Vivus Max instead of Synthetic Pyrethroids?

Under sub-threshold conditions, application of synthetic pyrethroids (SP's) for *Helicoverpa* control will have limited



NPV infected larva in chickpeas

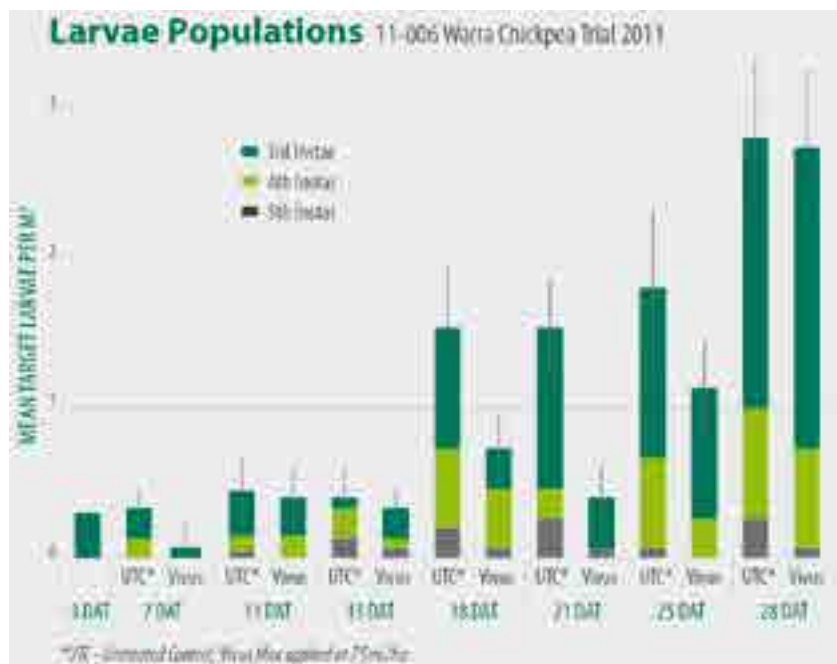
to no economic benefit. SP's usually offer good control of eggs and larvae that are present, but have short residual control. NPV inoculation using Vivus Max will provide ongoing suppression of *Helicoverpa* for many weeks, with no disruption to beneficial species that may be present (such as ants and spiders).

The Recommendation

The trial program showed that early applications of Vivus Max at low rates gave a consistent economic benefit to chickpea farmers under both low and high pressure scenarios. AgBiTech's recommendation is as follows:

- Use Vivus Max at the registered rate of 75mL/ha (with or without Optimol);
- Apply after larvae first appear and before the presence of pods – larvae must be present to get the “NPV inoculation” benefit; and,
- If possible, time applications to be applied in mixture with other pesticides – Vivus Max is highly compatible in mixture.

For further information, call
Sophie Gulliver (AgBiTech Technical Specialist) on
0409 001 142 or visit www.agbitech.com



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Sunflowers making a solid contribution to farm income

TWO separate crop rotation trials in northern NSW have demonstrated the value of summer cropping under varying environmental conditions and across seasons.

The impact of different crops in each season was captured through cumulative gross margins calculated for each site. Cumulative gross margins across several years show sunflower

is a good fit rotational crop in both harsher and milder growing conditions.

West of Moree the growing conditions were particularly harsh in the 2013–14 summer when Tony Lockrey, AMPS Moree Consulting Agronomist, in conjunction with the AMPS Research team, conducted sunflower and sorghum hybrid trials on Michael and Ros Woods' property, 'Braemar', where sunflowers and sorghum regularly feature in the rotation.

While summer crops are not usually the highest gross margin crops for the Woods family in their western farming system, they have been a key strategy used to slow the build up of crown rot inoculum and nematodes.

With the local AMPS Research committee of growers and private consultants keen to continue their sorghum and sunflower variety evaluations in the west, the Woods generously hosted both the randomised and replicated trials in their 600 hectare field.

Comparing gross margins

"We took the opportunity to compare the gross margins of each crop as well, particularly over time," said Tony. "We assessed crop gross margins, rotational benefits and risk strategies in a particularly difficult season where very low summer rainfall and extreme temperatures combined to deliver record

TABLE 1: Moree West Dryland gross margins – hybrid trial plots and commercial field trial with sorghum and sunflower 2013–14 summer

	Sorghum trial*	Sorghum commercial*	Sunflower trial	Sunflower commercial
Av yield	1.68	0.5	1.16	0.75
Price/t	\$250	\$250	\$850	\$850
Gross return	\$420	\$125	\$986	\$638
Costs	\$379	\$379	\$314	\$314
Net return/ha	\$41	–\$254	\$672	\$324

*Note sorghum planting dates where August 31 for the field and 20 September for the trial.

TABLE 2: Gross margin calculations at 'Braemar', West Moree

Braemar, target \$300/ha/yr, land value \$2470/ha

2012	GM/ha	2013–14	GM/ha	2015	GM/ha	Cumulative GM
wheat	\$360	followed by sorghum	–\$254	followed by wheat	\$421	\$527
		sunflower	\$324		\$421	\$1105

TABLE 3: Grain yield and gross margin analysis of summer crop comparison trial, Parraweena Pastoral Company, Blackville NSW 2013–14

Crop	Grain yield (t/ha)	Grain price (\$/t)	Income (\$/t)	Variable costs ^a (\$/ha)	Gross margin (\$/ha)
Sunflower	2.42	\$700	\$1694	\$521	\$1173
Sorghum	8.03	\$265	\$2128	\$527	\$1600
Mungbean ^b	2.05	\$1000	\$1701	\$476	\$1574
Soybean cv. PR443	2.91	\$650	\$1885	\$384	\$1500
Soybean cv. Richmond	2.31	\$650	\$1501	\$384	\$1117
Soybean cv. Soya791	2.09	\$650	\$1358	\$384	\$974
Soybean ^c cv. Moonbi	1.92	\$650	\$1248	\$384	\$864

a Variable costs included in-crop herbicide and fertiliser applications, cost of planting and harvesting, machinery costs and grain grading costs.

b Twenty percent of the mungbean grain required grading at a cost of \$105/t. The price of \$1000/t used in this analysis was for premium grade. Grading can result in 5 to 8% losses to the total yield according to the Australian Mungbean Association.

c Note the yield penalty from sowing an early, fast maturing soybean variety like Moonbi a month later than recommended.

Full details can be found in the NSW DPI report 'Northern grains region trial results, Autumn 2015'.

TABLE 4: Gross margin calculations at 'Parraweena', Liverpool Plains

Parraweena, target \$900/ha/yr, land value \$7400/ha

2012	GM/ha	2013–14	GM/ha	2014–15	GM/ha	Cumulative GM/ha
wheat	\$1196	followed by sunflower	\$1173	followed by sorghum	\$1975	\$4344
		sorghum	\$1601	sorghum	\$924	\$3721
		mungbean	\$1574	sorghum	\$1807	\$4577
		soybean (av)	\$1118	sorghum	\$1662	\$3976



Hyoleic 41 sunflower – trial plot, planted August 30, SSkip.



Commercial sunflower – planted August 27, 150 cm row spacing.

transpiration rates,” he said. “In these conditions sunflower had a slight advantage due to the crop’s earlier finish.

“The plot trials compared the yield performance of current and potential hybrids of both crops while the commercial scale trial (300 hectares for each crop) tested the rotational benefits of the two crops over four years,” Tony said.

The commercial field of sunflower was planted on August 27 2013 on 150 cm row spacing. The 8-hybrid sunflower trial plot was planted on August 30 on a 2 in, 1 out (SSkip) configuration on 1 m rows. Sunflower produced a positive gross margin at both the trial plot (\$672) and commercial scale (\$324), significantly outperforming sorghum (Table 1).

Sunflower brings economic and agronomic value to the Northern NSW cropping system, which is best seen when gross margins are calculated across several years (Table 2).

Tony said the cereal disease and nematode break, moderate N requirements, grass weed control options, tap root physiology, crop timing and moisture management benefits of sunflower are well worth consideration.

“It is clearly very important to look at full rotation gross margins when formulating flexible and sustainable farm cropping plans,” he said. “Growing different crops and/or using split planting dates helps spread the risk of negative gross margins from climate extremes.”

Liverpool Plains’ rotations

On the highly productive southern Liverpool Plains, grower Joe Fleming requested a replicated strip trial to compare the summer cropping options of soybean, mungbean, sunflower and sorghum in 2013–14. The block was fallowed over winter and then sorghum was sown across all plots in summer of 2014–15.

This trial was conducted as part of the NSW DPI and GRDC ‘Northern Pulse Agronomy Initiative’ project, which is looking at the benefits of pulses in crop rotations.

Nathan Ensbe, NSW DPI Technical Officer (soybean agronomy) said the gross margins from the initial replicated strip trial on Joe Fleming’s Blackville property, Parraweena Pastoral Company in 2013–14 favoured sorghum and mungbean due to the high yield of sorghum and the high market price for mungbean (Table 3).

“Sorghum and sunflower were considered higher risk than the soybean crops given the higher input costs,” he said.

(Full details can be found in the NSW DPI report ‘Northern grains region trial results, Autumn 2015’.)

The field was fallowed for the 2014 winter then in the 2014–15 summer, sorghum was sown across the trial plots.

“The effect of crop rotation was clearly evident when the

sorghum was harvested,” said Nathan. “The highest gross margin was from the plots previously sown to sunflower and conversely, sorghum following sorghum was the lowest yielding of all systems.”

“When the cumulative gross margins are calculated across three cropping seasons, winter 2012, summer 2013–14 and summer 2014–15 (Table 4), it is clear that market price and the break crop effect are key factors to overall financial returns,” he said.

In long fallow cropping systems, growers need to make a lot of money with a few crops. On the Liverpool Plains, Joe Fleming is seeing the value of double cropping their main cereal program following a summer crop to increase gross margins across the rotation.

More information: www.bettersunflowers.com.au

Tony Lockrey, Consulting agronomist AMPS Moree on 0428 529 001 or tony@ampsagribusiness.com.au and

Nathan Ensbe, Technical Officer (soybean agronomy) NSW DPI Grafton on 02 6640 1647 or nathan.ensbe@dpi.nsw.gov.au

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Sorghum stands up in dry conditions

A KEY characteristic Andrew Rogers wants in his sorghum program is standability, so his crops won't fall over after being sprayed out. In addition, the northern NSW farmer is also after good seasonal vigour, grain size and yield potential.

This wish list has been answered in the form of Pioneer brand G44 hybrid sorghum, which Andrew grew for the first time in the 2015–16 season on his Myall Creek property, which he farms with his brother and parents.

Conditions had been dry until a good fall of rain in November allowed him to plant his G44 on the 11th of the month.

"The establishment of the crop was better than what we thought, as we didn't have rain for about three weeks after planting.

"We were aiming at about 55,000 seeds per hectare and we got 48,000 plants per hectare established, which was spot on for how the season turned out," he says.

At planting the Rogers put 110 kg per hectare of urea down in the inter-row, along with 50 kg per hectare of Granulock Z fertiliser.

Weed control consisted of 2.0 kg per hectare of atrazine and 0.5 L per hectare of Dual Gold pre-plant and then at planting they applied another 1.0 L per hectare of Dual Gold and some Roundup to knock out small weeds.

Following decent rainfall through January, there was no more

rain for the last eight weeks of the growing period, with the G44 relying on subsoil moisture.

"Overall we had 180 mm of in-crop growing season rain, including what we planted on, making it a dry season, although temperatures were quite mild which helped," he says.

The Rogers sprayed the G44 out on March 20 before harvesting took place at the start of April, with the dry conditions taking a toll on other sorghums.

"A lot of other varieties were falling over after being sprayed out and lodged quite badly in some paddocks, but the G44 was excellent, it stood up and never looked like lodging.

"It harvested really well and yielded 7.0 tonnes per hectare, which I thought was excellent. We weren't thinking anything above 5.5–6 tonnes per hectare with the season we'd had and especially with the dry finish.

"We were also a bit worried about pinched up grain, but it all filled up fairly well, with screenings only being 2.5–3 per cent, while test weights were around 82 kg per hectolitre," he says.

Next summer the Rogers are planning on planting half their sorghum program to G44, reserving the variety for creek flats where it will do well.

"We're going to manage it as a variety that we can leave to harvest last just because of its standability – after you spray it out you haven't got to worry about rain with this variety," Andrew says. ■



Andrew Rogers in his paddock of G44 hybrid sorghum.

New research aims to assist snail and slug management

A NEW research project aims to increase knowledge of damaging snail and slug species and provide grain growers with information to allow them to effectively and economically manage these pests.

The GRDC-funded project will be led in Western Australia by Department of Agriculture and Food (DAFWA) entomologist Svetlana Micic. It is a national project led by the South Australian Research and Development Institute (SARDI).

Research under the project will also be conducted in South Australia, Victoria and Tasmania.

GRDC Western Regional Panel member and Ravensthorpe grower Andy Duncan said snails and slugs caused crop damage and yield losses and imposed significant control costs on growers.

"Snails can cause additional costs such as harvester modifications and damage, grain cleaning, grain value loss and grain rejections," he said.

"Snails are an emerging pest in WA and control and losses are conservatively estimated to cost the state's growers \$3 million annually.

"Snail numbers and their geographic spread appear to have increased in line with recent good seasons.

"To help control snails and their spread, it is important to bait early and remain vigilant about biosecurity, including adhering to hygiene measures and carefully managing the movement between farms of vehicles, machinery, pallets and other equipment."

Andy said slugs were particularly damaging to establishing canola crops, with yield losses in untreated areas of experiments as high as 60 to 80 per cent.

He said the three-year project would expand ecological and biological knowledge of slugs and snails to provide growers with regionally-specific information for effective timing of controls.



GRDC Western Regional Panel member Andy Duncan says a new research project aims to provide growers with regionally-specific information for effective timing of controls for snails and slugs.

"In WA, the focus will be on the grainbelt's two most problematic species – small pointed (conical) snails and black keeled slugs – and trial sites will be located in the Great Southern and south-east coastal regions," Andy said.

He said the project would include investigation of environmental triggers for snail and slug activity to help inform growers in specific regions about risk factors in high pressure seasons.

"DAFWA researchers will investigate relationships between climate and abiotic factors – soil acidity, soil amelioration and crop rotation – and snail and slug activity, and subsequent crop damage.

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Cancer technology could help cure crop disease problems

RESearchers at the Centre for Crop and Disease Management (CCDM) – co-supported by Curtin University and the Grains Research and Development Corporation (GRDC) – are using digital Polymerase Chain Reaction (dPCR) cancer detection technology to discover fungicide resistance mutations in crop disease.

Dr Fran Lopez-Ruiz, leader of the CCDM's Fungicide Resistance Group, said the technology enabled his team to run 'a fine



Dr Fran Lopez-Ruiz leads the CCDM's Fungicide Resistance Group and says the dPCR cancer detection technology allows a much earlier and more accurate detection of emerging fungicide resistance.

Small pointed (conical) snails impose significant costs on growers.

"These relationships will be used to inform bait timing information," Andy said.

Snail baiting project

An additional research project – initiated by the GRDC Albany Regional Cropping Solutions Network (RCSN) and led by the Stirlings to Coast Farmers (SCF) group – was also set to commence.

"Applicable to growers along WA's south coast, the project will investigate effective baiting options for the control of small pointed snails," Andy said.

"It will include a survey of Albany port zone growers to investigate their use of baits, and conduct trials comparing baiting options in high risk areas on varying soil types."

The new projects build on previous GRDC-funded snail and slug research by DAFWA that found winter baiting of these pests could cut crop losses from feeding damage and reduce grain contamination at harvest.

"Svetlana Micic told the GRDC Grains Research Update events earlier this year that baiting is best targeted in areas of dense slug and snail populations and applied before egg laying to break their life cycles," Andy said.

"A 2015 RCSN project supported by the South East Premium Wheat Growers Association (SEPWA), SCF and Southern Dirt, led by Svetlana, also investigated post-harvest control methods for snails, including windrow burning.

"This research found that windrows attracted more snails than the inter-row if there was no fallen stubble in the inter-rows.

"It found burning windrows caused 100 per cent mortality of snails in the windrows, but that snails in the inter-rows could pose an issue for the next crop."

Information on identifying and managing snails and slugs is available on the GRDC website, including in the western region wheat and canola GrowNotes at www.grdc.com.au/grownotes

tooth comb' through multiple samples at once, picking up DNA mutations that may have been missed with previously-used laboratory methods.

"Since the first occurrence of wheat and barley powdery mildew symptoms in 2015 until the end of the season, dPCR gave us the ability to genetically screen over 140 samples for any signs of known mutations associated with fungicide resistance, at a much faster rate and with extreme sensitivity," Fran said.

Faster and more accurate

"Previously, screening this number of samples would have taken us nearly two years, with a much lower detection level.

"Using this technology, mutations associated with the early stages of DeMethylation Inhibitors (DMI) fungicide resistance were detected for the first time in Australian wheat powdery mildew samples collected from Tasmania and New South Wales.

"The results were communicated to growers, allowing them to appropriately control disease and better manage fungicide resistance.

"Also for the first time, we detected a mutation associated with high levels of DMI fungicide resistance in barley powdery mildew samples from outside of Western Australia in New South Wales, Victoria and Tasmania.

Resistance is widespread

"With this information, it is now clearer than ever before that fungicide resistance is widespread and becoming an increasing threat to crops, requiring integrated disease management options to slow down the rise of resistance mutations," Fran said.

dPCR works by allowing researchers to collect multiple samples from one crop, pool them, and extract fungal DNA to look for resistance mutations. dPCR is also capable of

quantifying the amount of DNA that contains the resistance mutations.

"We are now increasingly confident in our ability to detect signs of fungicide resistance before it becomes a problem," Fran said.

"dPCR is bringing mutation detection into the digital age and we look forward to unlocking new information on fungicide resistance in other important pathogens in the 2016 season."

Fran said to slow down the rise of resistance-endowing mutations, growers should be using multiple strategies such as seeding resistant cultivars, using crop rotations, stubble management, controlling the green-bridge, and rotating their fungicides – or using fungicide mixtures – with different modes of action.

CCDM director, Professor Mark Gibberd, said this early detection research by Fran and his team was a direct example of how the CCDM was providing innovation to the grains industry by leveraging off discoveries in other areas of research.

Thinking outside the box

"By thinking outside the box, we are enabling the rapid development and adoption of new technologies, such as dPCR, and I look forward to seeing the next innovation that helps growers improve their profitability and sustainability."

During the 2016 season, growers outside of Western Australia with crops affected by barley or wheat powdery mildew are urged to submit a sample to the CCDM for fungicide resistance testing. For a sampling kit, email frg@curtin.edu.au or phone (08) 9266 1204.

More information: Dr Fran Lopez-Ruiz, Centre for Crop and Disease Management, Curtin University Ph: 08 9266 3061
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BOURGAULT

Precision planting trials show \$47 per hectare saving

TRIALS have demonstrated that the use of precision seeding technology could substantially cut canola growers' upfront seed costs without reducing crop yields. The research was supported by the Grains Research and Development Corporation (GRDC) and conducted in WA's Northern Agricultural Region by the Department of Agriculture and Food (DAFWA), with assistance from the Northern Agri Group.

DAFWA researcher Martin Harries said precision planters in broadacre applications were usually used for crops such as corn, cotton or soybeans. But previous WA and Canadian studies had shown that yields for canola and lupins could also be improved when plants were sown more uniformly.

"Another reason for testing the technology is that canola seed costs have increased by about \$30 per kilogram for growers who have switched from open pollinated (OP) to hybrid varieties and better seed placement methods may enable seed rates to be lowered without compromising yield," he said.

Precision planting trials

An Agricola Italiana K series pneumatic precision drill, designed to place seed at equal distances along the crop row, was used last year to sow Hyola 404RR canola at rates of 0.3, 0.5, 1.0 and 2.5 kg per hectare at trial sites at Binnu and Ogilvie in WA's northern cropping region.

Depending on the type of canola sown (OP or hybrid), seeding rates used by most growers in the area are 1.5 to 2.5 kg per hectare.

"At both sites there was a trend of decreasing yield from high to low seeding rates, but the reduction in yield was less than expected given the very low plant density in the low seed rate treatments," Martin said.

"At the Binnu site the gross margins of the 2.5 kg and 1.0 kg per hectare treatments were similar, indicating that \$47 per hectare could be saved in up-front costs without impacting final income.



DAFWA researcher Martin Harries at a precision seeding trial site at Ogilvie in August, 2015. There is no significant difference between the biomass of canola seeded at 2.5 kg per hectare, left, and 0.5 kg per hectare, right. (Photo: DAFWA)



Canola sown by Tammin grower Brad Jones this year using precision planting technology at a rate of 0.8 kg per hectare.
(Photo by Brad Jones)

"At seeding rates lower than 1.0 kg per hectare, gross margins declined at this site.

"At the Ogilvie site, gross margins were similar for the 2.5 kg per hectare, 1.0 kg and 0.5 kg per hectare treatments – again suggesting that upfront costs could be reduced without impacting on income."

Martin said another interesting outcome was that yields exceeding two tonnes per hectare were achieved on the very wide 50 cm row spacing used in the trial.

On-farm application

Brad Jones, who farms at Tammin, 180 km east of Perth, has jointly designed and purchased a new seeding bar equipped with precision planting technology which he used for the first time this season.

He has used 80-hole canola 'plates' in the planter boxes to sow 620 hectares of canola at rates ranging from 0.8 to 1.2 per hectare, for trial purposes. The canola will be compared with areas seeded using a conventional Deep Blade System (DBS) seeding bar. Soybean plates will be used to seed field peas.

"The objective with the canola is to drive our seeding rates lower to offset some of the cost risk with hybrids, while I believe there will be savings from more precise spacing of crop seed for all crop types," Brad said.

"The learning curve has been a straight vertical climb and the list of mistakes we have made is as long as my arm," he said.

"There are lots of lessons to be learnt in applying this technology – such as using it across varying soil types and separating cultivation from seed placement.

"But at this stage the 'singulation' of the crop seed has been successful and we are confident with our decision to adopt this technology.

"We are giving ourselves two or three years to embed it into our program across all crop types."

**More information: Martin Harries, DAFWA - Ph: 0428 942 682;
E: martin.harries@agric.wa.gov.au**

Independent analysis of canola trials

BAYER recently moved to improve the accuracy of its on-farm canola variety demonstrations for growers by entering into an alliance with Precision Agriculture to provide independent analysis of the company's new *MySeed* trials program.

Market Development Agronomist Jeremy White said the company was keen to work with growers to test new varieties in local conditions, however, compared with replicated trials, differences in performance could often be difficult to determine.

"Paddock variability, past practices and the difficulty in repeating treatments (or varieties) numerous times across a paddock often means that yield differences can be as much due to how the trial was set up as the varieties being tested," Jeremy said.

But he said many growers had the ability to yield map paddocks – and combined with Precision Agriculture's independent analysis – this would now offer the opportunity for highly accurate on-farm demonstration trials.

"The analysis will use past yield maps to select the best paddocks and parts of paddocks for trials, ensuring that differences between treatments are caused by the treatments, not the paddock," Jeremy said.

"At the end of the season, yield maps will be 'cleaned' and analysed by Precision Agriculture, providing both the grower and Bayer the fairest comparison between varieties from their property.

"When these results are collated with others, we get a strong picture of how the Bayer varieties have performed against the competition in the field.

"The partnership between Bayer and Precision Agriculture means the result to growers will be as close as possible to a fair comparison between varieties in the paddock.

"This way, when growers purchase a bag of Bayer seed, they can have confidence that the variety has been independently tested in paddocks just like theirs," he said.

Improved professionalism of trials

Precision Agriculture Ag Services General Manager Andrew Whitlock said the alliance with Bayer would significantly improve the professionalism of farm scale trials.

Andrew said historical yield data helped to determine areas of paddocks with consistent performance, while trials could deliberately be run through high and low production zones. Harvest yield results will then later be reconciled against maps to effectively extract accurate data.

"A lot of farm scale trials are done poorly, but if they can be designed properly and the data extracted after yield maps are cleaned properly, then you can better trust the results," Andrew said.

"Farmers can then look at a demonstration site and have confidence in the results. More confidence also means more value for all involved."

He welcomed the opportunity to work with Bayer and said the company's desire to conduct highly professional trials and, in turn, achieve quality data was most encouraging.

Wheatbelt bracing for powdery mildew challenge

WESTERN Australia's northern wheatbelt cropping industry is bracing itself for another powdery mildew challenge this season after the disease devastated some crops in the region last year.

Local Landmark agronomist Grant Thompson said over the past 20 years, he had never seen the disease so widespread.

"You can generally get it in a couple of varieties and closer to the coast, where there are humid canopies, but last year it was very widespread," Grant said.

"It rained, then it was dry for a period and this dulled the disease, and then it rained again and there was head infection. There was a lot of white powder coming off crops at harvest.

"In hindsight, one spray was not enough. We could have done two to three spray strategies."

He said there was strong potential for widespread powdery mildew again this year.

"It's a stubble borne disease, so there is a large portion of the northern agricultural region that has powdery mildew fruiting bodies attached to stubbles."

Caught by surprise

Rob Kitto, who farms on the Casuarina Sandplain south-west of Mullewa, was one grower who was "caught by surprise" with the disease last season.

Rob and his wife, Tanya, who have four children, operate a continuous cropping program of wheat (4000 hectares), lupins (3500 hectares) and canola (500 hectares) at their 'Erangy Spring Farm' property.

"We normally get a bit of powdery mildew, but it's not much of an issue because the weather usually works in our favour," Rob said.

"Last year though, it went super-sized. We were finding it in crops before the good winter rain, then June was warm and dry and we were still finding it, but thought we would be okay. Then it rained and it infected everything – and it was hard to keep on top of."

He said they firstly applied Folicur fungicide over everything, but it did not perform well and so they then turned to the broadspectrum triazole fungicide, Prosaro 420 SC from Bayer, for the worst affected crops.

"With Folicur, people were not seeing any difference after 10 days, but with Prosaro, we noticed the difference in 10 days. The disease levels dropped off. It cleaned up the plants really well and the crops got away again."

"Prosaro is that much better than all the rest of them. You are better off doing it and doing it well."

The Bayer fungicide was applied at the label rate with 100 L per hectare of water. The disease, combined with the dry finish and frost events, had quite an impact on crops.

"Some parts of crops that were not frosted or affected by the disease yielded 3.5–4 tonnes per hectare, but other areas were down to zero," Rob said.

"We were looking at an average 2.6–2.8 tonnes per hectare wheat crop. When it comes in at about one tonne per hectare less, it's pretty disappointing."

A better understanding

He said there had been some rain in the region and some volunteer cereals, so careful monitoring would be required for this season.

"At least now, we have a better understanding of what we are dealing with."

"We ran the liquid kit on the seeder bar with a suitable fungicide and that should get us through to flag leaf. At \$4 per hectare, you just have to put it on. We will also monitor the pressure a lot more. We will be proactive – and you need to have chemical on-hand. You need to get onto it early."

Grant said most farmers who applied Prosaro achieved better control than those using other triazole fungicides.

"It's \$10 per hectare compared with \$2–\$4 per hectare, but the better quality product did a better job than cheaper triazoles," he said.



Territory Sales Manager Ian Cook, Landmark agronomist Grant Thompson and Mullewa grower Rob Kitto pictured at the 2015 harvest discussing the benefits of using Prosaro fungicide to help combat powdery mildew disease.

Weighing up yield prediction tools

A PROJECT to assess crop yield prediction tools has found that their varying levels of complexity are important to consider when weighing up which is the best to use in a particular situation.

"The level of understanding of the person setting up each tool will directly impact on how accurately the model replicates the real environment," South East Premium Wheat Growers Association (SEPWA) project officer Alice Butler said.

"We found that the simple tools can be easily used by growers, but the more complex ones are 'consultant tools' or require at least consultant and grower collaboration for a reliable and robust set-up."

The project, led by SEPWA, was initiated by the GRDC's Esperance Regional Cropping Solutions Network (RCSN) group and was conducted with assistance from growers, Farm & General, the DAFWA and Precision Agronomics Australia.

Estimating what a paddock will yield helps growers to manage herbicide and fertiliser inputs during the season, forward sell grain and accurately insure crops. This is important for managing gross margins and ensuring profitability.

Comparing the options

Alice said that *Yield Prophet* was the best known yield estimation tool, but other options were becoming available to help growers forecast yields and manage inputs.

"To compare the options, SEPWA conducted a study in 2015 whereby growers at Mount Ney, Condingup, Neridup and Scaddan were set up with *Yield Prophet*, *iPaddockYield*,

ProductionWise, Potential Yield CALculator (PYCAL) and N-rich Strips," she said.

"The study found that different models were better at predicting yields for different sites.

"It also highlighted the complexity of yield prediction and that this could cause misunderstanding and lower grower confidence in some of the models."

Alice said *iPaddockYield*, N-rich strips and PYCAL were easy to set up and understand while *ProductionWise* and *Yield Prophet* required assistance and a higher level of time investment.

"*Yield Prophet* requires soil characterisation, soil test results, rainfall data, the previous year's yields, crop rooting depth and nitrogen, making it a much more sophisticated model," she said.

"*ProductionWise* had the same level of complexity as *Yield Prophet*, with both models running off the Agricultural Production Systems sIMulator (APSIM) model, but the additional use of Normalised Difference Vegetation Index (NDVI) information from satellite imagery was valuable.

"Additional features include the ability to create farm maps and run gross margin analysis."

SEPWA also conducted a state-wide survey of 82 growers to assess their knowledge and use of the tools and how likely they would be to adjust seasonal inputs based on the information generated from them.

"Overall, 60 per cent of growers indicated they were likely or highly likely to adjust seasonal inputs based on information from a yield or seasonal prediction tool," Alice said. ■

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New canola hybrids on show this season

DUPONT Pioneer is advancing new canola hybrids developed to better meet canola growers' requirements for flexibility and performance with the planned release of three new hybrids into the market in 2017.

There are two new Clearfield (CL) hybrids and one new Triazine Tolerant (TT) hybrid joining Pioneer's canola hybrid range.

Dupont Pioneer Canola Product and Agronomy Manager, Clint Rogers, says the products have come through a vigorous research, testing and evaluation program

"They have met all the checks and balances around trait performance, yield performance, oil, blackleg and more, have been the best performers and are now coming to commercial fruition," he explains.

Three new varieties set for release

The first Clearfield hybrid is Pioneer brand 45Y91 (CL) hybrid canola, which is a mid (5) maturity Clearfield hybrid that demonstrates unique phenology.

Clint says 45Y91 (CL) can be sown early without the risk of flowering too early, presenting the potential for early season grazing opportunities.

"We've got 45Y91 (CL) in large-scale demonstrations right throughout the canola growing regions of both eastern and western Australia.

"Growers will be grazing 45Y91 (CL) beside their existing Clearfield plantings to evaluate the potential for early sowing, grazing and grain recovery," he says.

The second Clearfield hybrid due for 2017 release is Pioneer brand 44Y90 (CL) hybrid canola, which was unmatched for

performance and consistency in the early-mid (4) maturity segment of the 2015 NVT trials.

"This hybrid's yield and oil content is segment leading, coupled with an excellent agronomic package and exceptional hybrid vigour. This hybrid vigour helps deliver effective weed control and reduced weed seed set through superior crop competition and early canopy closure," Clint said.

Complementing the new Clearfield hybrids is the release of the company's second T-Series hybrid, Pioneer brand 44T02 (TT) hybrid canola.

The variety excelled in the 2015 GRDC NVT results, ranking as the highest yielding early-mid (4) maturity Triazine Tolerant product.

"It gives a very solid performance in low to medium rainfall environments and its excellent adaptability and yield for maturity helps manage risk in more marginal areas by making sure of a very solid bottom end yield if conditions deteriorate.

"44T02 (TT) has a well-rounded agronomic package, delivering excellent standability, uniform ripening and excellent shatter tolerance, so in those more marginal environments it definitely gives an opportunity for direct heading," he explains.

Side by side demonstrations

During the 2016 season, growers across Australia will have the opportunity to see the three new hybrids in action as part of an extensive side-by-side demonstration program.

"This will allow growers to inspect these hybrids pre-release, so they're comfortable with the performance and management of the products before planting them commercially in 2017," Clint said. ■



NSW farmer Peter Jackson in a crop of Pioneer 44Y90 CL set for commercial release in 2017.

Where to next as domestic grain prices fall?

■ By Nidera Australia analysts

WITH a large number of marketers at the annual Australian Grains Industry Conference in Melbourne, it was a relatively quiet end to July. But with a large contingency of the industry in one place, conversation revolved around the mid-year movement of the grain markets.

To recap we have had domestic values fall out of bed, since the beginning of July. For example, delivered Darling Downs (southern Qld) old crop feed wheat was worth approximately \$270 a tonne at the end of June – by the end of July it had slipped \$20 to around \$250 – a drop of more than seven per cent in four weeks.

There are always market corrections, but it is difficult to see what will fuel a recovery for the Australian old crop. There is still some value out there, but it is a dwindling pool of demand.

Consumers have their full attention on the new crop and with the way the Australian winter crop is progressing, they won't be hasty in taking cover.

Where are the bears and bulls?

Amongst the bearish tones during the past month, there has been ongoing discussion about the EU and US crops.

Firstly, let's cancel out concerns about the US crop – any weather threat or event has been stamped out by good rainfall. There had been a see-saw affair that created light pieces of volatility in the US futures markets, but with little influence on cash prices, particularly here in Australia.

The US winter wheat harvest is now coming to an end – and all reports so far have been positive, with only minor concerns over quality.

Moving to the EU and the progress and quality of the French crop provides some bullish news.

Updated reports have continued to lower production estimates for the French wheat crop. It is now back to around 31 or 32 million tonnes – well down from initial estimates of 41 mt.

This has spurred some solid price support in EU grain markets, with MATIF wheat (the French equivalent of CBOT) up approximately \$US8 to \$9 per tonne in late July.

With this in mind, attention is drawn to the German crop and how it will progress. Early comments are positive with no issues in test weights and quality. But the larger areas are yet to be harvested.

Overall, there are some concerns for the EU crop so we will keep a close watch. In the larger scheme of things, will it have an impact on global supply and demand?

A major shift in the global grain dynamic will most likely require something more to spark prices in a meaningful way and it is hard to predict where this will come from.

For more information contact the Nidera Australia Hotline on 1300 643 372 or go to: www.nidera.com.au



The price of old crop feed wheat slipped \$20 to around \$250 per tonne by the end of July.



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Record global feed supplies lowers wheat price forecast

■ By Rabobank

OUR US wheat price outlook has been lowered, but we remain more bullish about the European scene following cuts to 2016–17 French and German soft wheat production projections – at 35 million tonnes and 25 mt – respectively (down 13 per cent and 4.3 per cent), amid difficult conditions and deteriorating quality and yields.

As a result, we hold 2016–17 EU wheat production at 154 mt, down 3 per cent and below the USDA's estimate of 156.5 mt. Yet prospects for Russia's crop have improved – to an estimated 65.6 mt – increasing Black Sea regional output.

With crops in good condition, demand for high-quality grain is likely to shift across to the Black Sea, driving Russian exports to 27.1 mt, especially given spot cash discounts of US\$20 per tonne vs. French origin wheat. Interestingly, French milling wheat is priced above US Gulf, effectively pricing French milling quality out

of the global market. But this is not a lack of supply – it is simply a lack of quality.

CBOT Wheat price expectations are revised lower on record projected global feed supplies, ensuring a particularly competitive export environment. CBOT Wheat prices fell significantly through late June, as exceptional US harvest prospects and heightened confidence in the US corn crop sparked a price race-to-the-bottom across feed grain cash markets.

Global feed grain glut

Both record US yields and near-record ending stocks according to the USDA – plus an impending EU feed-quality crop will contribute to a 2016–17 global feed grain glut.

Following the northern hemisphere harvest, wheat is expected to follow the corn market more closely, as both grains compete for demand.

Initial projections for a 20 to 40 per cent increase in the Argentine wheat acreage expansion are coming under threat as a consequence of slow plantings following difficult, wet conditions.

The latest reports peg new crop acreage at 4.4 million hectares, up just 17 per cent, adding a further two mt in estimated production.

FIGURE 1: CBOT wheat price forecast lower



FIGURE 2: Record global wheat, barley and corn production will compete heavily for feed demand, pressuring prices



AT A GLANCE

WHEAT

Global wheat forecast revised lower on record projected global feed supplies.

- Large expected global wheat and feed grain supplies to pressure cash markets.
- Quality and yield concerns being realised across the EU, particularly in France and Germany.
- Slow Argentine wheat plantings see cuts in potential 2016–17 acreage expansion.

CORN

Price forecast reduced again, as big US crops are forecast to push stocks to 30-year highs.

- US acreage close to record high, and yield prospects are still very good.
- Brazilian production estimated below 70 mt, resulting in a 50 per cent export reduction, increasing the demand for US corn.
- La Niña is still likely, which could result in Argentine crop issues next year.

SOYBEANS

Price forecast is changed modestly.

- Weather remains major market driver, but current forecast is favourable.
- Current crop condition report points to strong yields near those of the last two years.
- Late-season drought has reduced corn supply in Brazil – producers may plant more corn vs. soybeans next season.

Brazil beefs up cropping and livestock integration

BRASIL, home to the world's largest beef cattle herd, is intent on lifting productivity to increase competitiveness in global beef markets. But this isn't expected to erode Australia's trade position – at least in the medium term – according to an expert on the South American beef sector.

Rabobank Brazil-based senior analyst Adolfo Fontes – who was in Australia recently as a keynote speaker at the World Braham Conference in Rockhampton – said the “potential to increase beef production in Brazil is huge” through improved genetics and grain-fed systems to boost carcass weights.

Crop-livestock systems

“We are starting to see a shift towards more intensive production systems in Brazil,” he said, “with expectations that by 2025, 20 per cent of beef will be produced through a feedlot system – up from 10 per cent currently. We are also seeing Brazilian farmers increasingly adopt integrated crop-livestock systems to utilise their maize or soybean crops, and it is estimated that five million hectares are farmed this way.”

Adolfo said while intensive production systems would increase the quantity, and also quality, of Brazil's beef, it was still lagging behind the sophisticated production systems of the US and Australia – where feedlots account for around 90 and 30 per cent of beef production, respectively.

Adolfo said Brazilian farmers were also focused on improving genetics, with European breeds such as Angus and Hereford increasingly incorporated into the national herd through crossbreeding.

“If we can lift the productivity of our Brazilian cattle herd – which stands at 220 million head – we could emerge as the world's largest beef producer,” he said. “Currently the US are the largest producer – yet they ‘only’ have around 90 million head of cattle.”

As the world's second largest beef producer, Brazil also holds second-place in global beef trade, with key markets including China, Egypt, Russia and the EU.

“Brazil is set to become the biggest supplier of beef into China, with around 200,000 tonnes expected to be exported this year,” Adolfo said, “but most of this growth represents a transition from the Hong Kong market to official Chinese channels.”

Adolfo said Brazil was also on track to secure access to the US fresh beef market, with the first shipment anticipated by the middle of the year.

“While exports to the US will be limited by quota agreements, access to the US market will improve Brazil's position in international markets and could be the catalyst for other markets to open their trade barriers – with sights set on Japan, South Korea, Mexico and Canada – although this could be a long way off,” he said.

No erosion of Australian market

Reassuring Australian beef producers, Adolfo said Brazil's improved trade position wasn't expected to erode Australia's market share, with global beef consumption forecast to continue to outstrip Brazil's rising production.

“Australia is renowned for its high quality product, traceability and food safety and we expect Australia to continue to be the key, high-quality supplier into markets such as the US,” he said.



Rabobank Brazil-based senior analyst Adolfo Fontes.

“That said, once Brazil improves the quality of its product – which is achievable in the next 10 to 20 years – we could see competition increase.”

Adolfo said there were “challenges to the outlook” but Brazil is facing infrastructure bottlenecks as well as political and economic uncertainty.

“Currently 96 per cent of Brazil's exports go through ports in the south of the country, but it would be faster and cheaper to ship product from the north,” he said. “While Brazil is working to address these challenges through road upgrades, progress is being hindered by the complex political and economic situation.”

Economic crisis

With Brazil facing high inflation and rising unemployment, Adolfo said some commentators are describing the current economic crisis as the most serious the country has ever seen.

“GDP is expected to fall by more than three per cent in 2016, and this has seen domestic beef consumption decline in favour of cheaper proteins such as poultry.”

This has seen a greater proportion of product directed into exports, Adolfo said, with export competitiveness aided by the devaluation of the Brazilian currency.

“Even with the weak Brazilian exchange rate, Australian beef remains competitive into China from a price perspective,” he said, “and we would expect the per unit price of Brazilian beef to stabilise with the currency not likely to fall further.”

Responsible for analysing the beef sector for Rabobank in Brazil, Adolfo previously spent five years as the market intelligence coordinator for a leading international company in the animal nutrition business.

Super cool results from grain storage research

■ By Philip Burrill, DAF Qld

AT A GLANCE...

- Seek advice to ensure the right size aeration fans and associated equipment are fitted – ducting, roof vents and fan controller. Not all silo suppliers get it right.
- Recommended aeration cooling airflow rates are 2 to 4 litres of air per second, per tonne (L/s/t). Do your aeration fans achieve this when your silos are full of wheat, barley, chickpeas, sorghum or canola?
- Are you achieving the target grain temperatures of 18° to 23°C during summer storage and less than 15°C during the winter period?
- Aeration maintenance: Farm case studies show that aeration equipment checks and maintenance can lead to a significant improvement to aeration performance and grain storage results.
- Recirculating air with a small fan during fumigation in a sealed silo (150–2000 tonnes) ensures rapid, uniform distribution of phosphine gas. Otherwise it can take two to five days for gas to reach all areas inside a silo.

AERATION cooling is just one of four key best practice strategies that provide good results for on-farm storage. When combined, they form the foundation for successful storage and importantly, a grower can build a reputation as a reliable supplier of quality grain.

- 1. Aeration:** Correctly designed and managed, will provide cool grain temperatures and uniform grain moisture conditions. The result is reduced problems with grain moulds and insect pests in storage, plus the ability to maintain grain quality attributes such as germination, pulse seed colour, oil quality and flour quality.
- 2. Hygiene:** A good standard of storage facility hygiene is crucial in keeping storage pest numbers to a minimum and reducing the risk of grain contamination.
- 3. Monitoring:** Each month check grain in storage for insect pests (sieving/trapping) and at the same time inspect grain quality and temperature. Keep a monthly storage record to record these details, including any grain treatments you applied.
- 4. Fumigation:** In Australia we now only have gases (fumigation) to deal with insect pest infestations in stored grain. To achieve effective fumigations the storage/silo must be sealable – gas-tight (AS2628) to hold the gas concentration for the required time.

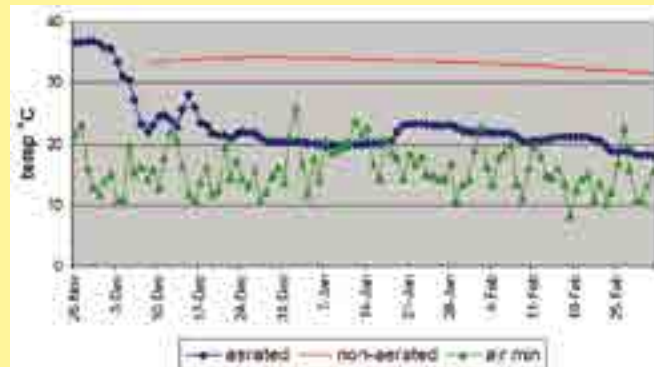
Effective aeration – what does it look like?

For the summer storage period November to April we aim to achieve grain temperatures of 18° to 23°C with well managed aeration cooling. For the winter period May to September, the target is grain temperatures of less than 15°C.

Push a robust thermometer attached securely to a broom handle – or better still – a purpose built grain temperature probe one metre into grain. Leave for a few minutes in grain before reading to see what grain temperature your aeration system has achieved.

There are three areas to focus on for good aeration results:

FIGURE 1: Comparing two silos of wheat. The non-aerated silo had grain temperature sit above 30°C for three months – ideal for insect breeding. Well managed aeration in summer brings temperatures down towards 20°C.



- Aeration equipment for the job;
- Operating aeration system effectively; and,
- Maintaining/checking the equipment is doing the job.

Aeration equipment for the job

The three main components are fans, ducting inside the storage and the roof vents.

Fan selection: Fan size, number per silo and type of fan are common areas for confusion. It usually requires an experienced grain aeration specialist to provide advice to either the silo manufacturer/supplier, or directly to the grower. There are a number of important considerations to consider before fitting fans to a silo or storage.

Silo size: Height and width, electricity supply available at site, grain types stored, typical harvest grain moisture contents, and what is the intended purpose of fans? Is it only for aeration cooling (2–4 L/s/t), or do you want to set up one or two silos with much larger airflows (15–25 L/s/t) for the purpose of aeration drying?

These details can be quickly sorted out with one or two phone calls – when you are dealing with an experienced aeration specialist. It is vital that the right questions are asked to ensure the fan selection, ducting and venting design suits the intended purpose for your grain storage situation.

Farm case study 1

A 130 tonne capacity cone based silo, nearly full with 105 tonnes of barley, fitted with one 0.37 kW aeration fan was tested for airflow output.

Using the 'A-Flow' testing device (see GRDC Fact Sheet, "Performance testing aeration systems") the single aeration fan was only able to generate 166 litres of air per second, or 1.6 L/s/t airflow against the 105 tonnes of barley.

Result: Grower decided to fit a second fan (same size) on the opposite side, aiming for 3.0 L/s/t.

Farm case study 2

Two Grainmaster 150 tonne capacity cone based silos, both fitted with a pair of 0.37 kW Agrdry F100 aeration fans.

One silo was full with 140 tonnes of soybeans and the other silo full with 150 tonnes of white French millet. With identical fans running on identical silos the total airflow output through the soybeans was 397 L/s, providing a useful 2.8 L/s/t.

But airflow going into the white French millet silo was only a total of 141 L/s, providing a much lower 0.9 L/s/t.

The extra back pressure on fans created by the small seed millet was reducing aeration airflow to well below the recommended cooling range of 2–4 L/s/t.

Ducting inside silo: There are two common types, the round tube ducting that can be made to lift up for cleaning, or the house shaped ducting that is fixed down to the cone base. Ducting length, strength, location in silo and size of perforation holes/slots, are all involved in achieving optimum airflows through grain. Ability to clean and remove grain residues from ducting for silo hygiene is important for both cone base or flat bottom silos.

Roof vents: Vents can be as simple as a 'Chinaman hat' style used on the centre fill top hatch, or the many variations of 'goose neck' roof vents. Unfortunately, it is not uncommon to see venting design problems on a range of silo brands.

The vent size/area needs to be appropriate to suit the fan output. A fan's airflow should not be used at start up to lift heavy vent lids, or constantly work against lid springs. This ensures fan airflow is not restricted.

For all sealable silos, vents require simple, effective systems for creating a gas tight seal during fumigation.

Do you also have easy access to vents for maintenance on the rubber seal?

Farm case study 3

Three new 150 tonne capacity, sealable, aerated silos, each fitted with two 0.37 kW Downfield F370 aeration fans (smallest curve on Figure 2 is the F370 fan).

The storage facility manager was concerned about fan output after he tested fans shortly after the silos construction was completed. He was comparing the operating sound of fans running using the four vents fitted to the roof, with the fan's sound when he also manually opened the centre top fill hatch.

The fan performance sounded like it improved with the extra vent space provided.

When fan output was tested (A-Flow device) on the 'empty'

(no grain back pressure) new silo, the pair of F370 fans could only achieve a total of 209 L/s airflow with the four vents used as designed.

When the centre top fill lid was also opened, output immediately increased to 517 L/s.

On closer inspection the four sealable vents on the roof had no system to hold them open during aeration. There was only a long flexible cable to pull them closed/sealed for silo fumigations. Fans were losing more than half their unloaded performance, just by forcing them to lift four steel plate vent lids.

Result: When the silo manufacturer was made aware of the design problem they arranged to fit a simple vent lid lifter.

Access to four vents around the roof edge to maintain rubber seals, is the next design challenge.

Operating aeration system effectively

Running the fan at the right times will achieve cool grain temperatures and uniform moistures.

Aeration cooling aims to push through a series of 'cooling fronts' starting from the base of the silo (Figure 3).

While there are a number of producers still manually operating aeration fans, for most storage facilities we recommend using a good quality automatic aeration controller with a sensor measuring both ambient air temperature and humidity to automatically turn on fans at optimum times.

Manual operation of fans

There are three stages when operating aeration cooling fans from the start of harvest:

- As soon as enough grain covers the ducting, turn on aeration fans while filling silo. Run continuously (24 hrs/day) until the first cooling front comes through the full grain depth. This usually takes three to five days. If safe, go to the top of the silo and see if the air coming out has changed from a warm, humid smell to a fresh, cool smell – a good indication that the first cooling front is through (Figure 3).
- Once this has occurred, run the fans for approximately 12 hours per day for the next five to seven days. Select the cooler night air, but avoid extended periods of high humidity air which may wet grain. Avoid fog, misty or showery conditions.
- Check the grain temperature and condition. Grain

FIGURE 2: Note the large variation in aeration fan outputs for four typical fans fitted to grain storages

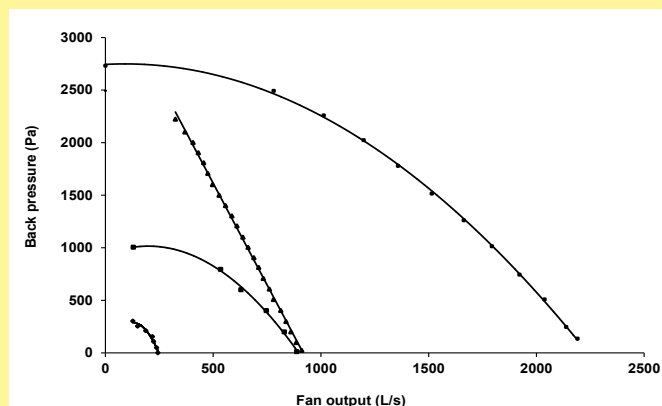
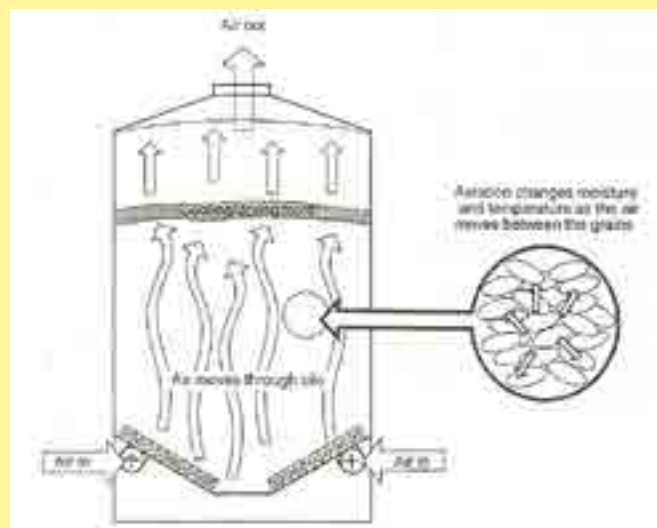
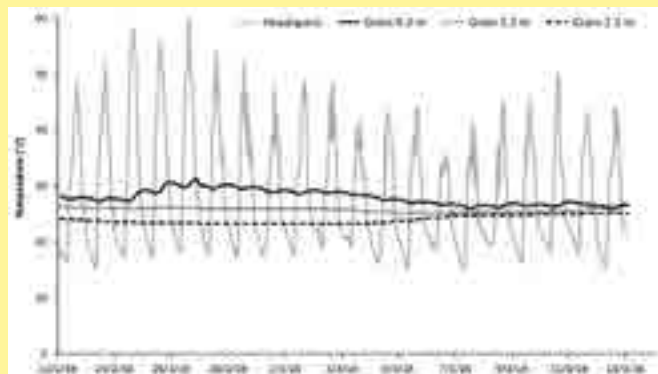


FIGURE 3: Cooling/drying fronts in the aeration process



(C. Newman Agric. WA)

FIGURE 4: Temperatures in a silo of barley, in headspace and at three grain depths. The warmer than expected grain temperatures indicated possible aeration problems. See Farm Case study 1



temperature in summer should now be close to 20°C. The longer term 'protect' phase now begins. Operate fans for about 100 hours per month, selecting cool, mostly dry air from three to five days per week to maintain cool grain conditions. An automatic controller will usually be much more reliable at this task.

Automatic controller operation of fans

Today there are automatic aeration controllers available that automatically step through the three stages outlined above.

Seek independent advice as to what are the better quality controllers to consider, as there are poor quality units that may put your stored grain at risk. Ensure the supplier has a good reputation for providing after sales support and parts if required.

For a new unit fitted to a storage facility, there is a simple start up process to follow. See manual, or consult supplier.

As a general rule, leave the auto controller itself powered up. It is recording a history of current weather conditions so it is able to turn fans on at the optimum times.

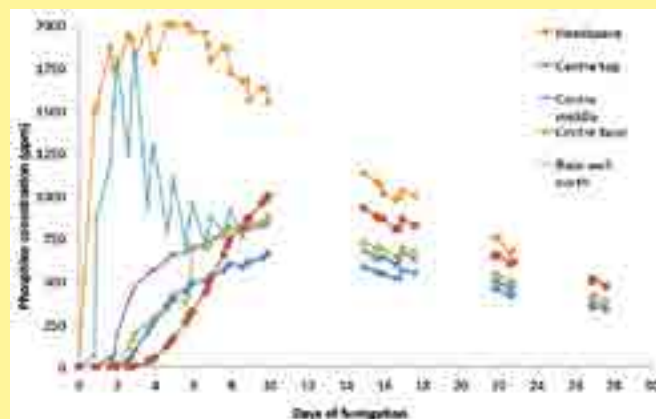
Maintaining and checking aeration equipment

There are a few basic checks and maintenance steps to ensure your system is doing the job:



Seek independent advice to ensure you get the right aeration controller for the job.

FIGURE 5: Phosphine gas concentrations at seven points in a silo during fumigation of 1416 tonnes of wheat. Phosphine blankets were placed in the silo headspace with no recirculation. It took as long as five days for all grain at the silo base to reached at least 200 ppm gas concentration.



- Check grain temperatures to see if you are achieving the target temperatures of 18° to 23°C during summer storage and less than 15°C during the winter period.
- See Figure 4 where an OPI cable was used in the aerated barley silo (Farm case study 1) to record grain temperatures at various depths. This helped identify the low airflow problem.
- When checking silos each month for insects, also look at the hour meter on the aeration auto controller to see if fans are averaging about 100 hours per month (+/- 20 hrs).
- At least once per year use a good quality thermometer and relative humidity reader to check the aeration auto controller's sensor has not been damaged and is reading correctly.
- Manually test-run fans on silos to check they are all operating. Clean fans if required.

Farm case study 4

A 10 minute fan cleaning job can produce large improvements. A single 0.37 kW aeration fan was tested for airflow output on a 128 tonne capacity coned based silo holding 105 tonnes of barley. It was observed that the fan impeller had a significant build-up of dust on the blades prior to testing. Using the 'A-Flow' testing device, the aeration fan output was recorded as 86 L/s, or 0.8 L/s/t airflow against the 105 tonnes of barley.

After cleaning the dust from the blades the fan was retested and produced an output of 152 L/s, or 1.5 L/s/t.

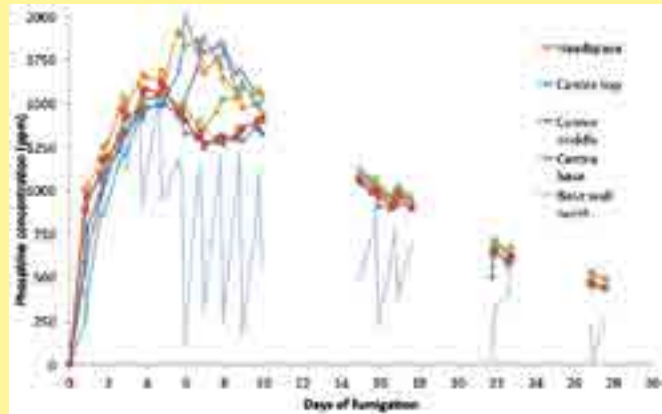
Result: Grower cleaned remaining fans.

Silo recirculation – how can it help with fumigation?

Australia now only has gases to control live insect pests in infested grain. Dichlorvos spray on insecticide is no longer registered for this use. To achieve effective fumigations, silos must be pressure tested to check they are sealed – gas-tight. This ensures they hold high gas concentrations for the required time to kill pests.

Silos pressure tests can be carried out by using a short burst (5 – 10 sec.) of the aeration fan, or a portable leaf blower to initially pressurise the silo for the test. The pressure decay (250 to 125 Pa) can be timed by using the silo's relief valves, a length of 20 mm clear plastic tube in a "U" shape with water in it (manometer), or a digital manometer connected to the silo. (See GRDC Fact Sheet:

FIGURE 6: Phosphine gas concentrations in a silo (1423 tonnes of wheat) where a small fan was used to draw gas from blankets in the silo headspace and pump it to the silo base via aeration ducts for the first five days of fumigation. Gas concentration in all areas of the silo reached over 800 ppm within the first 24 hours.



A small fan (F370–0.37 kW) used during the first five days of fumigation to recirculate phosphine to give rapid and uniform gas distribution.

“Pressure testing sealable silos.”)

During fumigation, phosphine gas is typically liberated over five or six days from the tablets or blankets that have been placed in the silo. But this gas only moves slowly, taking about 24 hours to travel six metres through grain.

If you are fumigating a medium to large silo (150–2000 tonnes) the gas may take two to five days to eventually arrive in all parts of the silo. In large silo fumigations this may result in some grain – at the furthest distance from tablets – only getting six days of phosphine gas instead of the required 10 days or longer exposure period. Six days is not enough time to kill all the life cycle stages of the pests.

A typical phosphine fumigation required to kill all pests is a minimum of 200 ppm phosphine gas concentration for at least 10 days. See horizontal blue line in Figure 5.

Options for fumigation recirculation

For all fumigation recirculation systems, the sealable silo needs to be gas-tight so there is no gas leakage during the fumigation. Figure 6, “Base wall north” shows the impact of a leak at the silo manhole which caused large daily fluctuations in gas concentrations.

- Phosphine blankets or tablets can be placed in the silo headspace along with a small fan connected to the headspace via 90 mm pipe plumbing coming down the silo wall from the roof. Phosphine gas is drawn from the headspace and pumped into the base of the silo via both aeration ducts.
- For ground level application of tablets or blankets, a sealable phosphine box can be plumbed into this system – either a moveable box, or mounted permanently on each silo.
- Using a fan to force the phosphine gas movement around in silos during fumigation is generally recommended, rather than relying on a passive ‘thermosiphon’ approach. For medium and large silo fumigations (150 tonnes plus), or silos storing smaller grain sizes (eg. millets, canola, lentils and so on) that reduces air movement, fan force recirculation rather than thermosiphon is advised. Fan forced recirculation may also assist where the grain type (eg. oilseeds) typically absorbs higher amounts of phosphine during fumigation.

Equipment for fumigation recirculation

- Sealable silo – gas-tight, that passes pressure test.
- Plumbing pipes (90–100 mm) from silo roof to ground level. Use quality pipe, fittings and seals that will ensure many years of safe, gas-tight fumigations.
- Small fan (eg. Downfield F370–0.37 kW) to recirculate air. In most cases this fan size will be suitable for both small and large silos. In trials (Figures 6) this fan size provided a complete silo air change every 12 hours for the full silo holding 1420 tonnes of wheat.
- Fittings for fan intake and outlet. Flexible hoses (50–100 mm) couplings and gate valves.

Fumigation recirculation

- Pressure test the silo to check for leaks.
- Follow all label directions and place tablets/blankets in the headspace or phosphine box.
- Run small recirculation fan for first 5 days of fumigation. Leave silo sealed for remaining days of fumigation period as label requires (eg. 7, 10, 20 days).

Note: There are benefits to using the silo headspace to locate the blankets or tablets. The large surface area of grain in the headspace provides safe, large easy access for gas penetration and diffusion into the grain.

Warning

Always seek reliable advice before fitting fumigation recirculation systems to silos/storages. Some systems that are currently sold are not recommended because of unsafe design features. Phosphine is not only a toxic gas, but can be flammable and explosive if restricted in a small area or used in a manner that causes gas concentrations to rise quickly to high levels.

Follow label directions and seek advice.

The research undertaken is made possible by the significant contributions of growers through both trial cooperation and the support of GRDC. The author would like to thank them for their continued support as well as the DAF Postharvest research team and GRDC’s national grain storage extension team.

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Killing storage pests without mercy – fumigation strategies that work

■ Andrew Ridley, Philip Burrill and Pat Collins, Queensland Department of Agriculture and Fisheries

AT A GLANCE...

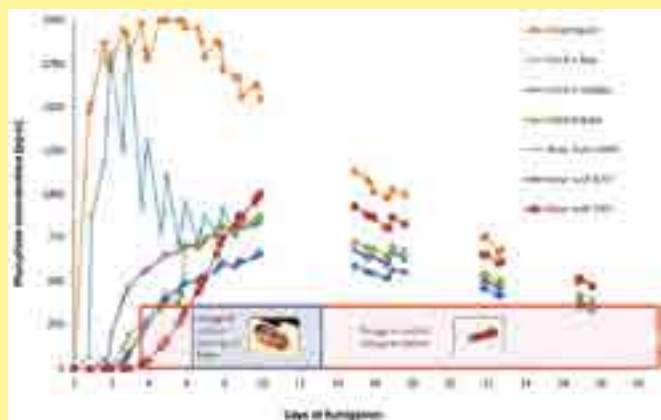
Results of trial fumigations with phosphine conducted in 1400 tonne silos to test the capability of these large storages have led us to make the following conclusions:

- Recirculation greatly facilitates the distribution of gas in large silos.
- Fumigation in large silos without recirculation results in much lower concentrations in the base of the silo.
- Peak concentrations of phosphine typically occur between day four and six and decline for the rest of the fumigation.
- The current pressure half-life Australian Standard (AS2628) of five minutes is appropriate for large silos and is vital for effective fumigation.
- Fumigations are likely to fail where there are points of gas/fresh air leaks in a silo. Pressure testing prior to fumigation is a vital step in identifying and locating gas leaks.
- Strongly phosphine-resistant rusty grain beetle can only be controlled by extending fumigation time beyond the label direction (of 20 days for blankets) or by implementing active recirculation.

THERE are very few options available to growers to control storage pests when an insect infestation has been detected. Phosphine – sold as the solid formulation of aluminium phosphide (AIP) under trade names such as phostoxin or fumitoxin – is by far the most common disinfestation treatment for stored grain.

The label was first written in the 1970s for relatively small silos and other storages. A significant number of growers are now investing in large capacity (eg. 1500 tonnes), flat bottom silos

FIGURE 1: Phosphine concentrations measured in silo A (passive fumigation)



The silo had a pressure half-life of 7 minutes and 30 seconds. The dosage (concentration x time) required to control phosphine-resistant lesser grain borer is indicated by the blue box and for phosphine-resistant rusty grain beetle by the red box.

for storing grain on-farm. We do not know whether the label directions are appropriate for these larger storages.

Coupled with this uncertainty is the development of strong phosphine resistance in the rusty grain beetle. The resistant populations of the rusty grain beetle, found at a number of sites in eastern Australia, are significantly harder to control than other pests and label rates may need to be updated.

Fan forced recirculation of gas in large silos helps to distribute phosphine and has been advised for some time. Recirculation is not a requirement on the current label but may be a cost effective way to perform better fumigations.

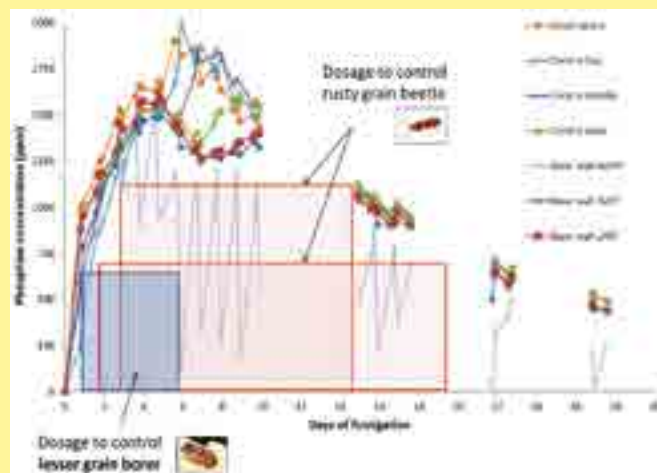
Large silo trial

The aim of this trial was to answer the following questions:

- Can strongly resistant rusty grain beetle be controlled in large farm silos?
- Is the current Australian Standard (AS2628 – 5 min pressure half-life) for silo gas-tightness appropriate for large silos?
- What concentrations of phosphine are achieved under passive gas distribution and to what extent does that lengthen the time required for complete kill of insects?
- Do large silos need recirculation for effective fumigation? and,
- What is an acceptable recirculation air flow rate and system design for large silos?

Two silos, labelled A and B, were fumigated at label rates. The phosphine in silo A was dispersed by natural means (passive fumigation). The gas in silo B was recirculated (active fumigation) for the first five days of the fumigation. Phosphine concentrations were monitored at four centre sampling points (headspace and

FIGURE 2: Phosphine concentrations measured in silo B (active fumigation)



A recirculation system with an air-flow rate of 0.013 L/s/t was fitted to the silo and was run for the first five days of the fumigation. The silo had a below standard pressure half-life of 2 minutes 10 seconds. The dosage (concentration x time) required to control phosphine-resistant lesser grain borer is indicated by the blue box and for phosphine-resistant rusty grain beetle by the red boxes. Two alternative strategies to meet the required dose to control phosphine-resistant rusty grain beetle are shown. That is, a higher concentration, shorter exposure period and a lower concentration, longer exposure period.

at 9, 5, and 1 m above the floor) and at three points around the base wall (North, 120° and 240°) of each silo.

Silo A had a Pressure Half Life (PHL) of 7 minutes and 35 seconds and silo B had a PHL of 2 minutes and 10 seconds.

Both silos were leaking air at the silo base entry door during the pressure tests indicating a location for potential gas loss and dilution of gas with fresh air from outside.

What we found

- For phosphine fumigations, strongly phosphine resistant rusty grain beetle can only be controlled by extending fumigation time beyond the label direction (of 20 days for blankets) or by implementing active recirculation in gas-tight, sealable silo (AS2628).
- The current pressure half-life standard (AS2628) of 5 minutes is suitable for large silos.
- Fumigation without recirculation requires a fumigation period of over 30 days.
- Recirculation significantly shortened the fumigation period required to 14 days.
- The label directions for solid formulations of phosphine must be updated to allow effective control of strongly resistant rusty grain beetle.
- Should label rate fumigations with phosphine fail, and rusty grain beetle is identified, consider an alternative treatments such as sulfuryl fluoride (Profume).

Based on these conclusions, options for updating the label to ensure control of phosphine resistant rusty grain beetle include:

1. Increase application rate to maintain current fumigation period of 20 days for passive fumigations.
2. Keep current application rate but extend the passive fumigation period possibly past 30 days.
3. Keep the current application rate but mandate active recirculation, and maintain or possibly reduce the fumigation period.
4. Increase the application rate, mandate active recirculation and reduce the fumigation period.

Increasing the application rate (option 1) may be possible but would require APVMA approval and may require significant industry input to undertake residue testing etc.

Increasing fumigation period (option 2) is viable but



Philip Burrill (DAF Qld) measuring air-flow in the recirculation system.

fumigations may become too long to be practical. This option is heavily reliant on silos being sealed to the Australian Standard of a 5 min pressure half-life.

Mandating recirculation (option 3) would require a small capital cost to retro-fit silos.

Increasing the application rate in conjunction with active fumigation (option 4) could reduce fumigation times to a week or less.

A number of issues would need to be resolved if any changes are to be made to the label:

Increase application rate

- Residue testing
- WHS provisions

Increase fumigation time

- Fumigating partially filled silos
- Fumigating highly sorptive commodities such as canola

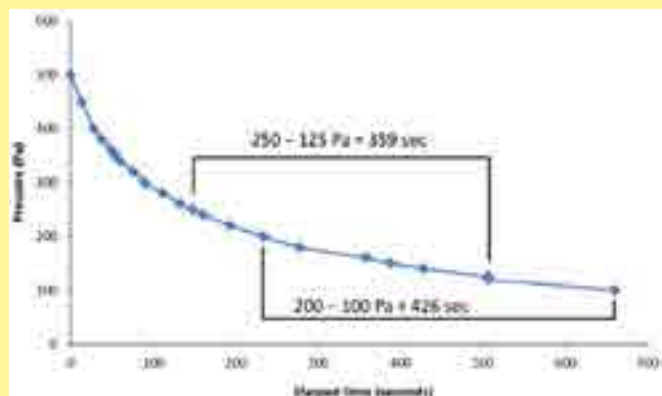
Active recirculation

- Minimum flow rates
- Fan run times

The research was part of the project PBCRC3150 supported by the PBCRC of which the GRDC is a partner. Trial fumigations were conducted at Balarang Lands (Weemelah) owned and operated by Jason and Lisa Orchin. We thank them for their support. The authors also wish to thank Peter Hobday from AgriStorage and Logistics for assistance with conducting the trial.

More information Andrew Ridley, Department of Agriculture and Fisheries, Queensland EcoSciences Precinct, Boggo Road, Dutton Park Ph: 0491 215 268, 07 3255 4442, Email: andrew.ridley@daf.qld.gov.au

FIGURE 3: Pressure loss from silo A demonstrates that pressure is lost at a fast rate at higher pressures compared to lower pressures



The rate of pressure loss slows down as the pressure gets closer to atmospheric. This is why it is important to conduct pressure half-life tests using the industry AS2628 standard test method, 250 to 125 Pa.



Phosphine gas reticulation greatly improves the control of pests, such as the red flour beetle (pictured), in large grain storages.

Farm 'smarter' not harder

AUSTRALIAN grain growers are being urged to farm 'smarter' not harder in order to remain viable and sustainable in the long term. Technology adoption, improved data utilisation, more strategic research and development investment, farm business structure efficiency and 'best practice' farming system management promise to shape Australian agriculture over the next 50 years and will hold the key to boosting operational efficiencies and profitability.

Speaking earlier in the year at a Grains Research and Development Corporation (GRDC) Farm Business update in Narrabri, NSW, grain grower and principal of Penberthy Agricultural Consultants (PenAgCon) Drew Penberthy said growers needed to generate greater efficiencies in their farm business to offset slowing productivity growth and rising production costs.

"Australian agriculture in the future will be about improving the efficiency, sustainability and consistent supply of quality products," Drew said.

Switch of emphasis needed

"More emphasis will need to be placed on inputs, storage, waste, distribution and ultimately farm profitability rather than perhaps just production.

"In spite of producing food on the driest inhabited continent, on low quality soils and with major climate variability, previous reliance on water and energy to drive up yields will not be an option for the next phase of our productivity gains.

"We need to make the business of farming more valuable. For this to happen, more emphasis needs to be placed on farming system analysis of rotations, industry research and development (R&D), emerging data utilisation technologies, review of current farm structure and the perceived social value of agriculture to the wider community."

The GRDC is investing in many of these areas including farming systems research, with a major project underway in the northern region aimed at improving the integrated management of weeds, diseases, pests, crop agronomy and water use efficiency.

Rotation management will be critical

Drew said rotation management would play an integral role in future farm profitability. This would help growers reduce fertiliser dependency, improve soil structures, reduce cereal stubble – and therefore issues with diseases such as crown rot and root lesion nematodes – as well as widening the choice of herbicide chemistries and improving rainfall capture, storage and water use efficiency.

"Controlled traffic, zero and minimum-tillage systems have certainly changed the production reliability in our farming systems. But with it have come plenty of other issues," Drew said.

"Rotations will be the key to managing many of the associated issues such as disease, herbicide resistance and the safe use of residual herbicides. They will also enable earlier planting opportunities to combat heat risk, increase double cropping opportunities, improve fallow efficiency through the use of cover crops and improve soils' infiltration and water holding capacity."

At the same time, technology promises to transform farming practice and dramatically reduce fuel and labour costs with the introduction of innovations such as driverless tractors and robots that can target and kill herbicide resistant weeds and deliver accurate doses of fertiliser and fungicides.

Data availability and utilisation will also offer unparalleled opportunities to improve production efficiency by detailing the genetic makeup (genotypes) of individual farms and how that relates to the physical characteristics of the farm (phenotypes) to anticipate performance under a diverse set of environmental conditions.

"Agronomists will still need the traditional knowledge of cropping systems, fertiliser regimes, field pathology and so on but they will also need to know about techniques to assess crop health based on analysis of the reflectance from crops and images captured from drones and/or satellites," Drew said.

"In future this data will be captured from even more diverse sources. Farmers and their consultants will link this information with predictive climate models and use the results to make more timely management decisions such as time of planting, fertiliser application, disease management, harvest management and ultimately when and how to market the commodity.

"At the end of the day this will allow the producer to capture a greater share of available profit margins."

Continued focus on R&D capacity and capability

Underpinning these advances is a continued focus on R&D capacity and capability which will require Australia to collaborate globally and pioneer new models of research investment.

Drew said Australian research capability and facilities were world-renowned and had successfully developed a focus on drought, frost, disease, plant architecture for hostile subsoils, along with yield and quality characteristics.

While excited by the opportunities facing Australian agriculture over the coming years, Drew said the industry would only reap the benefits through practice change and technology uptake.

"Smart farming has many hurdles to overcome. The greatest obstacle is the current low profit margins which means that the implementation cost of these products is perceived to be too expensive.

"This will change as more people realise the benefits to their future bottom line through increased efficiencies and more precise management decisions."

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"We need to make the business of farming more valuable." – Drew Penberthy.

Chickpea Ascochyta – the latest on variability and management

■ Kevin Moore¹, Kristy Hobson¹, Nicole Dron¹, Prabhakaran Sambasivam², Rebecca Ford³, Steve Harden¹, Yasir Mehmood³, Jenny Davidson⁴, Shimna Sudheesh⁵, Sukhjiwan Kaur⁵ and Sean Bithell¹

AT A GLANCE...

- In 2015, Ascochyta blight (AB) occurred in a higher proportion of chickpea crops (60 of 243 crop inspections) than in 2014 (62 of 332 crop inspections). Most infected crops were PBA HatTrick which was also the most commonly grown variety.
- Work to determine if the Ascochyta pathogen is changing started in 2013. A number of projects are working together to provide an integrated approach to chickpea Ascochyta blight to improve variety resistance and best management practices.
- Initial results show that the population varies in time for spore germination, germ tube length, ability to cause disease (pathogenicity), and time to develop fruiting bodies (latent period).
- Significant differences in the reaction of some varieties and advanced breeding lines to two aggressive isolates of the AB pathogen have been found. So it is essential that growers adhere to best management practices, such as sustainable rotations, to minimise selection pressure on the pathogen and maximise the longevity of variety resistance.
- While research into variability of the AB pathogen continues, it seems prudent to adopt a conservative approach to AB management.

IN 2015, 243 chickpea crop inspections were conducted as part of a GRDC supported project. Ascochyta blight (AB) (*Phoma rabiei* formerly called *Ascochyta rabiei*) was detected in 60 crops. Inoculum had carried over from the 2014 season and wet conditions during June–July favoured infection and disease development. High chickpea prices tempted some growers to break best practice and plant back to back chickpeas resulting in severe disease.

Some growers reported more AB in PBA HatTrick than they ever saw in Jimbour but many of these crops had been inundated in June and July 2015 and we know that AB resistance of waterlogged chickpeas is compromised. Further the genetic purity of the variety could not be determined.

Generally, however, good management and dry conditions through August–October kept AB under control and no major yield losses were reported.

Latest research on variability in the Ascochyta pathogen

Is the pathogen changing? Yes, and as a population of living individuals (isolates), we should expect it to change.

Has the pathogen changed in response to selection pressure such as the widespread cultivation of varieties with improved resistance or other factors? We don't yet know. To know if something has changed, you need to track it over a suitable time period.

Detailed studies on molecular variability in the AB fungus

commenced in 2008 and have shown that the overall population variation hasn't changed much. But pathogenicity studies that began in 2013 indicate that there are differences in pathogenicity among isolates and that highly pathogenic isolates are causing disease on PBA HatTrick.

This article provides key results from a range of research groups working on this combined project to better understand the chickpea AB population and its threat to the resistance sources through potential adaptation and selection.

Latent period

The incubation period is the time from infection to the appearance of symptoms. The latent period (LP) is the time from infection to the development of pycnidia (the small dark fruiting bodies that develop in the leaf and stem lesions). The LP is important because it determines how fast the disease can cycle in a crop. Determining these characteristics is thus another way of measuring variability in the pathogen population.

Three experiments were conducted in 2015. In each experiment, five isolates representing a sub-set of the pathogen population in eastern Australia plus a sixth control isolate (obtained in 2014 from PBA HatTrick at Yallaroi, TR6415) were evaluated in a growth cabinet on four chickpea genotypes. There were eight replicates (pots) for each of the 24 genotype by isolate combinations.

At the 3 leaf stage plants were grouped by isolate and inoculated with a conidial suspension of 100,000 conidia/mL (sprayed to run-off). Plants were examined daily for symptoms and pycnidia. The mean LP was estimated by survival analysis with the status of a pot based on whether pycnidia had or had not developed.

The four genotypes, their AB rating and abbreviation are:

- ICC3996 (rated R, coded ICC);
- GenesisTM 090 (rated R, coded GEN);
- PBA HatTrick (rated MR, coded HAT); and,
- Kyabra (rated S, coded KYB).



Research is underway to determine if the Ascochyta pathogen in chickpea crops is changing.



The use of alternative AB resistance genes is essential if our chickpea breeding program is to deliver useful new varieties.

For each experiment, LP varied significantly between some isolates and genotypes (LP range 6–8 days). Furthermore, all isolates had the shortest LP on the most susceptible entry – KYB and the longest LP on the most resistant entry – ICC or the second most resistant entry – GEN.

Within an experiment, no single isolate had the shortest LPs on all genotypes. We interpret this as indicating there are no clear differences among isolates in the contribution of LP to isolate aggressiveness.

These experiments complement the pathogenicity work and confirm variability does exist in the pathogen population.

TABLE 1: Ascochyta blight ratings, response of varieties and breeding lines to two *Phoma rabiei* isolates

Name	AB Field rating	% of main stems broken		Marker genotype
		Isolate FT13092-1	Isolate TR5919	
Kyabra	S	100	100	–
PBA HatTrick	MR	0	20	+, desi
PBA Boundary	MR	35	75	+, desi
Genesis 836	MS	8	28	Not conclusive
CICA0912	R*	0	42	+, desi
CICA1007	MR*	0	50	+, desi
CICA1521	R*	0	8	+, desi
Almaz	MS	8	8	–, suggests other genes
Genesis 090	R	0	8	+, kabuli
Genesis 425	R	8	17	+, kabuli
Genesis Kalkee	MS	50	20	–, suggests other genes
PBA Monarch	MS	3	42	+, kabuli plus others
CICA1156	R*	0	0	+, kabuli

*Advanced breeding lines, putative AB rating

Histopathology experiments

A range of preliminary histopathology experiments have been completed. Key findings from a range of work in this area are that:

- Spore germination begins much faster on the susceptible Kyabra and on PBA HatTrick than on the resistant Genesis090;
- Spore germination is consistently slower and lower on the resistance source ICC3996 than on any other chickpea genotype tested;
- There is significant variation in germination time among different isolates and this correlates with their level of pathogenicity; and,
- After germination, germ tube length prior to invasion is significantly shorter on ICC3996 than any other chickpea genotype tested.

These differential fungal responses may be indicative of host recognition and defence strategies, which are being further investigated.

How is this information used by the PBA Chickpea program?

In 2014 and 2015 two aggressive isolates identified by the pathogen variability project were screened by SARDI in South Australia on three desi and kabuli varieties. In 2015 the two isolates tested were collected in 2013; FT13092-1 from South Australia on Genesis 090 and TR5919 from northern NSW (Tooraweenah) on PBA HatTrick.

Of the 154 entries tested, 62 breeding lines significantly differed in their resistance (% of main stem broken) to the two isolates (subset of lines presented in Table 1).

The northern isolate was found to be more aggressive than the South Australian isolate.

There was no significant difference in the response of PBA HatTrick to the two isolates, but PBA Boundary, CICA0912 and CICA1007 had significantly higher disease with TR5919.

Conversely, the kabuli variety – Genesis Kalkee – had significantly lower disease with the TR5919 isolate compared to the South Australian isolate.

The desi CICA1521 and kabuli CICA1156 had very low levels of disease from both isolates.

The 2014 research examined two isolates collected in 2010 and a much smaller number of entries, 8 (out of 137), had a significantly different response to the two isolates.

To complement this information, molecular markers have been screened across the 154 entries. A total of five flanking molecular markers for AB resistance were identified. These markers have been validated across a diverse set of chickpea lines.

By combining the phenotypic and genotypic information, the breeding program will gain a greater understanding of the genetic resistance in each breeding line. The wider implementation of AB molecular markers across the PBA Chickpea program has identified breeding material which may contain alternative resistance genes.

Research into alternative genetic resistance genes is continuing. The use of alternative resistance genes in the breeding program will be essential to ensure new chickpea varieties have adequate levels of AB resistance.

While research into variability of the AB pathogen continues, it seems prudent to adopt a conservative approach to AB management.

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Phytophthora in various chickpea varieties

■ Kevin Moore¹, Lisa Kelly², Kristy Hobson¹, Steve Harden¹, Willy Martin³, Kris King³, Gail Chiplin¹ and Sean Bithell¹

AT A GLANCE...

- In a wet season, substantial (94 per cent) yield losses from phytophthora root rot (PRR) occur in susceptible varieties such as PBA Boundary. Do not grow PBA Boundary if you suspect a PRR risk.
- Varieties with improved resistance to PRR (PBA HatTrick and Yorker) can also have large yield losses (68–79 per cent) in a very heavy PRR season.
- Although yield losses will occur in very heavy PRR seasons, crosses between chickpea and wild Cicer species, such as the breeding line CICA1328, offer the best resistance to PRR.
- Avoid paddocks with a history of lucerne, medics or chickpea PRR.

PHYTOPHTHORA *medicaginis* – the cause of phytophthora root rot (PRR) of chickpea – is endemic and widespread in southern QLD and northern NSW. It carries over from season to season on infected chickpea volunteers, lucerne, native medics and as resistant structures (oospores) in the soil. Although registered for use on chickpeas, metalaxyl seed treatment is expensive, does not provide season-long protection and is not recommended. There are no in-crop control measures for PRR

and reducing losses from the disease are based on avoiding risky paddocks and choosing the right variety.

Current commercial varieties differ in their resistance to *P. medicaginis*, with Yorker and PBA HatTrick having the best resistance and are rated MR (historically Yorker has been slightly



PRR basal lesions extending up the plant stem. (Photo: Mal Ryley)

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TABLE 1: Yields of commercial chickpea varieties and breeding lines protected from *Phytophthora* root rot, and % yield losses from PRR in a 2015 trial at Warwick QLD

Variety/line ^A	Yield (t/ha) in absence of <i>Phytophthora</i> infection	Yield (t/ha) in presence of <i>Phytophthora</i> infection	% yield loss due to <i>Phytophthora</i> infection
CICA1328 ^A	2.64	1.54	41.7
D06344>F3BREE2AB027 ^A	2.52	1.05	58.4
PBA HatTrick	2.50	0.81	67.7
Yorker	2.61	0.57	78.7
CICA1007	2.93	0.71	75.9
CICA0912	2.76	0.37	86.6
PBA Boundary	2.88	0.17	94.0

^AThese lines are crosses between chickpea (*C. arietinum*) and a wild Cicer species. (P Yield<0.001; lsd Yield = 0.46).

TABLE 2: Yields of commercial chickpea varieties and breeding lines protected from *Phytophthora* root rot, and % yield losses from PRR in a 2014 trial at Warwick QLD

Variety/line ^A	Yield (t/ha) in absence of <i>Phytophthora</i> infection	Yield (t/ha) in presence of <i>Phytophthora</i> infection	% yield loss due to <i>Phytophthora</i> infection
CICA1328 ^A	2.76	2.71	1.8
Yorker	3.01	2.69	10.4
CICA1211	3.01	2.66	11.6
D06344>F3BREE2AB027 ^A	2.93	2.13	27.4
PBA HatTrick	2.94	1.98	32.8
CICA0912	3.23	1.79	44.6
PBA Boundary	2.79	0.73	73.8

^AThese lines are crosses between chickpea (*C. arietinum*) and a wild Cicer species (P Yield<0.05; lsd Yield = 0.80)

better than PBA HatTrick), while Jimbour is MS-MR, Flipper and Kyabra are MS and PBA Boundary has the lowest resistance (S).

PBA Boundary should not be grown in paddocks with a history of PRR, lucerne, medics or other known hosts such as sulla.

From 2007 to 2015 PRR resistance trials at the DAF Qld Hermitage research facility near Warwick have evaluated a range of varieties and advanced PBA breeding lines. Each year the trial is inoculated with *P. medicaginis* at planting. There are two treatments:

- Seed treatment with thiram + thiabendazole and metalaxyl and regular soil drenches with metalaxyl (Note: soil drenches with metalaxyl not currently registered); and,
- Seed treatment with thiram + thiabendazole only with no soil drenches.

The first treatment has prevented infection by the PRR pathogen in all of these trials.

The difference in yield between the metalaxyl-treated plots and untreated plots are used to calculate the yield loss caused by PRR, % loss = $100 \times (\text{Average yield of metalaxyl-treated plots} - \text{Average yield of nil metalaxyl plots}) / \text{Average yield of metalaxyl-treated plots}$.

Yields in metalaxyl-treated plots were close to seasonal averages for the 2015 season with the lowest yielding breeding lines and varieties (CICA1328, Yorker and PBA HatTrick) yielding close to 2.5 tonnes per hectare (Table 1).

In 2015 the level of PRR in the trial was considerably higher than those previous seasons such as 2014 (Table 2). For example yield losses were greater than 40 per cent for CICA1328 in 2015 but only 1.8 per cent in 2015 and yield losses for PBA Boundary were 94 per cent in 2015 and 74 per cent in 2014. But the 2015 trial again confirmed that Yorker and PBA HatTrick had better resistance than PBA Boundary (Table 1), which has been consistent across previous trials.

Results for the high PRR disease season of 2015 showed that susceptible varieties sustain substantial yield loss from PRR and that varieties with moderate resistance have reduced losses. The 2015 trial again confirmed the superior PRR resistance of the PBA breeding line CICA1328 which is a cross between a chickpea (*Cicer arietinum*) line and a wild Cicer species.

CICA1007 was included in the 2015 trial because it has high yield and large seed size in a Yorker background. In the absence of PRR it was the second highest yielder in the trial (2.93 tonnes per hectare) and its yield loss to PRR was similar to Yorker.

¹NSW DPI Tamworth; ²DAFQ Toowoomba; ³DAFQ Warwick

Thanks to growers and agronomists for help with crop inspections and submitting specimens, as well as Woods Grains, Goondiwindi for planting material for trials and to chemical companies who provided products for research purposes and trial management.

This research is made possible by the significant contributions of growers through both trial cooperation, field access and the support of the GRDC, the authors would like to thank them for their continued support.

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Taking the grey out of wheat products

■ By Sandra Avant, Agricultural Research Service – USDA

AT A GLANCE...

- Polyphenol oxidase is a natural enzyme in plants.
- It turns cut apples brown and some wheat products grey.
- Based on Australian-bred varieties, ARS-USDA scientists have developed a wheat with almost no polyphenol oxidase.

EVEN if you don't know what "polyphenol oxidase" is, you've seen what it can do. Polyphenol oxidase, an enzyme found in all plants, causes undesirable reactions such as browning in sliced apples, black spots in cut avocados, and dark marks on banana peels. It's also responsible for grey discoloration in wheat products such as fresh noodles, fresh and frozen breads, and refrigerated biscuits – all made from hard white wheat.

Hard white wheat products such as white whole-grain breads are becoming more popular. Hard white wheat is the wheat of choice in select export markets, especially in Asia, where it is used to make a variety of fresh noodle products.

Disadvantage when compared to Australian wheat

High levels of polyphenol oxidase in the grain make US hard white wheats undesirable and place them at a disadvantage relative to wheats from Australia in the Asian markets, says Bob Graybosch, plant geneticist and research leader of the Agricultural Research Service's (ARS) Grain, Forage, and Bioenergy Research Unit in Lincoln, Nebraska. "Polyphenol oxidase is a big deal for Asian markets, because they don't want to see grey noodles when they hang them up to dry and then sell."

For 15 years, Bob has been studying the polyphenol oxidase trait in wheat, investigating numerous samples of white wheat obtained from the ARS National Small Grains Collection (NSGC), in Aberdeen, Idaho.

"A lot of US white wheats still have high levels of polyphenol oxidase," Bob says. "To have a successful white wheat for both the export market and the domestic market, milling companies want low or no polyphenol oxidase."

Some low-polyphenol oxidase hard winter white wheats have been developed, but complete removal of this enzyme trait is more desirable.

In 2000, working with the University of Nebraska and Montana State University, Bob screened more than 3000 wheats from the NSGC for the presence of polyphenol oxidase. The team then mated wheats that had low levels of the enzyme. Wheat breeding lines with very low or even near-zero levels of polyphenol oxidase were generated from these crosses.

"And lo and behold, we did it," he says. "We developed a wheat with practically no polyphenol oxidase."

Using Australian varieties from the 1930s

Bob produced the wheat line, called 070R1074, by crossing two Australian wheats that were entered into the small-grains germplasm collection in the 1930s.



Wheat has an enzyme that can cause grey discoloration in fresh noodles, an undesirable trait in Asian markets.

(PHOTO: Peggy Greb)

"For 70 years, these two Australian wheats have been in the germplasm collection with this trait of interest and economic importance that the milling industry and exporters need and want," Bob says. "This demonstrates the value of this diversified wheat collection. You don't always know what you have until you do something with it."

In a recent study, Bob and his colleagues discovered naturally occurring genetic mutations in 070R1074 that resulted in the nearly complete loss of polyphenol oxidase activity. The trait has now been integrated in improved breeding lines developed by crossing 070R1074 with elite Montana and Nebraska wheats.

Further incorporation into elite lines will result in highly desirable cultivars that will expand the demand for US hard white winter wheat. ■



US researchers are breeding hard white winter wheat lines with very low levels of polyphenol oxidase. These new lines have been generated from crosses with old Australian varieties. (PHOTO: Dave Marshall)

Farming in Foreign Fields...



Flagship Quadtrac offers 692 hp of efficiency

A LEADING contract farming business in East Anglia in the UK has recently invested in the world's largest series-manufactured tractor – a 692 hp Case IH Quadtrac 620 – to maximise the efficiency of its operations across 1800 hectares of combinable crops in Suffolk and Norfolk.

Founded by Jes Hansen in 1993, Tyneholme Estates has built an excellent reputation for its highly-professional approach and paying attention to even the smallest detail – attributes which continue to set it apart in a very competitive sector.

“Our approach to farming profitably is to tap into market opportunities which offer premium potential, lock in known returns for the crops we produce, rigorously control production costs and operate the best equipment to achieve timely operations and maximise yields,” Jes explains.

“Farming well is a very specialist profession and operating on the scale that we do allows us to harness the benefits of large, high-capacity machinery yet still achieve a low cost per acre, which is increasingly important.

“When I came here in 1993 the estate had been operated along traditional lines and was in need of complete modernisation. One of the key issues holding back performance was the lack of timeliness and it was obvious that the heavy land would have to be drilled much earlier to achieve higher yields and more consistent results.

“Seed rates were a key factor in drilling earlier and in conjunction with an independent adviser in Denmark, I developed a guide which we still use today. We start with a very low seed rate at the beginning of the season and increase it every three days.

“We achieved some very good results by drilling earlier but because we ploughed and power harrowed every acre, some years wet weather caused severe problems. In 2005 we started

A Case IH Quadtrac 620 tractor recently delivered to a large contract farming operation in East Anglia (UK) will increase efficiency and timeliness while reducing production costs.

to use deeper non-inversion cultivations to improve timeliness on fields that were suitable, but the nature of our soils meant that we still had to work 20 to 25 cm deep.

“Having tried various types and makes of equipment we eventually settled on using a Vaderstad Top Down, followed by a power harrow to improve the quality of the seedbed, which worked very well. It was apparent that we needed to have more power available,” Jes explained.

Catalyst for change

In 2007, wet weather made harvesting grass seed particularly difficult and the estate's two existing rotary combines struggled to cope. After a Case IH 9010 combine came to the farm on demonstration – and proved to be four times faster, produced a much better sample and never blocked – Jes decided to re-evaluate his entire approach.

The existing combines were replaced with two Case IH Axial-Flow 9010 combines with 9.1 m header fronts and the tractor fleet received a complete makeover. The departure of several smaller units paved the way for the arrival of several new Case IH tractors, including a Quadtrac 430, Magnum 310 and two Puma models. The effect of this massive power boost would soon make its impact felt.

“The decision to buy our first Quadtrac in 2007 was not one that we took lightly,” Jes explains. “The cost certainly made us think for a while but it was obvious that was the way to go. We had been doing a good job with our previous wheeled tractors, but the arrival of the Quadtrac took the quality and timeliness of seedbed preparation and drilling to a whole new level.



Jes Hansen, founder of Tyneholme Estates.

"The Quadtrac flew up and down the field and left a clean, level headland. That really made my mind up. There were other advantages from choosing a Quadtrac because it meant that we could continue supporting our Case IH dealer, Doe Power in Framlingham, which I was keen to do because of the excellent maintenance and back-up service they provide.

"The original Quadtrac was a 2006 model and had completed 1000 hours when we bought it in 2007. By the time we traded it in after the 2014 harvest it had done 6000 hours. Over those seven seasons it was really reliable, with no unscheduled stops or breakdowns. Apart from changing the tracks at 3500 hours we only had to fit three track rollers.

"The key to reliability is correct servicing. Every two years we sent the Quadtrac to Doe Power for a full service in their workshops and in the meantime our operators maintained it to a very high standard. One of the key points with the Quadtrac is to make sure that the track rollers run at the correct temperature, because if they start to heat up it is a sign that something is wrong. We have an infra-red thermometer that allows the operator to check the temperature of each roller a couple of times each day just by pointing the beam at it.

"The Quadtrac 430 was scheduled for change in 2017, but to benefit from the new UK tax allowances which were introduced in 2014, we decided to trade it in earlier. There was very little difference in cost between the flagship Quadtrac 620 – which gives us almost 700 hp – and two smaller models in the range, so it made sense, particularly as it came with a good finance package and three-year warranty.

"Being able to operate at the correct speed is very important to achieve optimum results from our cultivation and drilling equipment, but to do that we have to have the power. The Quadtrac 620 provides that and should cover our existing workload in fewer hours, but we are taking on more land so it will probably still do 900 hours a year."

The cropping program

Cropping at Tyneholme Estates includes 1000 hectares of first and second wheat, including 6500 tonnes of Solstice or Skyfall grown on contract for Warburtons, whose Chairman presented Jes with its Grower Award in 2006–07.

In addition, Tyneholme Estates also produces 500 hectares of oilseed rape (canola), winter and spring barley, 150 hectares of marrowfat peas and 60 hectares of red fescue grass seed.

The latter is very good for conditioning heavy land due to its root structure, and being down for two years, provides an excellent break. Another major benefit is that red fescue is tolerant to glyphosate at certain times, allowing blackgrass to be controlled.

"We are always looking for new farming and cropping opportunities, such as the peas which we grew for the first time in 2009," Jes explains. "They have been an exceptional crop and their gross margin has averaged £1225 (\$2400) per hectare, compared with £555 (\$1090) for oilseed rape in 2014. In 2015 we grew spinach for seed for a company in Denmark. It is a new spring crop in the UK but again represents a new premium opportunity that will take our business forward."

The flagship of the range

The Quadtrac 620 is the flagship of the Case IH tractor range, powered by a six-cylinder, 12.9-litre FPT Industrial Cursor 13 engine, which is rated at 629 hp but produces up to 692 hp – SCR technology enables it to fulfil Tier 4 Final/Stage IV emission standards.

To harness this prodigious output the Quadtrac incorporates a 16 x 2 Full Powershift transmission, its Automatic Productivity Management (APM) system automatically selecting the best combination of gear and engine speed to match the implement and terrain.

Four independently-driven tracks provide a constant soil contact area of more than 5.6 m². This virtually eliminates slip as well as minimising ground pressure and soil damage.

Largest in the industry, the cab provides all-round visibility and features the latest generation of Multicontroller which operates the main functions. An exclusive suspension system provides the operator with a comfortable ride.

"The cab is one of the big benefits of the new Quadtrac," Jes explains. "It is exceptionally quiet and the suspension is excellent."

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Key tools help to reduce weeds

LONG fallow and select use of newer herbicide modes of action are playing major roles among a suite of tools helping to reduce weed pressures at the Flinn family's farming enterprise near Trangie in NSW's central west.

Kevin and Jill Flinn, together with their son Richard and his wife Emma, daughter Johanna and son-in-law Will Leader, operate the 3600 hectare 'Iona' property, which includes a 1000 hectare separate block acquired about 10 years ago and 400 hectares of irrigation on another block.

On land varying from heavy black clays through to light country, they grow wheat, barley, oats, canola, chickpeas and lucerne and run about 1000 Wiltipoll ewes and 350 Poll Shorthorn cows.

Kevin said weed pressures, including herbicide resistant weeds, were more prominent on the 1000 hectare block and on the main farm, where there had been high use of Group A and B herbicides after applying trifluralin pre-sowing. Growing oats for grazing only, had been another contributor to the weed populations.

Annual ryegrass, black oats, phalaris and barley grass are some of the major problem weeds, while others include doublegee, blue heliotrope, fleabane and umbrella grass.

Crop rotations vary, but can follow a program of canola-wheat-wheat-chickpeas-wheat-fallow.

Strong focus on fallow

Ryan Pratten, of Muldoon Pratten Ag Consulting, who Kevin said was one of the "most important cogs in the wheel" of the family's farming operation, said there was now a strong focus on fallow, including long fallowing every six to eight years, which involved cultivating, ripping and then minimum tillage.

"Fallow has been very successful for total production and weed control – and it gives the country a break. It helps drought-proof the business," Ryan said.

Weed populations were increasing (up to 500 per square metre) and were significantly limiting production before the Flinns

also switched to using the Group K pre-emergent herbicide, Sakura 850 WG.

Containing the active ingredient, pyroxasulfone, Sakura controls annual ryegrass, barley grass, silver grass, annual phalaris and toad rush and also suppresses certain grass weeds in wheat (not durum wheat), triticale, chickpeas, field peas and lupins. It has also recently been registered for use in lentils.

The family generally sows into moisture, with the Sakura incorporated via their 12-metre Flexi-Coil bar set on 30 cm tyne spacings with knife points and press wheels. Their black soils can be sown dry, while rainfall has been received soon after seeding to assist herbicide activity.

"In our first year with Sakura, we applied it in the worst area for grasses in a paddock and it brought it back to the rest of the paddock," Kevin said.

"We are also getting reasonable results on black oats – very good suppression. "The flexibility with Sakura is really helpful. We have sprayed Sakura, gone and planted other areas with Treflan and then went back to the Sakura paddock.

"It is also good for standing stubbles and on heavy stubble loads, like back-to-back wheat stubble."

He said they planned to use Sakura on areas within paddocks when needed.

"We don't want to develop weeds resistant to Sakura.

"We haven't relied on Treflan a lot and so it is still good for us here. We use Treflan for fallow, on the bare soil, as well as on stubbles."

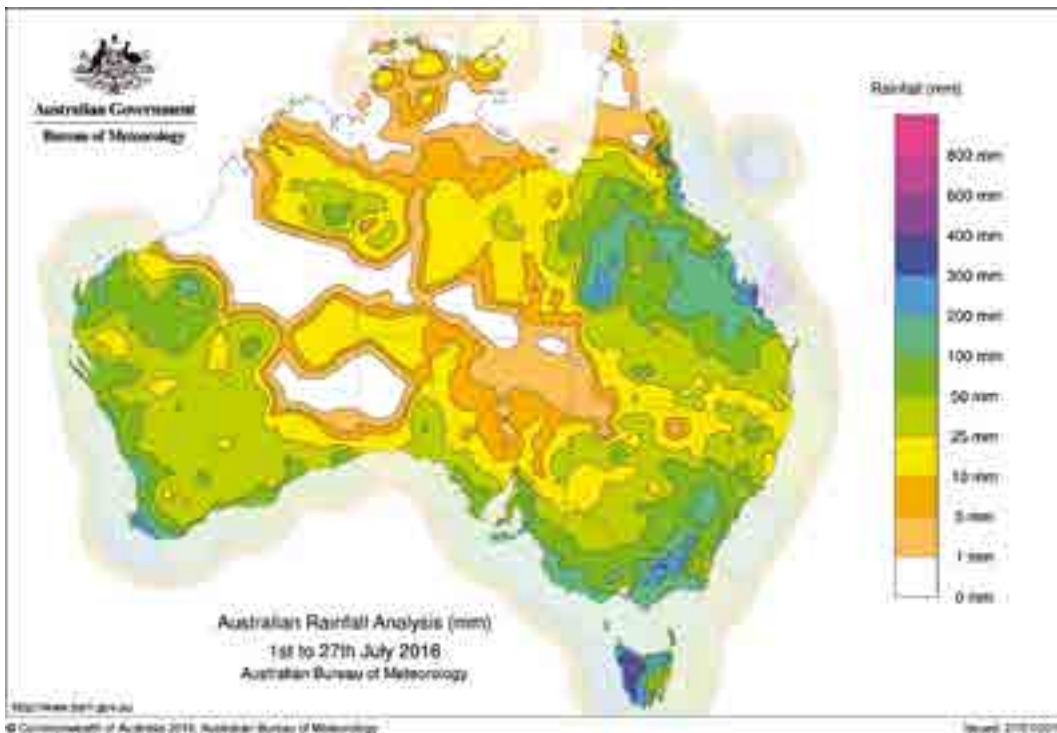
During the season, the post-emergent broadleaf herbicide, Precept, is proving to be effective.

"Its compatibility and crop safety in being used with a grass herbicide in one pass is excellent and it has provided good weed control," Ryan said.

To further aid weed management, the Flinns are also growing triazine-tolerant canola, burning broadleaf stubble windrows and baling stubbles, although Ryan said burning was only carried out as a last resort.



Kevin Flinn, Ryan Pratten (Muldoon Pratten Ag Consulting), Jon Bennett (Bayer) and Richard Flinn inspect grain quality during the 2015 harvest.



RAINFALL REPORT...

Rainfall during July across the national grainbelt has generally been excellent. As can only be expected across a vast region, the rainfall totals have varied with some waterlogged areas and others still needing more rain. But soil moisture conditions are generally excellent as the Australian winter crop heads towards the critical spring period.

District Reports...

July–August 2016

Western region



NORTH

Rainfall across our region has been very good over the past two months. Temperatures have been cool but crops are generally growing well. Some lighter soil types have yellowed off crops with leaching rainfall and cool conditions. These are the low water holding capacity soils that are the lowest yielding in our area. Some growers are topping them up again but they generally do not respond in extra yield.

Wheat is from early grain fill to jointing and all crops look very good. Powdery mildew and leaf rust are in some crops but fungicides have been applied to much of the crop. Yield potential looks to be above average.

Canola crops are from late flowering to early flowering and look very good. Sclerotinia and aphids are the main concern at this stage. Fungicide is being put on and many are keeping a

close eye on the aphids. DBM are not an issue at this stage but I expect to see them as we get into warmer spring conditions.

Lupins are flowering and generally look good. August is their major growth month and they will be looking very good as we get to the end of the season. I expect above average yields.

Crops in our region are generally looking very good and expectations are for an above average yielding season if we get an OK finish. We have moisture now that will get crops through to late August and the hope is we get more good rain to get us well into September. The only downer is the sliding grain prices! I hope things are good in your patch.

Peter Norris

**Agronomy For Profit and Synergy Consulting, Geraldton
July 26, 2016**

SOUTH COAST

Seasonal conditions on WA's South Coast have continued to be wet. As an indication, rainfall at Munglinup, 100 km to the west of Esperance, is 174 mm above average – while at Salmon Gums, 100 km to the north, it's 87 mm above.

But these wet conditions have put many crops, particularly within 50 km of the coast, under some water logging stress. Further inland, the crops are in very good shape with excellent potential.

The main challenge with the constant wet weather has been post emergent spraying while dodging showers. Machinery 'flotation' has also been an issue at times.

Demand for nitrogen has been high as growers chase the increased yield potential – or because they are trying to nurse crops out of a water logged condition through small and strategic doses of nitrogen.

All fertiliser suppliers have found it a challenge to keep up with nitrogen demand.

Growers are now busy applying fungicides in canola for sclerotinia control and are just beginning flag leaf fungicide applications in the early sown cereals.

The really good news story from the region is how good the crops look in the area that was devastated by the catastrophic fire

District Reports...

July–August 2016

on November 17 last year. With a kind finish, the yield potential in this area will be above average.

To date, the winter of 2016 has been one of the coldest many growers can remember for more than two decades. The regional air and soil temperatures reflect this as does the slow crop development over the past two months.

Quenten Knight,
Agronomist, Precision Agronomics Australia
July 26, 2016

Southern region



SOUTH AUSTRALIA SUMMARY

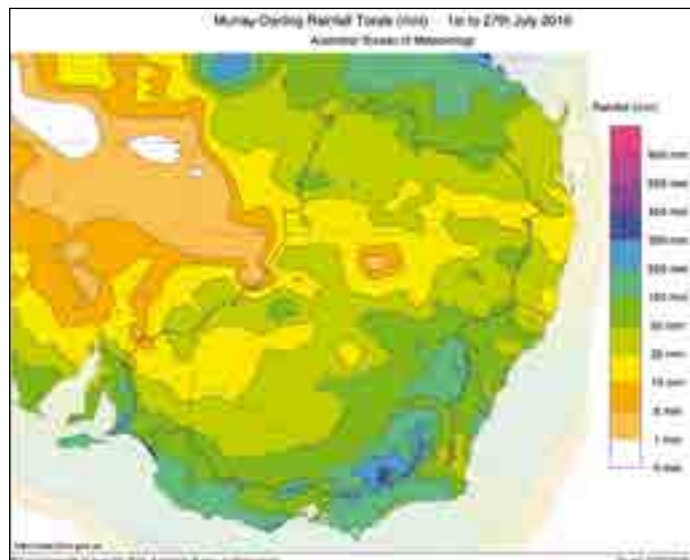
The weather

May rainfall was average to above average in most of the agricultural districts of SA. Rainfall in areas of the Lower Eyre Peninsula and Central Yorke Peninsula was very much above average.

June rainfall was average to above average in most of the agricultural districts with areas of very much above average rainfall on Northern Yorke Peninsula and Eastern Eyre Peninsula.

Mean maximum temperatures for May were average on Western Eyre Peninsula and the western part of the Upper North and above average in the remainder of the agricultural districts.

Mean maximum temperatures for June were above average on Kangaroo Island and average in the remainder of SA's agricultural areas.



Generally favourable conditions and rainfall for most cropping regions have continued in July.

Winter crops

The estimated winter crop area in 2016 is similar to last season at 3.9 million hectares. Soil moisture profiles are now generally full with the rains of late autumn and winter to date. The winter crop this season is now well positioned with above average harvest projections in excess of 7.0 million tonnes.

The seeding period was extended with many farmers sowing into dry soils in April and early May – while others delayed sowing until rains in late May. Wet conditions during June delayed the completion of seeding on heavy clay soils.

The early-sown cereal crops have grown rapidly with the mild conditions during May and some crops along the coastal areas of the Upper North and North Yorke Peninsula were at the booting to early head emergence stage by early July.

Some early-sown crops had poor emergence due to the marginal soil moisture conditions, but by early June had fully emerged following good rains in late May.

Some early-sown canola crops in several districts had poor establishment and some crops or parts of crops were re-sown, primarily with peas.

Strong winds in mid to late May caused wind erosion and sand blasting to newly emerged crops in several districts with some small areas re-sown.

Farmers on Eyre and Yorke Peninsula have applied nitrogen to early-sown crops. There was a shortage of nitrogen fertiliser during June.

Russian wheat aphid and other pests and diseases

Russian wheat aphid (RWA) was identified for the first time in Australia in the Tarlee area in mid-May. Early efforts to eradicate the pest proved fruitless as it was quickly identified over a wide area of eastern South Australia and western Victoria, indicating that it must have been present for some time.

The RWA is widespread through the eastern part of the state. It has caused severe damage to some March and April sown cereal crops in the northern agricultural districts. Most of these crops have been sprayed and have recovered rapidly with no reinfestation of the aphids.

Later-sown crops generally only have low numbers of RWA and the cold wet weather has been effective in washing aphids off plants and reducing numbers. Farmers and agronomists will closely monitor crops for aphid numbers as the temperatures increase in spring.

Green peach aphid numbers have built-up on volunteer canola plants and are now infesting newly sown canola crops in a number of districts. Virus symptoms (showing yellow, reddened and stunted plants) have been observed on several crops on Lower Eyre Peninsula.

Red legged earth mites and lucerne flea are widespread in most districts. The use of insecticide with knockdown herbicides in paddocks sown with susceptible crops has reduced damage in many crops. Control has been required in some crops to reduce damage.

A range of other pests has caused minor damage to emerging crops in a number of districts and pest numbers appear higher where summer weeds and volunteer crops were not controlled.

Wheat curl mites have transmitted wheat streak mosaic virus from volunteer cereals to crops on Eastern Eyre Peninsula and Northern Yorke Peninsula.

Spot form of net blotch is present in early-sown barley crops

on Eyre and Yorke Peninsula. Other leaf diseases are currently at relatively low levels.

Crop areas

The estimated area sown to barley has been reduced in many districts across the state due to the low price outlook while the area sown to wheat seems to have remained stable.

There has been a significant increase in the area sown to lentils across the state, particularly on Yorke Peninsula.

The area sown to canola has been reduced in the South East but increased on Eyre Peninsula and parts of the Mallee.

Pastures

Pasture growth has been variable across the state with good growth of early sown pastures on Eyre Peninsula, the Mid and Lower North and Northern Yorke Peninsula but relatively slow growth in other districts.

There has been an increased area of pasture sown on Upper Eyre Peninsula, Southern Mallee and the South East, due to the good livestock prices.

Supplementary feeding of livestock was necessary in many areas of the state, particularly on the heavier clay soils where pasture germination was slow.

Dave Lewis, Primary Industries and Regions SA (PIRSA)
July 4, 2016

District Reports...

July–August 2016

MALLEE

Currently crops in the Victorian Mallee look fantastic. The region is currently sitting on a decile 6 for annual and growing season rainfall.

Crop growth stages are ahead of usual given the warm, moist conditions. Early sown wheat and barley is already at growth stage 32–33 (second node) and not far from flag leaf emergence. Canola is just beginning to bolt and legumes will soon be at canopy closure.

With an Indian Ocean Dipole (IOD) negative (-ve) forecast and soil probes showing soil water movement at depth (for the first time in a number of years), more inputs are being applied as most growers can't afford to 'miss out' on the favourable season. Plenty of wheel tracks are being made as a result of spraying and topdressing activities.

But this optimism is tempered by the negligible August–September rainfall experienced in the past two seasons during the spring transition period – but climatic conditions were very different in those seasons.

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

Brought to you in association with  JOHN DEERE	25yr Annual Average (mm)		2016 rainfall to date (mm)		Summer 25yr Annual Average (mm)		2015–16		Autumn 25yr Annual Average (mm)		2016		Winter 25yr Annual Average (mm)		2016		Spring 25yr Annual Average (mm)		2015	
Emerald Qld	539		578		252		419		100		22		60		244		122		74	
Toowoomba Qld	663		407		277		264		127		96		82		150		121		181	
Roma Qld	572		317		252		252		117		30		74		93		126		73	
Goondiwindi Qld	612		346		254		348		120		52		99		81		135		79	
Narrabri NSW	630		371		227		176		118		79		124		163		160		114	
Gunnedah NSW	650		223		232		144		112		53		126		99		177		112	
Dubbo NSW	603		476		199		186		122		97		128		253		152		120	
West Wyalong NSW	443		411		119		95		78		108		119		232		126		95	
Wagga Wagga NSW	541		383		130		109		110		155		154		157		143		160	
Swan Hill Vic	318		174		73		48		62		82		88		51		95		41	
Bendigo Vic	509		306		108		51		102		131		162		138		136		79	
Horsham Vic	379		230		77		63		70		87		128		92		107		46	
Lake Bolac Vic	519		316		114		100		99		132		157		119		152		67	
Murray Bridge SA	369		219		67		40		80		74		124		113		99		54	
Kadina SA	339		275		57		38		78		137		116		110		88		60	
Cummins SA	391		371		50		83		90		136		171		161		82		59	
Esperance WA	614		391		78		112		142		187		248		136		144		104	
Wagin WA	395		276		43		88		94		163		168		63		89		52	
Northam WA	399		367		38		83		85		184		191		109		86		40	
Mingenew WA	354		204		27		22		91		106		175		78		68		33	
Moora WA	382		314		41		40		86		113		185		164		72		40	
Mullewa WA	326		212		46		34		96		67		135		121		50		13	

Last rainfall reading July 26 2016.

District Reports...

July–August 2016

Costs, budgets and Russian wheat aphids

Keeping a close handle on the cost of inputs has been important to match crop potential and proactively re-adjust budgets as required.

Many growers are already considering harvest logistics and what marketing options there are. But in this lower rainfall area, most are still wary and production is 'King'.

Every year a new issue seems to pop up and Russian wheat aphid is this year's. As temperatures warm, close monitoring will occur to decide if an insecticide application is warranted.

There's plenty of optimism about this season, but there's still a little way to go yet!

De-Anne Ferrier
Birchip Cropping Group
July 25, 2016

NSW OVERVIEW

The weather

Most of New South Wales experienced well above average rainfall during June and July, with some areas recording their wettest June on record. And the rainfall outlook through to September indicates wetter than normal conditions are likely across NSW.

Cooler daytime temperatures are also likely through to September. Overnight temperatures are likely to be cooler in the west, north and along most of the coast, but there is a near-equal chance of cooler or warmer than normal overnight temperatures in the southern and some central areas of NSW.

The Pacific Ocean is in an ENSO-neutral state. A negative Indian Ocean Dipole event is occurring, contributing to a greater likelihood of wetter than normal conditions and cooler daytime temperatures. Many global climate models suggest a borderline or weak La Niña event is possible during winter and spring.

Winter crops

Early sown winter crops are performing well. Some trafficability problems delayed weed and insect pest control and topdressing. Late sown crops have suffered the most from waterlogging, with seed bursting also a problem.

In some locations conditions have been too wet for resowing and have restricted topdressing, weed and insect pest control.

Weed management remains a priority due to the lack of control opportunities prior to sowing.

Insect pests have caused more problems than normal, particularly on early sown crops and establishing pastures.

In many cases where grazing of dual purpose cereals was underway, stock have had to be removed due to the extremely wet conditions.

Plant growth slowed due to the wet, cold and cloudy conditions of late June and early July.

Relative to historical records, topsoil moisture has been generally well above average to extremely high across the state.

Stock and pastures

Although the cool, wet and cloudy conditions slowed the

rate of pasture growth, it has continued to improve across NSW. Relative to historical records, June and July pasture growth was above average across most of the far west, central west and southern NSW.

Stock condition remains reasonably good. Some supplementary feeding has been carried out due to the cold, wet conditions increasing energy requirements, as well as the currently high moisture content of pastures and dual purpose crops.

Stock health issues have been occurring including grass tetany, pregnancy toxemia, hypocalcaemia, foot scald and bloat.

NSW Department of Primary Industries
July 17, 2016

Northern region

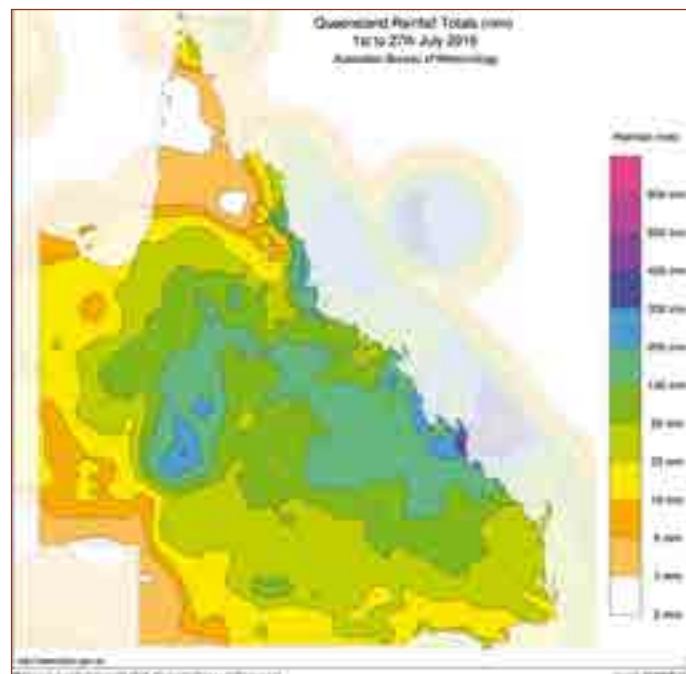


DARLING DOWNS

Weather conditions

The planting rains started in early June for the eastern Darling Downs but it took until late June for enough moisture to accumulate for planting west of Pittsworth. The result is one of the later winter plants for many years. Soil moisture conditions have improved but were not good enough to double crop from summer crops for most areas.

Temperatures have been all over the place ranging from a run of frosts in late June early July, then warm spring temperatures in



the mid 20s, and now in the past few days, we're back to wintery conditions.

Winter crop

Chickpeas are the main crop for this winter, due to the exceptionally high prices on offer (above \$900 per tonne) and the potential for very healthy gross margins. Every grower who can has planted some chickpeas, with the area across the Downs up by 30 per cent on last season's record area.

Growers started deep planting 10 to 12 cm down into moisture from early May, and the last crops of chickpeas were planted in the third week of July – so there are crops yet to emerge and others starting to flower.

The main early season problem has been mouse damage, which has been controlled with baiting. There has also been some pig damage where control has been less successful. Both of these pests have been digging up seed along the row line.

But overall, establishment has been good and the crops are growing well.

There have been small falls of rain and heavy dews over the past four weeks – which are ideal conditions to promote disease in chickpeas. In the past week southern Queensland has seen at least seven confirmed cases of ascochyta blight, mainly in the susceptible varieties. Preventative fungicide spraying is underway, but it is expected that there will be a shortage of fungicide this season.

The cereal area is reduced by 30 per cent – due to the big chickpea area and not enough planting rain to double crop country. There has been a late flurry of oats planted for feed.

Summer prospects

The irrigated area will be reduced this summer due to low water storages and limited pumping opportunities. Many irrigators will be relying on bore water to start the season.

This is likely to reduce the irrigated cotton area, but the strong



Ascochyta was showing up in Downs' chickpeas by early July.

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prices for cotton will ensure a compensatory increase in the dryland area.

There is some interest in spring mungbeans, but most of the mungbeans will be summer planted.

The low price outlook for sorghum will reduce its area this summer, but there is expected to be an increase in the hectares planted to corn.

But last summer's cropping paddocks are a long way from having a full moisture profile. This means growers are looking for more good rain before they finalise their summer planting intentions.

Hugh Reardon-Smith
Agronomist, Landmark Pittsworth
July 25, 2016

CENTRAL QUEENSLAND

Weather

Widespread rain fell across Central Queensland on July 15 following a long, hot, dry summer and autumn. The Central Highlands is wettest with falls of 100 to 180 mm while the Dawson received 80 to 100 mm. The Callide had less with falls ranging from 50 to 80 mm. Coastal areas to the east around Yeppoon and north to Byfield were very wet with 300 to 400 mm recorded.

Summer crop

Sorghum: There was about 80,000 hectares of sorghum planted across CQ this season with only a small area in the Callide, a bigger area in the Dawson with most of the crop planted on the Central Highlands. Much of the Central Highlands crop was planted very late into February. Most of the sorghum crop in southern CQ was harvested by May but a significant area north of Emerald came in later.

Late sorghum (harvested after the end of May) is slow to dry to deliverable moisture levels so grain drying is almost a given for late crops when we occasionally have a wet winter.

The recent week of wet weather will result in seed sprouting in the heads and the remaining crop effectively lost.

Despite the hot, dry weather and occasional patchy storm rain across CQ this summer, the sorghum generally yielded well. While most of the crop yielded from 2.0 to 4.0 tonnes per hectare, yields of 4.0 to 6.0 tonnes were not uncommon in the better paddocks.

Charcoal rot continues to be a major issue especially for Central Highlands growers. This is particularly the case on shallow Downs soil when it's a good crop, and then we cop a dry finish with the biggest and best heads most likely to lodge.

Charcoal rot was not reported in the Callide (very little sorghum) and the Dawson but had an impact on almost all sorghum crops on the Central Highlands. Almost every crop and most varieties suffered some lodging (2 to 5 per cent) with minor lodging in perhaps 50 per cent of crops. But some sorghum crops suffered major losses (over 10 per cent) and in the worst cases – up to 50 per cent lodging.

A small amount of the lodged crops have been recovered using crop lifters.

Mungbeans: Low sorghum prices and high mungbean

District Reports...

July–August 2016

prices encouraged new and old growers to plant large areas of mungbeans this summer. Generally, both spring and the summer crops encountered tough growing conditions in almost all districts.

The largest area of spring mungbeans was planted in the Callide and had a wet start but a dry finish. Generally, the earlier summer crops across all districts fared better than later planted summer crops. About 15,000 hectares of spring and 50,000 hectares of summer mungbeans were planted. Yields varied enormously from fail to better than 2.0 tonnes per hectare.

Cotton: The 2015–16 summer saw about 18,000 hectares of cotton planted on the Emerald Irrigation Area and 3000 hectares on the Dawson. A hot, dry, summer set up high yields for cotton in CQ but for some growers a week's wet weather at defoliation resulted in a down-grade in quality.

Winter crop

Chickpea: High chickpea prices and a dry soil surface resulted in a record area for CQ. About 40,000 hectares south of Emerald (Gindie, Rolleston, Dawson and Callide) and up to 80,000 hectares north of Emerald has been planted to chickpea. Almost all of that was deep planted to 'seek moisture'. Timely rain would have increased the area planted by 30 to 50 per cent.

Rainfall during June of 70 to 130 mm across the Central Highlands and 50–80 mm across the Dawson/Callide has allowed more winter crop to be planted.

I estimate the CQ chickpea plant at about 80,000 hectares south of Emerald (Gindie, Rolleston, Dawson and Callide) and up to 100,000 hectares north of Emerald.

Wheat: A big area of chickpeas combined with a lack of planting rain resulted in a major reduction in the area planted to



Charcoal rot continues to be a major disease issue in CQ sorghum crops especially in those years with potentially high yields but a dry finish. This crop of sorghum in the Gindie district, south of Emerald, had a pre-harvest spray and was within days of being harvested when it was flattened by rain and winds.

wheat. My guess is about 70 to 80,000 hectares of wheat has been planted across CQ, mostly on paddocks that either grew chickpea last year or are in need of groundcover to reduce the risk of erosion.

Weeds

Feather Top Rhodes grass (*Chloris virgata*) continues to be a major weed problem in CQ and a common reason for ploughing. More cases of hard to kill (potentially resistant to glyphosate) sweet summer grass (*Brachiaria eruciformis*) are being reported. Common hard to kill broadleaf weeds include milk thistle (or sowthistle), tridax daisy and fleabane.

Livestock and pastures

Generally, cattle across CQ are in good to excellent condition. Excellent prices are being paid for weaners encouraging some producers to sell earlier or to reduce stock numbers. Selling empty cows is an obvious choice but is not something all managers do.

Maurice Conway

**Department of Agriculture, Fisheries & Forestry
Emerald, Queensland
July 24, 2016**

ANSWER TO IAN'S MYSTERY TRACTOR QUIZ

The tractor is an Oliver 70, manufactured between 1937 and 1948. Many of these were sold in Australia and held in high regard by their owners.

The mystery tractor on page 17 was spotted on a derelict farm about 50 km north of Nome, Alaska.



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