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Taking the local nutrient yardstick to national variety trials

TRIALS at Merredin in Western Australia's eastern grainbelt have demonstrated that fertiliser decisions largely do not affect the relative local performance of different wheat and barley varieties in this low rainfall environment.

Yield and grain quality rankings for wheat and barley varieties grown using local management practices – especially for crop nutrition – were shown to be reasonably consistent with those achieved in adjacent GRDC National Variety Trials (NVT).

The Merredin and Districts Farm Improvement Group (MADFIG) administered the *Yardstick* trials over three years from 2015, with investment from the GRDC and support from the Department of Primary Industries and Regional Development (DPIRD). The trials were established and managed by service providers Kalyx and Living Farm.

This project – identified as a priority by MADFIG and the Kwinana East GRDC Regional Cropping Solutions Network (RCSN) group – was designed to add value to NVT testing by using typical local grower nutrient management practices adjacent to the NVT site.

Independent variety trials

The GRDC NVT program provides access to independent results on the performance of recently released grain and field crop varieties. It is a national program of comparative crop variety

Seasonal variation had more impact on the performance of individual wheat varieties than nutrition strategies in trials at Merredin in WA's eastern grainbelt. (PHOTO: MADFIG)

testing with standardised trial management, data generation, collection and dissemination.

Merredin grower and MADFIG member Andrew Crook said the *Yardstick* trials were initiated after a series of dry seasons highlighted the importance of getting variety choice right and raised questions about whether varieties differed in their responses to fertiliser management.

The GRDC has invested in several *Yardstick* trials in WA, which are being locally managed and run in each of the state's five grain-receival port zones. (PHOTO: MADFIG)

"During this period, some local growers questioned whether NVT results were fully applicable to them given the standard amount of fertiliser used in the NVT trials was higher than rates commonly used by growers in the area," Andrew said.

"But results from three years of the *Yardstick* trials have shown that variety performance rankings, especially for wheat, are reasonably consistent with NVT variety rankings in the area.

"This should give local growers confidence that varieties that perform well within the NVT program should also perform well when grown under their own management systems."

Andrew said the trials also highlighted that seasonal variation had a greater impact on individual variety performance than nutrition strategies.

"This highlights the importance of understanding the key factors that will influence variety performance and how they will perform across seasons," he said.

How the *Yardstick* trials are done

The trials, on medium-to-heavy textured soils, evaluated 10 wheat varieties and five barley varieties in 2015, 12 wheat varieties and five barley varieties in 2016, and 14 wheat varieties and six barley varieties in 2017.

Four nutrition strategies were implemented across the wheat and barley trials to represent various district fertiliser strategies reflective of common seasonal or budgetary scenarios.

Three of the treatments remained the same for the three seasons and a 'play the season' strategy differed depending on rainfall.

Fertiliser strategies included lower rates of phosphorus and generally lower rates of nitrogen than those used in the adjacent NVT trials.

"The results indicate that some fertiliser is equal to, or better than none, for all varieties tested across the seasons," Andrew said. "Recognising favourable seasons and responding with appropriate management is the challenge, as there is a greater opportunity cost from not maximising profit potential in a favourable season.

"Equally, the trial results show the importance of being conservative in a dry season."

MADFIG acknowledge the vital role of Merredin-based DPIRD staff Vanessa Stewart and Jenni Clausen in the delivery of the trials and research outcomes. The support from Jenni was possible due to her involvement in the DPIRD and GRDC project 'Building crop protection and production agronomy research and development capacity in regional WA'.

The GRDC has recently produced a video and podcast about its national NVT program. To view the video, go to http://bit.ly/2zSO5My. To listen to the new GRDC podcast, go to http://bit.ly/2CT2FoC ■

Wild radish resistant to atrazine, super-sensitive to bromoxynil

By Peter Newman

Alexander Graham Bell famously said: "When one door closes another door opens, but we so often look so long and so regretfully upon the closed door, that we do not see the ones which open for us."

ATRAZINE resistant wild radish looks a lot like a door closing, but in many cases, it's also a door opening for bromoxynil.

Some new research by AHRI PhD student, Huan Lu, has shed some light on atrazine resistant wild radish and the results have some very practical applications for growers and agronomists.

The most common target site mutation that causes atrazine resistance in wild radish is the 264 mutation – the same mutation that gave us TT Canola. The only way to kill radish with this mutation is to sit the atrazine drum on top of them! They have very high resistance to atrazine and as it turns out they are super-sensitive to bromoxynil, requiring only about a third of the brom rate that it takes to kill susceptible wild radish. Wild radish with the 264 mutation is also resistant to metribuzin.

Huan Lu also discovered a new target site mutation, the 274 mutation that causes modest levels of resistance to atrazine, metribuzin and diuron but not bromoxynil.

If you are gazing regretfully at atrazine resistant wild radish perhaps spare a thought for the super sensitivity to bromoxynil that may have resulted.

Atrazine resistant radish is easy to kill with bromoxynil

This is big news, and you may have even seen it with your own eyes in the field. Huan Lu found that if you have highly resistant radish with the very common 264 mutation, it's super sensitive to bromoxynil. This phenomenon is also sometimes called negative cross-resistance. Wild radish with the 264 mutation has an LD50 for bromoxynil of only 15 grams per hectare compared to 49 grams per hectare for the susceptible (Table 1).

In other words, it's about three times as easy to kill with bromoxynil. Products such as Jaguar and Velocity that contain bromoxynil get a free kick with triazine resistant radish.

Wild radish with the less common 274 mutation was not resistant to bromoxynil.

How does it work?

Atrazine binds to the D1 protein by hydrogen bonds. When the 264 mutation is present, atrazine can't form these H-bonds and high-level resistance results. Bromoxynil is the complete opposite. When the 264 mutation is present, bromoxynil forms an extra H-bond to the D1 protein resulting in super-sensitivity to bromoxynil. The D1 protein is an integral part of the electron transfer in photosynthesis.

TABLE 1: LD50 of a susceptible wild radish population at two to three leaf compared to wild radish with either the 264-Gly or 274-Val mutation

Herbicide	LD50 (g/ha)		
	Susceptible	264 mutation	274 mutation
Atrazine	6	>4000	207
Metribuzin	15		57
Diuron	59		345
Bromoxynil	49	15	44

LD50 = lethal dose in gai per hectare to kill 50 per cent of the population.

The 274 mutation

This research discovered the first evidence of the 274 mutation in wild radish. This mutation causes modest levels of resistance to atrazine, metribuzin and diuron as can be seen in Table 1 and the dose-response curves in Figure 1.

In Australia, the triazines (eg. atrazine), the triazinones (eg. metribuzin), the ureas (eg. diuron) and the nitriles (eg. bromoxynil) are all group C herbicides. They all target photosynthesis, more specifically the electron transfer in PSII, but at slightly different binding sites – so we can't treat them all the same. There are seven known target site mutations that cause resistance to this group of herbicide.

Dose-response

The dose-response curves In Figure 1 illustrate the difference in resistance patterns between the different mutations. It's

Atrazine resistant wild radish may just be super sensitive to bromoxynil. (PHOTO: Danica Goggin) interesting to see how highly resistant the 264 population is to atrazine in chart (a), yet the opposite is true for bromoxynil in chart (d).

Metribuzin and the 264 mutation

You'll notice in the dose-response curves that Huan Lu didn't do a dose-response for metribuzin for the 264 population. Other research has confirmed that the common 264 mutation also causes metribuzin resistance, but not the very high-level resistance that we see with atrazine with this mutation. This may explain why some farmers and agronomists have seen that they still get some useful control from metribuzin on wild radish in lupins where they know they have atrazine resistant wild radish.

70 per cent market share – the back story

The northern wheatbelt of Western Australia represents Australia's highest level of adoption of glyphosate-tolerant canola with an approximate 70 per cent market share. Why? Triazine-resistant wild radish. This region is famous for the very long lupin-wheat rotation that some farmers have now operated for 40 years or so. This rotation is heavily reliant on simazine, and it's likely that this long period of simazine use resulted in the widespread evolution of triazine resistant wild radish in the region. The only way to profitably grow canola in this region for many grain growers, is to use the glyphosate-tolerant technology to enable successful wild radish control.

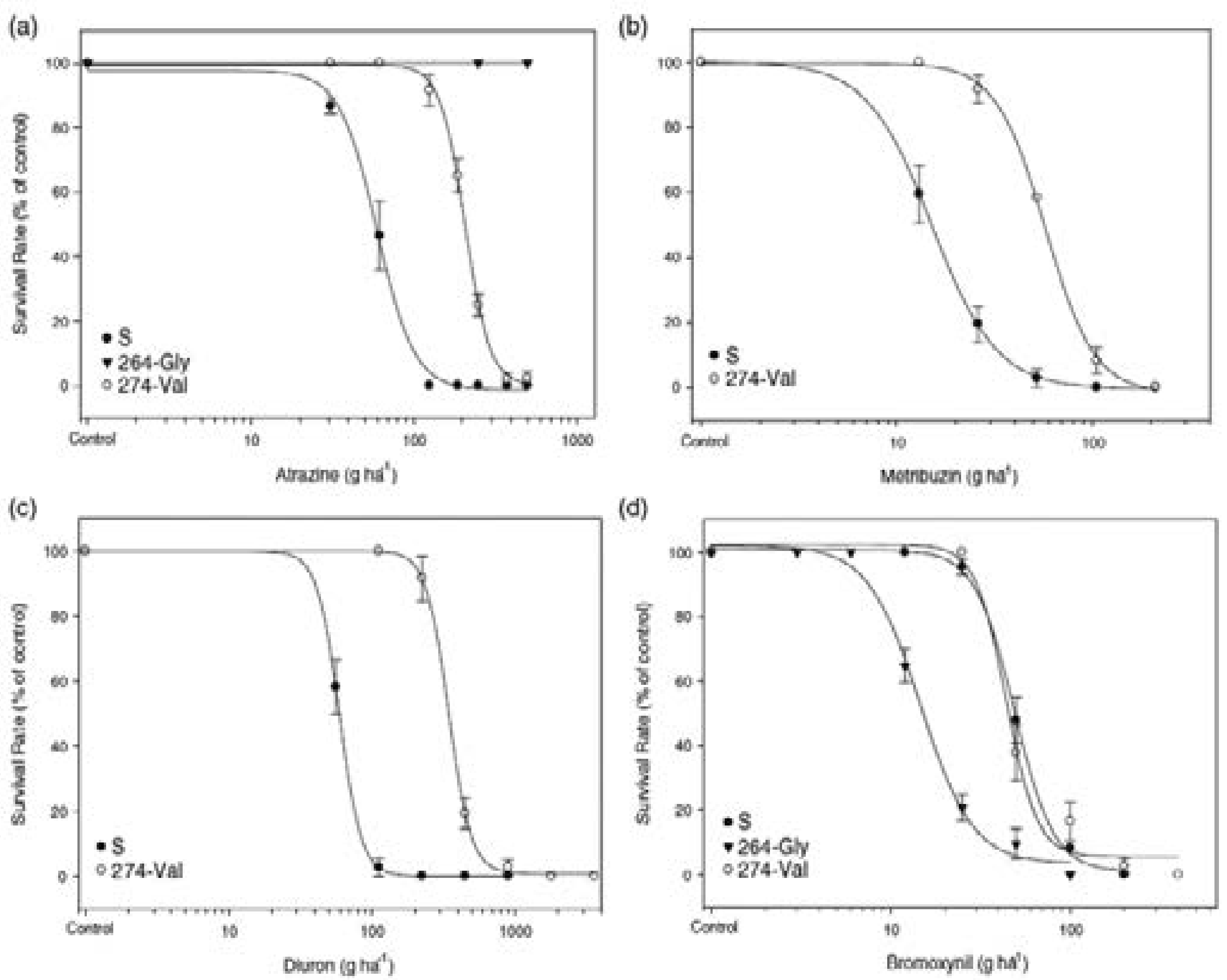
Breeding of TT canola

An interesting side note to this research is the story of how triazine tolerant (TT) canola was bred. A breeding program in Canada crossed a brassica weed with the 264 mutation with canola to produce TT canola. We know that this causes a 30 per cent 'fitness' penalty in canola and it is likely that the same will occur in wild radish. But given that wild radish is already exceptionally fit, we may not notice it in the field.

To sum up

At times it can be hard to see where all of this molecular biology research is headed, but this work can also give us great insight and help us understand what we are seeing in the field. This deep understanding of herbicide resistance mechanisms can have very practical applications and go a long way to helping us make good weed control decisions. ■

FIGURE 1: Dose-response curves based on survival rate for the S (●), 264=Gly (▼) and 274-Val (○) populations to selected PSII herbicides at 21 days after treatment



Data are means ± standard error (n=3). (a) atrazine, (b) metribuzin, (c) diuron and (d) bromoxynil.

Are grain crop burn-offs a cereal offence against the wine industry?

By Andrew Spence

AT A GLANCE…

A new smoke taint project in South Australia will study the impact of stubble burning by grain growers on wine grapes during harvest.

SEVERAL previous research projects have studied the impact on wine flavours of smoke from major bushfires and controlled public forest burns, but there is little analysis as to whether low intensity stubble fires have any lasting impact.

South Australian wine producing regions including the Barossa and Clare Valley, are adjacent to large swathes of grain-growing belts, which traditionally conduct any burn-offs during autumn.

Stubble burning is sometimes carried out to wipe out weeds, seeds and snails after harvest and before sowing.

But the timing sometimes coincides with wine vintage prompting the research by the University of Adelaide with the assistance of the Australian Wine Research Institute (AWRI).

AWRI Business Development Manager Dr Mark Krstic said the research would reveal more information about the ideal conditions for stubble burning to minimise any unintended risks of damage to grape and wine production.

Smoke taint research

"From our previous research on smoke taint, we know there are certain factors at play like smoke drift distance, type of smoke, time of day for burning, seasonal conditions, and wind speed," he said.

"We hope to be able to refine this through further research and give both the wine and grains industries enough information to make sound decisions when they are considering the needs of their own business, as well as their neighbours."

The Adelaide-based AWRI is a world leader in the field of wine smoke taint and was called in to help Tasmanian grape growers deal with the issue after major bushfires ravaged the state in January and February this year.

Trials over coming months will investigate the sensitivity of wine grapes to smoke from stubble burning.
(PHOTO: Barossa Grape & Wine Association)

South Australia produces about 50 per cent of Australia's wine and 75 per cent of the nation's premium wine each year, prompting the state government to provide $60,000 in funding to support the stubble burning research.

The state's Primary Industries and Regional Development Minister Tim Whetstone said although stubble burning was not as prevalent as it once was, it remained an important tool in the grain production cycle ahead of the planting of winter crops.

"The grains and wine sectors are two primary industry super powers in South Australia and it is important they are each able to co-exist without detriment to the other," said Tim.

The research will involve a series of field and winemaking trials in the coming months to discover the sensitivity of grapes to smoke from low intensity crop stubble burns. It will also seek to determine the exact point when smoke loses its potency to wine grapes. ■

Diverse crop rotation gives better long-term yield and protein

RESULTS from a trial in Western Australia's central grainbelt suggest the highest sustainable wheat crop yields and grain protein levels will be achieved from employing a diverse crop rotation – comprising wheat, a legume and canola – when compared with other rotations tested at the site.

The trial also produced the interesting result that retaining residue in a continuous cereal rotation significantly increased grain protein levels over the long term.

CSIRO researcher Phil Ward has worked on a long-term trial investigating the impacts of rotation diversity and residue handling on wheat yield and protein content.

"Factors influencing protein levels in wheat are an area of high importance and interest to grain growers," Phil says.

The trial has been conducted with GRDC investment on red loamy soil at Cunderdin (WA), where a long-term rotation trial was first established in 2007. The research has involved collaboration between the WA No-Tillage Farmers Association, The University of WA and CSIRO.

It has compared four rotations:

- Continuous wheat;
- Continuous cereal (wheat, wheat, barley);
- District practice (wheat, wheat, legume, and wheat, wheat, fallow); and,
- Diverse (wheat, legume, canola).

Growers and industry representatives being updated on a trial at Cunderdin investigating the impacts of rotation diversity and residue handling on wheat yield and protein content. (PHOTO: CSIRO)

What we found

Starting with the 2010 harvest, sub-plot treatments were established, comprising areas where residue was retained and spread behind the harvester, or windrowed and burned before sowing the next crop.

Nitrogen (N) was applied to each crop in response to seasonal conditions and expected N requirements. No extra N was applied to legumes or fallows.

Phil said differences between wheat yields in the various rotations were initially small for the first few years of the trial.

"But over the long-term, the diverse rotation – in which the frequency of cereal crops was 33 per cent – increased wheat yields by about 0.2 tonnes per hectare and wheat grain protein content by 0.9 to 1.6 per cent, when compared with continuous cereal or continuous wheat rotations," he said.

"Preliminary estimates suggest that these benefits are sustainable.

"While the causes of the yield and protein benefits are associated with including grain legumes in the rotation, there may be other benefits to do with soil nitrogen cycling that have not yet been quantified."

Phil said the district practice rotation – in which the frequency of cereal crops was 67 per cent – also resulted in higher grain yields (by about 0.4 tonnes per hectare) and higher grain protein levels (by 1.2 to 1.9 per cent) when compared with continuous cereal or continuous wheat rotations. But he said the sustainability of these benefits was yet to be determined.

"Without adequate replacement of soil nitrogen reserves in the district practice rotation, the high yields and protein benefits in this rotation might not last for much longer," he said.

Crop residue management

Phil said there was no consistent effect of residue management on crop yield.

"But retaining residue in the continuous cereal treatment significantly increased grain protein levels – from 11.2 per cent to 11.8 per cent from 2011 to 2017," Phil said.

"There was no significant effect of residue retention on average wheat grain protein in the diverse rotation.

"The retention of cereal stubble, with a generally low N content, was previously thought to tie up soil N, and was expected to lead to a decline in wheat grain protein.

"So the increase in grain protein with residue retention in the continuous cereal rotation was an interesting result."

This research was presented at the GRDC Grains Research Update in Perth in late February, 2019. ■