

Newsletter of :
 "GRDC Project UA00124 –
 Understanding and management
 of resistance to Group M, Group L
 and Group I herbicides.



IT HAS BEEN A BUSY TIME...

It has been a busy time on the herbicide resistance front since the last edition.

In a move some in the industry have been comparing with St Patrick's expulsion of snakes from Ireland, Chris Preston headed across the ditch in spring to give our Kiwi friends the benefit of his experience in glyphosate resistance management. Closely following in December 2012, our New Zealand colleagues confirmed their first case of glyphosate resistance. They are starting with Italian ryegrass from a vineyard. They have also formed a body similar to the Australian Glyphosate Sustainability Working Group, with an easier working title of the "Avoiding Resistance project" (ARP). Like AGSWG, ARP will bring together representatives from a range of agricultural and horticultural industries, chemical companies and regional authorities to highlight the problem of herbicide resistance and

ryegrass that showed they had not only run out of Group A chemistry, they had lost most of the Group Bs, there is a small amount of trifluralin resistance and have glyphosate resistance as well. The wild radish samples showed high levels of Group B resistance, some Group F resistance plus some 2,4-D resistance to boot. This makes them highly competitive with farmers around Wongan Hills and Geraldton.

February saw the Global Herbicide Resistance Symposium held at Fremantle, Western Australia. Steve Powles and his team managed to cajole some high level players in the herbicide resistance field to visit the world's most isolated city and share their vast knowledge with the participants. One topic that caught peoples' attention was the announcement by Monsanto that they were pursuing gene-silencing technology (RNA interference – to be called BioDirect™)

broadacre fields. Many growers are still taking the "It won't happen to me!" approach, much to the frustration of their advisers.

Our northern NSW and Queensland colleagues have been flat-out since the last edition with the greatest concentration of glyphosate resistant weed species in Australia. In this edition Tony Cook summarises two case studies on growers battling with glyphosate resistance on their farms as well as updating results on the barnyard grass survey.

Our team members this edition are Dr Sally Peltzer, DAFWA, Albany and John Stuchbery, JSA Independent, Donald, Victoria. Sally's role in this project is the not inconsiderable task of keeping two groups of consultants on the herbicide resistance straight and narrow while John takes up a similar role managing the Victorian consultants' group.

Remember: If you are not looking, you won't see

"If it looks like a duck, and quacks like a duck, we have at least to consider the possibility that we have a small aquatic bird of the family Anatidae on our hands." Douglas Adams 1952-2001



IMAGINE LIFE WITHOUT IT

formulate and disseminate national and also sector-specific strategies for avoidance.

Just to show the Kiwis they have some ground to make up, The Stirlings-to-Coast farmer group in southern Western Australia conducted a survey of annual

in the fight against glyphosate resistant weeds. The USA now has millions of hectares infested by thirteen different glyphosate resistant species.

Our colleagues in the Victorian Mallee are upping the ante with glyphosate resistant ryegrass showing up in

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RNA INTERFERENCE TECHNOLOGY (RNAi) – WILL IT HELP SAVE AND SUSTAIN GLYPHOSATE AND OTHER HERBICIDES?

The massive explosion in glyphosate resistant weeds, especially in US cropping, was a major focus of the recent Global Herbicide Resistance Challenge Conference held in Fremantle, Western Australia in February 2013. Researchers and practitioners from around the world are really worried about the loss of glyphosate to resistance.

However, on a more positive note, at the conference and in recent months the Monsanto Corporation has made public some limited but alluring results on the potential for interference RNA (RNAi) to improve the efficacy of glyphosate on glyphosate resistant weeds and, potentially, other herbicides. Monsanto have utilised precise RNA segments directly able to bind and inhibit normal DNA replication of the EPSPS (glyphosate target) gene in plants. EPSPS is the enzyme that glyphosate inhibits. Thus, RNAi technology (branded BioDirect™ by Monsanto) is potentially a genetic way of enabling herbicides to kill resistant weeds.



Figure 2. Glyphosate resistant palmer amaranth in RR cotton following three applications of glyphosate. Photo Chris Preston

Particularly interesting and important is that under experimental conditions it appears that RNAi can be sprayed in the normal way along with a herbicide and the RNA readily enters the leaf.

It is possible to specifically target the RNA to a resistant weed, in some cases, without damage to a crop.

Will it happen?

The potential for RNAi technology was a subject of considerable hallway conversation at the Global Herbicide Resistance Challenge Conference. Whether or not RNAi technology as a herbicide promoter will come to commercial fruition is very difficult to know at this time. Some experts at the conference believe that RNAi technology will be introduced whereas others are much more circumspect. Although there is little hard data available it stands to reason Monsanto would only make public comment if they are confident of success. If RNAi technology comes to commercial fruition it will be another tool we can use to battle weeds and resistance. Current effort with RNAi technology by Monsanto is aimed at Palmer amaranth (*Amaranthus palmeri*), which is currently threatening the viability of glyphosate resistant crops in the southern United States of America.

Commercialisation of RNAi technology will be years away and if commercialised for weed and resistance control it will not be as good as glyphosate.

Thus, I am reminded of an expression my Mum often used - "a bird in the hand is worth two in the bush". We have glyphosate now and given the absence of new herbicides do everything you can to help preserve glyphosate. Keep glyphosate sustainable through diversity is my mantra!

Go to the AGSWG website, WeedSmart website and AHRI website for further information on helping to manage glyphosate resistance.

Stephen Powles, Director, Australian Herbicide Resistance Initiative.

Definition: mRNA (noun)

Abbreviated form for messenger ribonucleic acid, the type of RNA that codes for the chemical blueprint for a protein (during protein synthesis).

<http://www.biology-online.org/dictionary/Mrna>

How will RNA interference technology be used in controlling herbicide resistance?

- Small double-stranded (DS) RNAs are developed specifically for a type of resistance within a specific weed species i.e. 'designer-RNA'
- These specific double-stranded RNAs are mixed with glyphosate (for glyphosate resistance) and sprayed onto the weeds.
- The RNA is absorbed through the leaf with the herbicide and enters the plant cells.
- The double-strand RNA separates and binds to the specific messenger RNA (mRNA) that helps make the specific protein.
- The mRNA is destroyed stopping the production of that protein – in this case the EPSPS enzyme. This allows the herbicide to function as it should leading to plant death.

More information on RNA interference technology



Figure 1. Heavy infestation of glyphosate resistant Palmer amaranth in soybeans, southern USA. Photo Chris Preston.

DOES SOUTHERN WA NOW RIVAL THE NORTH FOR HERBICIDE RESISTANCE?

Figure 3. Wild radish regrowth following application of 2,4-D. Photo James Bee, Nufarm



Glyphosate resistant rye grass and 2,4-D resistant wild radish were found during the "Herbicide Resistance Status in the Stirlings-to-Coast Farmers' Area" project sampled in November 2011. These worrying results indicate that integrated weed management needs to be rapidly adopted in southern Western Australia cropping systems to manage herbicide resistance, putting the area 'up there' with Western Australia's northern cropping belt. This fact has surprised southern farmers and agronomists alike.

Weed samples were submitted from eighteen properties from the Stirlings-to-Coast Farmers grower group consisting of 46 ryegrass samples and 16 wild radish samples from a range of paddocks, some with concerning weed levels, others just monitored for status.

Testing found one third of all ryegrass samples showing developing resistance to glyphosate with three samples having more than 20 per cent survival. Of additional concern was that all ryegrass samples were resistant to most grass-selective (Group A) herbicides including clethodim.

Four in five ryegrass samples were also highly resistant to all Group B herbicides.

One wild radish sample was highly resistant to 2,4-D with two samples from different properties showing low resistance.

One third of the 16 radish samples (from four properties) showed high levels of resistance to all group B herbicides including Intervix®.

Almost twenty percent of ryegrass samples had low resistance levels to trifluralin.

A quarter of all radish samples (three different properties) showed low levels of resistance to diflufenican.

Better news for farmers is that all radish samples were fully susceptible to Velocity®, bromoxynil, atrazine, glyphosate and Spray Seed®. Importantly, resistance has been identified on a paddock-by-paddock basis enabling planning and better weed management in the future.

Interestingly there was no relationship between growers' perceptions of their resistance status and the test results. After testing however, growers now have the knowledge to develop effective management strategies specific to each paddock and each property as a whole. This reinforces the need for integrated weed management plans to be incorporated into southern cropping systems, now rather than later.

The results have generated a high level of interest in resistance management in the area between Frankland and Wellstead, as well as the wider industry. Ideas will continue to be shared about weed management in this south coast environment where climate and fragile soils restrict the use of some tactics used in other areas such as whole paddock burning, autumn tickle and seed collection at harvest which can reduce harvesting efficiency in this humid area with limited daily harvest hours.

Jeremy Lemon, Senior Development Officer, DAFWA, Albany

Figure 4. Inspection of Nufarm 2,4-D resistance trial, southern WA. Photo A. Storrie



"IT WON'T HAPPEN TO ME!" GLYPHOSATE RESISTANCE IN THE MALLEE

Wimmera and Mallee

Glyphosate resistance is becoming a serious problem in the Victorian Wimmera and Mallee with 17 cases of annual ryegrass confirmed to date (Not just there. Ed.) as well as the second case of glyphosate resistant great brome grass. Glyphosate resistance is real!

In the past farmers were lulled into a false sense of security as there were always several more obvious causes for glyphosate spray failure with resistance being well down the list of suspects. However times have changed:

- We are now using higher rates of glyphosate so failure due to sub-lethal rates is less common.
- We are now using better spray application techniques and technology so failures due to poor application are also less common.
- We are now better educated on optimum weather conditions so failure due to poor conditions are less common.



Figure 5. If you have noticed ryegrass escapes like this immediate action is needed. Photo M. Bissett, AgriVision

We used to think that glyphosate resistant ryegrass will only be a major issue along fencelines, roadsides and in tree or vine crops. These areas are a good place to start looking for glyphosate resistant weeds but it is now being found in broadacre cropping paddocks in the Wimmera and Mallee.

Minimising the threat of glyphosate resistance

Using good crop agronomy is the starting point but weed bank management integrating herbicide and non-herbicide tactics is essential. Stopping the seed set of herbicide survivors is the key to any weed management plan.

Growers serious about glyphosate resistance will hand-pull spray survivors at every opportunity during the early stages of the infestation when there are a few scattered plants present.



Figure 6. Look for ryegrass growing among dead plants just like these in Mallee paddocks. Photo M. Bissett, AgriVision

Also paraquat is currently cheaper per litre than glyphosate so it needs to be used strategically in spray programs. It can be used following glyphosate as a double-knock (within 10 days of first herbicide) or used by itself. Rates need to be kept above 1.5 L/ha and applied to optimise droplet coverage.

Don't forget we already have our first cases of paraquat resistant annual ryegrass in South Australia.

Alternative herbicide options along fence lines and non-crop areas also need to be introduced.

"There are two types of landowners - those who know they have resistance and those who don't know they have resistance."

Glyphosate is the world's most important herbicide.

Imagine life without it.

Kent Wooding, AgriVision Consultants, Swan Hill, Victoria



Figure 7. Author Kent Wooding, AgriVision, Swan Hill

The first New Zealand case of glyphosate resistance has been confirmed in Italian ryegrass (*Lolium multiflorum*) in a Marlborough vineyard in December 2012.

The Avoiding Glyphosate Resistance team (the Kiwi version of the AGSWG), say glyphosate is the most frequently used herbicide in New Zealand and although there have been some anecdotal reports of resistance, this is the first confirmed occurrence. They say the resistance finding should provide a wake-up call for all users of the broad spectrum weed killer.

It is a warning to users of glyphosate that they need to be aware of the danger of resistance developing and be careful how they use it.

The Marlborough case was identified following a report from a chemical company in the autumn of 2011 that glyphosate was not killing all the weeds, specifically some grasses, on a vineyard in Marlborough. Surviving plants were grown to seed in a glasshouse in autumn 2012. The seed was then grown in the spring of 2012, and the plants treated with various rates of glyphosate. Nearly half the tested plants showed greater than 4 fold glyphosate resistance. The resistance testing was carried out by Dr Kerry Harrington and his PhD student Hossein Ghanizadeh at Massey University.

Sector-specific strategies on avoiding resistance will be developed as part of the Avoiding Glyphosate Resistance project. Anyone who is aware of weed populations surviving glyphosate treatment should contact the group as soon as possible, so that testing and follow-up action can be taken.



Figure 8. Trevor James, Hossein Ghanizadeh and Kerry Harrington outside the glasshouse where the resistance testing was conducted.

The SFF Avoiding Glyphosate Resistance Project

The Ministry for Primary Industries Sustainable Farming Fund Avoiding Glyphosate Resistance Project is bringing together representatives from a range of agricultural and horticultural industries, chemical companies and regional authorities to highlight the problem and formulate and disseminate national and also sector-specific strategies for avoidance. It is led by Mike Parker of the Foundation for Arable Research.

The co-funders for the project include Foundation for Arable Research, DairyNZ, Vegetables Research and Innovation Board, Road Controlling Authority Forum NZ Inc., BASF, and Nufarm. In-kind assistance also comes from Waikato Regional Council.

Trevor James, AgResearch NZ

TEAM MEMBER PROFILE

GET TO KNOW THE TEAM...

Sally Peltzer

Sally Peltzer is a Senior Research Officer (Weeds Group) with DAFWA based at Albany.

Within the GRDC's glyphosate resistance project, she coordinates two WA Advisor Groups, one in the northern agricultural cropping region between Perth and Geraldton and the other around Esperance on the eastern south coast. These groups decide on research and extension questions relevant to their area – see Giving a RATS issues 2 and 3.

One of Sally's other jobs is to promote the GRDC-funded Weed Seed Wizard (UWA00125). This is a national site-specific (weather, soil type and management) computer simulation tool where different weed management scenarios can be explored side by side helping consultants and farmers decide where a new practice fits into their specific system and location.

She is married to Andrew Storrie. When she and Andrew are not discussing weeds (woo-hoo. Ed), she likes to read crime thrillers, solve cryptic crosswords and try new recipes. She also devotes much of her spare time spoiling Henry (their dog) rotten.



John Stuchbery

John Stuchbery profile

John is a senior consultant and the manager at JSA Independent, a private consulting firm based at Donald in western Victoria. John has been providing technical and management advice to farmers in the Wimmera,



southern Mallee and Western District of Victoria since 1993 and has collaborated on research projects with farmer-based research groups and undertaken several GRDC funded projects.

John grew up on the family grazing and cropping property in the upper south east of South Australia. He has previously worked on the family farm, in research roles with the Departments of Agriculture in South Australia and Victoria and for the Australian Wheat Board in Port Lincoln, South Australia.

John's role in this project is to coordinate the Victorian-based Advisor Learning Group. This group includes 26 leading advisors from across the grain producing regions of Victoria who meet twice yearly to share experiences and to discuss the latest research in weed management.

John and wife Carol have four children. All of their children have attended or are attending school in Donald. Their oldest daughter is in Adelaide studying to be a physiotherapist.

Who is in the team? [READ MORE](#) to see who's in our team.

NORTHERN REGION UPDATE: SURVEYS, CASE STUDIES AND RESEARCH

Since the last edition of Giving at RATS, the northern region team has successfully completed two case study interviews; one on glyphosate resistant annual ryegrass (GR ARG) on the Liverpool Plains and another on glyphosate resistant windmill grass near Narromine. The second season of the glyphosate resistant barnyard grass survey has also started with some interim results available. Finally, two GR annual ryegrass trials near Coonamble and four GR barnyard grass experiments near Moree are complete and summarised findings will be discussed in a future edition of RATS.

CASE STUDIES

Glyphosate resistant annual ryegrass on the Liverpool Plains.

Glyphosate resistance was confirmed in 1999. At that time it existed as large clumps of up to one hectare in many paddocks. Today, annual ryegrass is present at low densities of a few plants per hectare). Between the time of confirmation

seed set or to prevent early season emergence prior to winter crop sowing.

- Changing the reliance on sorghum / winter fallow rotations.
- Sowing a range of winter crops where many modes-of-action can be used
- Using high levels of crop competition along with effective pre- and early-post-emergent herbicides. For example, feed wheats that yield from 4 to 6t/ha.
- Employing WeedSeeker® technology to control sparse infestations of ARG in fallow.
- Maintaining weed-free fence lines and farm tracks.

This case study exemplifies many aspects of integrated weed management. Although no harvest seed management tactics for ARG were used, weed numbers have been kept low.

Northern NSW is still fortunate that many populations of ARG can be controlled with herbicide groups A, B, C, D, K and L,



Figure 9. An irrigation channel near Narromine showing variable control from glyphosate on barnyard grass. Keeping irrigation channels clean is paramount as seed will be spread by water movement. Photo Tony Cook.

and today many strategies were undertaken to manage the weed. Special mention needs to be made of the summer/winter cropping options available and the effectiveness of the other mode-of-action herbicides. This contrasts to situations in the southern and western grain growing regions.

In summary this case study used to following tactics in 14 years:

- Changing from glyphosate to paraquat and clethodim in fallows.
- Using strategic cultivation on large plants to prevent

despite the loss of glyphosate. The Liverpool Plains climate and geography allows dynamic crop rotations and therefore excellent crop choice.

Eradication of ARG is close in some paddocks but is unlikely to be achieved in the medium to long term as floods transport new seed from surrounding areas. A recent RIRDC funded project has confirmed that GR ARG exists in waterways, roadsides and fence lines in the district. Nonetheless, this grower has consistently kept GR ARG numbers extremely low whilst maintaining excellent profitability.

NORTHERN REGION UPDATE: SURVEYS, CASE STUDIES AND RESEARCH

Glyphosate resistant windmill grass near Narromine.

Four years ago a Narromine, NSW, farmer had a population of windmill grass confirmed as glyphosate resistant. Winter cropping is the main activity on the farm although irrigated cotton is also grown. Management strategies used to manage windmill grass are less diverse than that of a GR ARG on the Liverpool Plains due to the lack of alternative enterprise options available.



Figure 10. Glyphosate resistant windmill grass is a big threat to Roundup Flex® Cotton production. Inter-row cultivation is often required to control this weed. Photo Tony Cook.

In summary this farmer used the following tactics in the past 4 years:

- ➔ Being prepared to cultivate in fallows when conditions were not suited to effective herbicide use.
- ➔ Using the double knock tactic at the correct timing. See APVMA Permit 13460
- ➔ Using inter-row cultivation in cotton.
- ➔ Growing early sown green manure pulse crops so that greatest bulk is produced prior to windmill grass seed set.
- ➔ Irrigation channels were spot treated (mainly hand weeded) to control windmill grass and fleabane.

The farmer is currently satisfied with the level of control these options provide, though he knows control is dependent on the season and would like to have a better range of options available.

Update on interim results from the GR barnyard grass survey.

The successful 2011/12 glyphosate resistance survey was repeated in the 2012/13 season. It was decided to widen the survey as the first focused on part of the northern grain region between Narrabri and Goondiwindi. Over 90 samples were received and approximately two thirds of these were sprayed and assessed for resistance.

Table 1. The table below summaries the 'hot off the press' findings

	Resistant	Marginal resistance	Susceptible	Total
Number of samples	20	4	36	60

One third of samples received were classified resistant. Most of these resistant biotypes were from the heartland of glyphosate resistant barnyard grass between Dalby and Narrabri. However isolated populations were confirmed resistant from Gattton, Wellington, Gunnedah and Warren. Low summer rainfall in the central west region of NSW limited the number of samples from that region, an area specifically targeted for this season.

Tony Cook, NSW DPI

RIDDING NZ OF GLYPHOSATE RESISTANCE

In September 2012, Dr Chris Preston was invited to Hamilton, NZ to speak at a workshop on Avoiding Glyphosate Resistance. This workshop was part of a Ministry for Primary Industries Sustainable Farming Fund Project. Attending were representatives of various industries and Government agencies who use glyphosate for weed control, as well as the chemical industry and regulatory agencies.

The aim of the workshop was to:

- Raise awareness and understanding of glyphosate resistance
- Outline the current practices and situations in detail
- Identify any potential risks and threats
- Identify specific actions that could help prevent and manage glyphosate resistance.

The workshop identified several areas of potential risk for glyphosate resistance. These were tree and vine crops, areas around broadacre crops and pastures and roadsides. Tree and vine crops are treated with glyphosate between 3 and 5 times per year. Driveways, load out areas and shelter belts will typically get an additional application. Few other herbicides are used. In broadacre cropping, the areas most intensively treated with glyphosate alone are headlands, fence lines, around sheds, driveways and drains. In pastures, the main risks are around raceways, effluent ponds, drains, building surrounds and on riparian margins. Roadsides are mown and treated with glyphosate; however, there is no data on how often roadsides are sprayed.

Recommendations arising from the workshop were to:

- Increase awareness of the potential for glyphosate resistance among users, particularly around high risk areas.
- Conduct surveys and testing to determine whether glyphosate resistance is already present in high risk areas.
- Conduct research on alternative chemicals and practices for glyphosate in high risk areas.
- Conduct modelling of economic scenarios for current practice, avoiding resistance and managing resistance to alert users to the costs of managing glyphosate resistance.
- Create a strategy for extension and education of users of glyphosate.



Figure 11. Dr Chris Preston discussing glyphosate resistance management with our New Zealand colleagues.

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