giving a RATS

Newsletter of :

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

What's in a name??

Resistance – what types of resistance do you have? Have you tested to determine what MOA's still work? We will cover the latest research and extension developments on resistance to glyphosate, paraquat and 2,4-D.

Application – are you getting a lethal dose of herbicide to the intended target?

We need to discuss issues affecting herbicide effectiveness such as the boom set up, meteorological conditions and the use of robust rates of herbicide.

Tactics – We just can't rely on herbicides, so what non-herbicide tactics are you using? This is where integrated weed management really comes in. Is there anything new that might be useful in your situation you haven't tried yet?

Systems – Every grower has different skills, knowledge, attitudes and aspirations so every farm system will be different – there are no prescriptive solutions. We will have interviews with 'Farm Adviser Learning Groups' and growers to see how they are dealing with these tough problems.

The fight continues

Welcome to the second edition of "Giving a RATS" which aims to keep you at the cutting edge of developments in resistance to glyphosate (M), paraquat (L) and 2,4-D (I).

In this edition we have a mix of articles looking at potential resistance threats in both cropping and non-agricultural areas, reports on some workshops where new solutions to problem weeds are being discussed, some good news from a big resistance survey in Western Australia and a plea for weeds samples for free testing!! What more could want?

INDEX FOR THIS ISSUE

Who is in the team?

In each edition we will have more specific information on two team members.

Dr. Christopher Preston,
Associate Professor, University of Adelaide and Project Leader;

Dr. Jenna Malone,
Postdoctoral fellow, University of Adelaide;

Mr Tony Cook,
Technical Specialist Weeds NSW DPI Tamworth;

Mr Tim Burley,
District Agronomist NSW DPI, Moree;

Mr Russel Carty,
Technical assistant NSW DPI, Moree;

Dr. Steve Walker,
Principal Research Fellow, University of Queensland;

Dr. David Thornby,
Research Scientist QLD DAFF, Toowoomba;

Prof Stephen Powles,
UWA, Perth;

Myrtille Lacoste,
Research Scientist, UWA, Perth;

Dr. Sally Peltzer,
Research and Communications Officer, Department of Agriculture and Food, WA, Albany;

Dr. Abul Hashem,
Senior Research Officer, Department of Agriculture and Food, WA, Northam;

John Stuchbery,
JSA Independent Consulting, Donald, Victoria and

Andrew Storrie,
AGRONOMO and Adjunct Research Fellow, UWA, Albany Western Australia.

It's important to remember that there is no relationship between resistance risk and weediness, invasiveness, or ease of control.

WEEDS TO WATCH OUT FOR!: 200 AUSTRALIAN WEEDS AND THEIR RISK OF EVOLVING HERBICIDE RESISTANCE.

David Thornby, Jeff Werth, and Joe Vitelli
Queensland Department of Agriculture, Fisheries and Forestry

Two recent projects on weed risk to developing herbicide resistance have found 23 species (12%) scored in the high risk range (a score of six or more) and included several important grasses as well as damaging environmental weeds like fireweed and parthenium weed (Table 1). Two hundred weeds were analysed to determine their innate likelihood to evolve and change in response to continued selection by herbicides. While the weeds tested are prevalent in Queensland and northern NSW, many are also more widely distributed around Australia.

Luckily almost half of all species assessed are at low risk of resistance (scoring less than three), and the remainder at moderate risk. Despite being at low risk of resistance, some low-scoring species are nevertheless important and highly prevalent weeds, both of cropping (e.g. nutgrass (*Cyperus rotundus*), bladder ketmia (*Hibiscus spp.*)) and non-cropping areas (eg salvinia (*Salvinia molesta*), alligator weed (*Alternanthera philoxeroides*)).

Table.1 Weeds at high risk of herbicide resistance.

Common Name	Botanical name	Score (out of 10)
Needle Burr	*Amaranthus spinosus*	8.1
Sweet summer grass	*Brachiaria eruciformis*	8.1
Flaxleaf fleabane	*Conyza bonariensis*	7.6
Silver grass	*Vulpia spp*	7.6
Liverseed grass	*Urochloa panicoides*	7.2
Cumbungi	*Typha spp*	7.0
Feathertop Rhodes grass	*Chloris virgata*	7.0
Arrowhead	*Sagittaria montevidensis*	6.9
Awnless Barnyard grass	*Echinochloa colona*	6.9
Barnyard grass	*Echinochloa crus-galli*	6.9
Cobbler's pegs	*Bidens pilosa*	6.9
Common sowthistle	*Sonchus oleraceus*	6.9
Milkweed	*Euphorbia heterophylla*	6.9
Parthenium weed	*Parthenium hysterophorus*	6.9
Thickhead weed	*Crassocephalum crepidioides*	6.5
Barley grass	*Hordeum leporinum*	6.3
Crowsfoot grass	*Eleusine indica*	6.3
Large crab grass	*Digitaria sanguinalis*	6.3
Northern barley grass	*Hordeum glaucum*	6.3
Paradoxa grass	*Phalaris paradoxa*	6.3
Annual ryegrass	*Lolium rigidum*	6.1
Fireweed	*Senecio madagascarensis*	6.1
Serrated tussock	*Nasella trichotoma*	6.1

Number one contender – Spiny amaranth. Photo: DAFWA

What does it mean for weed managers?

Weed managers, regardless of industry or organisation, have a toolkit of weed management tactics available to them for each species. Where a species is at high risk, it is vital not to rely on a single herbicide. Most weed managers have multiple problems competing for scarce resources – labour, time, money and attention – and risk assessments can be used by managers to help them decide how to organise their resources. From a resistance management perspective, it makes sense to devote more time to planning and monitoring, and increase the range of tactics, to species that we believe are at the highest risk of evolving herbicide resistance.

How the risk assessment works

A range of plant biological and ecological factors that could help determine how easily a species adapts to changes or stresses in its environment, such as the frequent use of one particular herbicide group were evaluated. Plant characteristics that relate to the ability to respond to selection pressure include:

- the number of descendants a survivor of the selection event (eg a herbicide spray) produces – more descendants (more seeds) means the population can change more rapidly
- the amount of each generation that is affected by the selecting agent – the greater the proportion of each generation that emerges and is sprayed, the faster the population's average response to that herbicide changes to favour the gene that provides the ability to survive
- whether the method of reproduction (selfing, out-crossing, vegetative) promotes or reduces genetic diversity and 'sharing' between parent plants
- the speed of generation turnover relative to when selection events are applied – in general terms, the number of generations per year. More rapid turnover of generations means more rapid selection and re-selection for the trait that allows plants to survive a particular herbicide

This list was broken down into the following characteristics:

- fecundity (number of seeds/bulbs (propagules) produced per year);
- annual emergence pattern and proportion emerging within the year;
- mating system (selfing or outcrossing);
- reproductive method; and
- number of generations per year.

Each characteristic has a different weighting, based on modelling and assessments of species with known resistance. Different levels of each characteristic score higher or lower within the weighted range. Tables 2-6 show the characteristics in detail and how the scoring system works. Species that produce a lot of seed, germinate readily, and produce more than one generation per year are the highest-scoring, and thus most at risk, weed species.

Table.2 Fecundity score

Rating	Guideline (maximum propagules/year)	Score
Very large	*>100,000*	10
Large	*10,000-100,000*	6
Medium	*1000-10,000*	3
Small	*<1000*	1

Table.3 Annual emergence score

Rating	Guideline (proportion emerging/year)	Score
Large, single cohort	>70%	10
Large, multiple cohorts	>70%	9
Medium, single cohort	10-70%	6
Medium, multiple cohorts	10-70%	5
Small	<10%	0

Table.4 Mating system score

Rating	Score
Primarily outcrossing	0.5
Commonly either outcrossing or selfing	1
Primarily selfing	0.5

Table 5. Reproductive method score

Rating	Score
Sexual only	1
Both	1
Vegetative only	0.5

Table.5 Generations per year score

Rating	Score
Frequently multiple	5
Sometimes multiple	2
Single	0
Perennial	-2
Perennial with multi-year juvenile period	-6

The maximum risk assessment score is 27. The species risk score is usually reported as an indexed score out of ten, obtained by dividing the raw score by 2.7.

Weed risks and management risks

Of course, the inherent biology of a weed, and the risk of resistance that comes with it, is not the only contributing factor as to whether a weed population actually develops herbicide resistance. Management – the use of herbicides and other methods to control weeds – is just as important as species biology. Frequent use of a single herbicide can lead to resistance even in relatively low-risk species, and will certainly lead to more rapid selection in high-risk species. The use of a diversity of tactics, or predominately non-herbicide tactics, reduces the likelihood of resistance becoming a problem – such as in some non-cropping situations, where the use of herbicides is infrequent compared to other options. And some types of herbicide are very easy to select resistance for, as resistant individuals are already quite common. Many brassica weeds in Australia, despite having a low inherent risk of resistance, are resistant to Group B herbicides – but this is likely because group B herbicides are very easy to select resistance for (as are Group A's), so lack of diversity in control tactics poses a proportionally large risk.

For the full weed list go to Appendix 1:
http://www.glyphosateresistance.org.au/articles_media.html

Acknowledgement

This work was supported by funding from the Cotton Research and Development Corporation and the Rural Industries Research and Development Corporation.

FLEABANE RECEIVES NATIONAL ATTENTION AT WORKSHOP IN WAGGA WAGGA

Leslie Weston, Charles Sturt University, and Steve Walker, University of Queensland

Following two successful national workshops held in Toowoomba in 2004 and 2007, the third national workshop on the ecology and management of fleabane was run by the EH Graham Centre, in collaboration with Queensland weed scientists, in Wagga Wagga on 21-22 March.

Canadian fleabane infesting vacant allotment, Albany WA.

Approximately 75 producers, advisors and researchers attended the sessions over two days when14 invited speakers from across Australia covered a broad range of topics including presentations on the biology and ecology of fleabane, identification of fleabane species, seed dispersal mechanisms, development of glyphosate resistance, up-to-date management information for crops, pastures and fallows, and the potential for biological control of fleabane.

Workshop program and summary abstracts can be found on line at:

http://www.csu.edu.au/research/grahamcentre/conferences_workshops/fleabane/Fleabane_Booklet.pdf

At the last session of the workshop, the delegates discussed and evaluated key research priorities identified during the previous sessions. Whilst there was considerable diversity of opinion regarding fleabane RD&E priorities for future investment, one key need was the compilation of existing information on fleabane biology and management.

This is now being progressed with the formation of a writing team of Roger Cousens, Hanwen Wu, Michael Widderick, Steve Walker, Louise Morin and Leslie Weston, who aim to have the monograph completed with 6-12 months. This publication will provide a thorough review of relevant research findings on the biology, ecology and management of fleabane species in Australia, as well as present the current gaps in research and suggest future research direction.

Other high priorities were research into alternative options for fleabane control in crops and pastures for the south-east Australian farming systems. In addition, there was considerable interest in exploring the potential for bio-control for fleabane management, and research on herbicide resistance and seed persistence in seed-bank. Movement of fleabane along roadsides and control options in non crop areas were also prioritized.

GLYPHOSATE RESISTANCE IN ROADS AND RAIL – HOW PREPARED ARE WE?

Andrew Storrie, AGRONOMO, John Cameron and Mark Congreve, ICAN P/L

Key Messages

- Glyphosate remains the primary weed control tactic of choice in the non-agricultural sector based on cost, ease of use and user safety.
- Most vegetation managers have little knowledge of herbicide resistance unless they have been confronted by it in other situations
- All those interviewed were keen for more information on resistance management
- Follow-up control of spray survivors is non-existent or unplanned
- Convincing decision makers within organisations to introduce additional management practices and costs for the 'future' problem of glyphosate resistance remains a challenge.

We all know how important glyphosate is in farming systems, with it being the most widely used herbicide in the world, not to mention how reduced tillage agriculture would not exist without it.

In the first issue of "Giving a RATS" we outlined that there are 22 species world wide that have developed glyphosate resistance with 6 of those being proudly Australian. We also presented the results of a physical survey of non-agricultural areas that showed glyphosate resistance was out there in annual ryegrass, fleabane, barnyard grass and windmill grass.

This article reports on the market research component of Project PRJ-006914 Management of glyphosate resistance in non-agricultural areas with a particular emphasis on roadside and rail management.

How we did it

A questionnaire was developed to gather data on practices, weeds of concern, relative risk to developing herbicide resistance, understanding of herbicide resistance and its

development, decision making processes and where weed management information is sourced. There were 53 face-to-face interviews and 23 telephone interviews. Interviewees were from NSW, Victoria, South Australia, Queensland and Western Australia covering a range of land managers from roadsides, rail, utilities, irrigation systems, specialist weeds contractors, local government, the NSW Roadside Environment Committee and the Department of Defence.

Interviews were of 30 to 120 minutes duration. Surveys were then allocated to organisational categories of aviation grounds, contractors, councils, irrigation, mining, rail, main roads, WA Department of Environment and Conservation (WA DEC) and utilities.

Weed control using glyphosate

For most areas including roadsides, roadside furniture, rail tracks, buildings and structures, mine conveyor belts, power delivery infrastructure, and firebreaks, where weeds are managed for the long term, there is no competitive vegetation and considered a high risk.

Revegetation projects on the other hand such as those following construction of roads, pipelines and mine site rehabilitation are deemed to have a lower risk to developing glyphosate resistance because the projects have a limited time-frame (2-3 years). Additionally, weed numbers are often low, and non-herbicide techniques such a scalping and replacement of topsoil are also practiced.

Road managers have weed control programs concentrating on total vegetation management for 1-5 m from the edge of the road seal. Some road managers only treat around guide posts and roadside furniture with glyphosate +/- residuals and then use slashing between the posts. Management of vegetation for the remainder of the road corridor varies between States. Although there is a trend to use these areas to conserve native vegetation, this can conflict with fire management objectives. Railways practice total vegetation control for the full width of the ballast, usually 4 to 6m either side of the track centre.

Roadside in south-western Western Australia showing width of herbicide spraying on road shoulder.

What drives weed control?

In most sectors safety and infrastructure maintenance are the key drivers for weed control. Roadsides must have clear lines-of-site around and up to posts and signs and the

TEAM MEMBER PROFILE

GET TO KNOW THE TEAM...

Myrtille Lacoste

Myrtille is originally from France where she completed a Masters in Agronomy with a specialisation in farming systems analysis. She worked in various countries around the world, including in East Timor as part of an AusAid/ACIAR-funded program.

Appointed by the Australian Herbicide Resistance Initiative, Myrtille works on decision support systems as part of the GRDC's national glyphosate resistance project. She is currently focusing on RIM ("Ryegrass Integrated Management"), a computer tool developed 10 years ago. RIM provided advisors and farmers with a simple and particularly user-friendly way of testing various management options, and see their impact on both ryegrass numbers and economic performance. Considering the success and impact that RIM had in weed management, Myrtille is now updating and re-developing the software. The new RIM will have more flexible and customisable settings as well as new options that will include weed seed harvest control.

Aside from agronomy, Myrtille devotes the rest of her brain to science fiction matters and also desperately tries to improve her Aussie accent – without much success as she is consistently being told...

David Thornby

David is a senior research scientist with the Queensland Department of Agriculture, Forestry and Fisheries, working on modelling solutions for weed management issues in northern subtropical farming systems. He has contributed to a number of projects on weed issues in grains and cotton in recent years, using computer tools to investigate herbicide resistance evolution, risk assessment and management.

David is based in Toowoomba. When not slaving away at a hot keyboard, he writes fiction, enjoys a good laugh, and likes to get back to his roots in rural Victoria.

allowable distance will vary with the allowed speed limit. Often there is a 30 cm intervention height for roadside vegetation. Railways also need to prevent vegetation growing in the ballast to reduce maintenance and maintain visibility.

Fire management is a significant reason for weed management in many land-uses. Roads in Western Australia and southern NSW have been used in fire management for many years and there is increasing pressure on road managers to use road corridors as firebreaks, with fire authorities wanting to clear or burn corridor vegetation more often.

Current control practices

Herbicides are the principle control strategy for most organisations. Glyphosate is the basis of nearly all herbicide applications which may or may not be applied with a tank-mix partner. Tank mixing another herbicide with glyphosate is common practice. This is usually done to broaden the weed spectrum rather than manage any potential threat from resistance. Some organisations see glyphosate as the only weed control strategy.

The number of glyphosate applications in a year is usually determined by use situation and rainfall. Drier areas normally had 1-2 applications per year, whereas wetter areas ranged from 0.5 to 5 applications. In most environments spring was the key spray time, while summer spraying was dependent on summer rainfall. Timing of control was also influenced by fire restrictions and when it was feasible to access the treatment area such as railways and busy public roads.

When asked what non-herbicide tactics were used, virtually all organisations used slashing (& whipper-snipping) as their main alternative management tool.

Level of herbicide resistance knowledge Most interviewees had low levels of understanding of the mechanisms that lead to herbicide resistance. This is to be expected as there has been little awareness and extension focus on non-agricultural herbicide use. Those with moderate to good understanding had either confronted resistance first hand, such as some rail and road managers, or had a connection with broadacre agriculture. Of concern was that many of those with a better understanding rated their risk of developing glyphosate resistance as low, despite not having any recognised resistant management strategies in place.

A number of interviewees indicated that they believed that their current herbicide practice was putting them at risk with some expecting they were at the early stages of resistance. When it became clear to the interviewee there were no easy replacements for glyphosate, their level of concern increased dramatically.

Current resistance management

Generally, little was being done to prevent herbicide resistance developing or to manage suspected resistant populations. Any monitoring was usually ad hoc, and normally involved staff driving the roads for other reasons and reporting if they saw anything unusual.

Rail managers conduct regular patrols of the lines to spot weeds and other issues with the track.

Trends in weed management

There was an increased reliance on contractors which usually meant a concurrent increased reliance on glyphosate to simplify management and minimise OH&S risks. Fewer residual herbicides are being used, largely to minimise risk of off-target damage and reduce costs.

There has been little thought to proactively seek an alternative product or strategy prior to the onset of resistance as this adds substantial complexity to their current operations. While there is concern over resistance, many roadside managers consider slashing will be their fall-back option. The potential for slashing to replace spraying maybe over-rated as the interval required between slashing events to influence species change on roadsides is so frequent that it would be economically unviable.

Rail line showing high levels of weed control.
Photo: A Storrie

Slashing is not an available practice for rail managers so they are eager to learn about any new management strategies as they realise changing herbicide mode-of-action is a short-term option.

Getting change and adoption

For change to occur, both field staff and managers need to understand the problem they are facing.

Attitudes to herbicide resistance changed during the interview as interviewees became aware of the potential threats glyphosate resistance posed, such as increased control costs and potential need to use products and strategies that posed potential environmental and OH&S issues for their organisation. All interviewees wanted more information about glyphosate resistance management.

Awareness programs are required at all levels of the organisation. To get behavioural change managers need to be informed that herbicide resistance is a potential OH&S, environmental and management issue that will affect future budgets.

Because contractors and sub-contractors are widely used in non-agricultural weed management, herbicide resistance training needs to be written into contracts. Additional duties such as monitoring and reporting herbicide escapes as well as the inclusion of alternate weed management tactic options could also be included in tender documents.

Acknowledgement

We would like to thank the Rural Industries Research & Development Corporation for funding this important project as well as the survey participants for so willingly giving their time and knowledge.

Mechelle Own in the field searching for weed samples

AHRI
AUSTRALIAN HERBICIDE RESISTANCE INITIATIVE

AHRI'S LATEST WA HERBICIDE RESISTANCE SURVEY REVEALS ANNUAL RYEGRASS RESISTANCE LEVELS ARE INCREASING BUT SOME HERBICIDES ARE STILL PROVIDING GOOD CONTROL

Mechelle Owen, Neree Martinez & Stephen Powles

Background

In 2010, the Australian Herbicide Resistance Initiative (AHRI) with Grains Research and Development Corporation (GRDC) funding, initiated the fourth herbicide resistance survey in Western Australia. This extensive survey aimed to determine the current level of resistance of key weed species to different herbicide modes of action and to assess the change in resistance frequency over time.

The first resistance survey in WA was conducted by AHRI in 1998 in a relatively small area of the WA wheatbelt to determine the extent of Group A & B herbicide resistance in annual ryegrass and wild radish. In 2003, another AHRI survey was conducted across the whole WA wheatbelt area and examined a range of herbicide chemistries. Annual ryegrass and wild radish seed samples were collected from five hundred cropping paddocks and showed a dramatic increase in herbicide resistance levels. The first wild oat survey, conducted in 2005, found widespread resistance to the Group A herbicide diclofop-methyl and low resistance levels to other Group A herbicides tested.

AHRI survey process

The latest AHRI survey (2010) was conducted to assess the current state of herbicide resistance to commonly used herbicides in the WA wheatbelt for five important weed species. Over 15,000 km was travelled, extending from Binnu in the north to Esperance in the south, visiting 466 cropping paddocks and collecting mature seed heads from ryegrass, wild radish, wild oat, barley grass and brome grass.

While previous surveys had been done randomly and anonymously, the 2010 survey required grower involvement, however, paddock selection was still random to allow comparison with the data on resistance occurrence. Growers involved received results for their paddocks.

Mature weed seeds were gathered at harvest from randomly selected paddocks on each grower's property. During the 2011 growing season, annual ryegrass seedlings were screened for resistance to commonly used herbicides including clethodim, trifluralin, diclofop-methyl, sulfometuron and glyphosate at recommended field rates. Wild radish, brome grass, barley grass and wild oat will be assessed in 2012/13.

AHRI survey results

Annual ryegrass resistance levels were found to be extremely high for the group B herbicide sulfometuron, with 98% of populations containing resistant plants (Table 1) and most populations having a high proportion of plants surviving. This is a 10% increase in the number of resistant populations since the last survey conducted in 2003. A similar result was found for the Group A herbicide diclofop, with 96% of populations containing resistant plants, an increase of 30% since the last survey in

2003. The greatest increase in resistance came from southern cropping regions for both herbicides.

Two label rates were used for the herbicide clethodim: the first rate used was 250ml of Select as it was the label rate in 2003 and allows direct comparison with the 2003 survey. The label rate has since changed to 500ml/ha and so this rate was also used in the 2010 survey. Under the 250ml rate of Select, 65% of populations contained resistant plants (Table 1), a large increase of 57% since 2003; a further 42% of populations also survived the 500ml rate. This herbicide had the greatest increase in resistance levels since 2003 (Table 1), with resistance becoming widespread across the state rather than being isolated to the northern agricultural region. Higher levels of resistance at the higher label rate were observed in the northern agricultural region.

Mechelle transplanting seedlings for herbicide resistance screening of ryegrass populations conducted at UWA during 2010 (May-September)

The pre-emergent herbicide trifluralin remained effective on 73% of populations. Only 1% of the resistant 27% of populations had high plant survival, and these populations were controlled by the pre-emergent herbicides Boxer Gold and Sakura. Only 2% of populations contained plants that were resistant to atrazine, while all populations were susceptible to paraquat. These results are similar to the 2003 survey results.

Table.6 Change in herbicide resistance levels for annual ryegrass from the Western Australian wheat belt over an 11 year period. Populations are classed as: Susceptible (S) (0% survival) or Resistant (R) (1-100% survival). (NT - herbicide was not tested)

Herbicide	1999		2003		2010	
	R	S	R	S	R	S
diclofop	46	54	68	32	96	4
clethodim	0.5	99.5	8	92	65	35
sulfonylurea	64	36	88	12	98	2
trifluralin	NT	NT	25	75	27	73
atrazine	NT	NT	1	99	2	98
glyphosate	NT	NT	1	99	7	93

The number of glyphosate-resistant populations increased from 1% in 2003 to 7% in 2010, with all resistant populations coming from higher rainfall coastal regions in the southern cropping region between Albany and Esperance.

The number of populations with resistance to both the Group A and B herbicides had increased to 95%, a reflection of the increase in resistance to sulfometuron and diclofop particularly in southern cropping regions.

Have resistance levels changed over time?

Overall, it can be seen that there is a large increase in the level of resistance to the Group A and B herbicides, while, more encouragingly, atrazine and trifluralin resistance remains low and has not changed greatly over the past 7 years (Table 1). While glyphosate resistance is evident, it was confined to high rainfall southern cropping regions, and growers from these regions should be particularly cautious in their use of glyphosate.

Unlike previous surveys, the 2010 AHRI survey required grower participation and we would like to extend our thanks to all the growers involved in the survey. We would also like to thank all those who helped in promoting the work and distributing survey participation forms to growers. This work was funded by GRDC.

PARAQUAT RESISTANCE IN THE SOUTH AUSTRALIAN PASTURE SEED INDUSTRY - RISK ASSESSMENT AND MANAGEMENT

Sarah Morran, Peter Boutsalis and Christopher Preston
School of Agriculture, Food & Wine,
University of Adelaide

Resistance to the important knockdown herbicide paraquat was confirmed in Australian populations of annual ryegrass (Lolium rigidum) in 2010. Paraquat resistance in annual ryegrass has been previously confirmed in South African vineyards. The two Australian populations were confirmed from clover seed production enterprises in the south-east of South Australia.

Project funding was sought from the Rural Industries Research & Development Corporation (RIRDC) to define the extent of paraquat resistant annual ryegrass in pasture seed production and examine farming practices in the industry that may contribute to or reduce the risk of

resistance evolution. The project involved a physical survey to test for resistance and a survey of grower practices.

Survey for resistance

The physical survey was conducted by collecting samples of annual ryegrass seed sourced from consultants and growers to test for paraquat resistance. Samples arrived either as whole plants and were tested using the Syngenta Quick Test® or as seed. Plants were treated with appropriate rates of paraquat (250 g/L) or paraquat + diquat (135 + 115 g/L). Populations where plants survived were considered to contain resistant individuals.

A total of 39 samples were tested for resistance to paraquat. Of these 9 samples contained paraquat resistant individuals. This research has confirmed resistance to paraquat exists in annual ryegrass populations in the pasture seed industry. At present the amount of resistance is restricted with approximately 80% of samples testing negative. A worrying discovery was that two populations contained individuals resistant to both paraquat and glyphosate.

Grower workshops

Grower workshops were run to survey weed management practises and provide an overview of farming practices among pasture seed growers in the south-east of South Australia. Glyphosate and paraquat are used as an integral part of weed management; however, over 80% of growers surveyed used a range of herbicides modes-of-action (Groups A, L, D, C and M) to control weeds.

Paraquat was applied most commonly once or twice per year at rates between 1.5 and 2 L/ha, which are low to moderate rates depending on weed size and density. Most growers indicated they used glyphosate and paraquat to target a mixture of small and large weeds, with a few individuals targeting mostly large, established weeds. Cultivation, crop topping with both paraquat and glyphosate, and burning stubble were also used regularly for weed management.

One-in-five lucerne growers thought they didn't have any resistance problems, while all pasture seed growers had some type of resistance. Both grower groups perceived they were most likely to have resistance to Group A (grass selective) herbicides, followed by Group M herbicides in weed populations in their paddocks. Almost half of the growers surveyed did not believe they had any resistance to paraquat.

The repeated use of paraquat over long time periods (>15years) in this region with no follow-up of spray survivors has resulted in the evolution of resistance. Growers of clover seed were more likely to report paraquat resistance in annual ryegrass, while growers of lucerne seed were more likely to report paraquat resistance in barley grass.

Glyphosate resistant annual ryegrass growing along an irrigation channel adjacent near irrigated pasture seed fields.

Management

The identification of annual ryegrass resistant to paraquat and glyphosate is a threat to the pasture seed industry and to all farmers in Australia. Growers need to implement integrated weed management strategies focussing on seed bank management and maintaining low weed numbers to reduce the risk of resistance evolution. Rotating herbicide MOA's can slow the development of resistance, but not prevent it. Because paraquat is the main non-selective alternate to glyphosate, and there are few other alternatives, the management of resistance to both paraquat and glyphosate must be a high priority for growers and agronomists. The adoption of integrated weed management strategies that minimise the evolution and spread of resistance is essential.

Annual ryegrass surviving application of both paraquat and glyphosate in an irrigated field formerly used for white clover production.

For more information on paraquat resistance go to: http://www.glyphosateresistance.org.au/paraquat_resistance.html

Project was funded by RIRDC. Project No. PRJ-006912

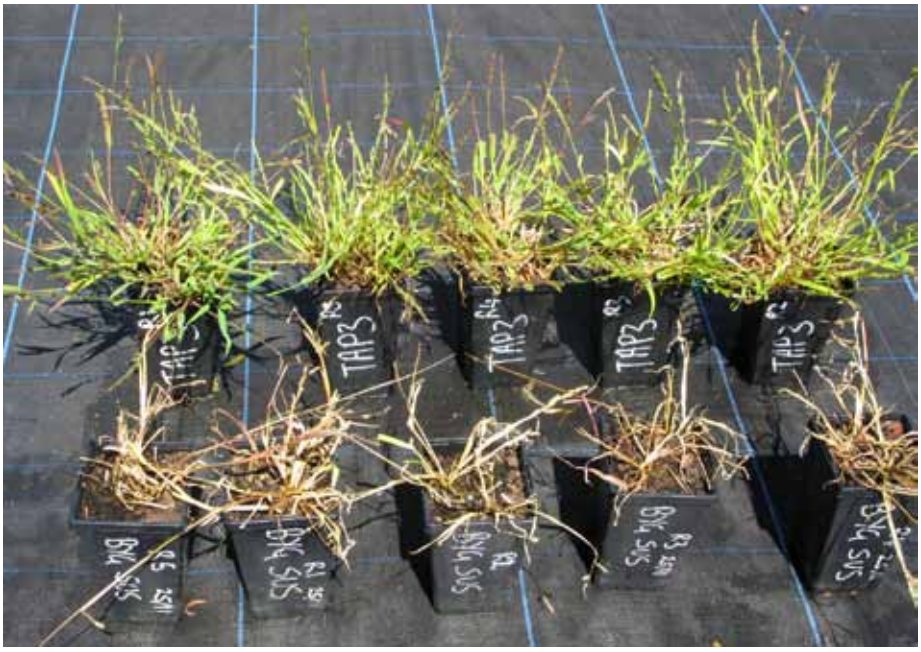
Glyphosate resistant annual ryegrass along a fence line adjacent to a field used for pasture seed production.

FREE TESTING CONTINUES THIS SUMMER AS CONFIRMED CASES OF GLYPHOSATE RESISTANCE IN BARNYARD GRASS TREBLES!!!

Tony Cook, NSW DPI, Tamworth

Nearly 60% of awnless barnyard grass (Echinochloa colona) samples from a targeted survey last summer have tested resistant to glyphosate. This represents a trebling of the number of previously confirmed cases and represents 'the tip of the glyphosate resistance iceberg' and there are hundreds of unconfirmed cases. Agronomists and growers are urged to take advantage of the free testing service that will be provided this coming summer to find out if glyphosate is still effective on this species.

Since the first population of glyphosate resistant awnless barnyard grass (BYG) was discovered in 2007, another 20 cases were confirmed resistant up until 2011. Most cases were located in the northern grain region between Narrabri, New South Wales and St George, Queensland with one case in the Kimberley region of northern WA.



Confirmed resistant sample (back row) and standard susceptible population of barnyard grass

The resistance survey commenced in November 2011 targeting high glyphosate use paddocks using an extensive network of 40 agronomists linked to the Northern Grower Alliance. This is part of a GRDC funded project managed between NSW Department of Primary Industries (NSW DPI), Queensland Department of Agriculture, Forests & Fisheries (Qld DAFF) and University of Queensland.

Of the 78 samples received, nearly 60% of these (45 samples) were confirmed resistant. This substantial rise in confirmed cases is no great surprise for several reasons because the number of confirmed cases always under estimates the real problem. Also despite the constant warnings about the threat of glyphosate resistance, many growers still use it without any alternative tactics to control survivors.

A typical patch of glyphosate resistant barnyard grass in a summer fallow paddock.

A recent survey for glyphosate resistance in non-cropping areas also resulted in big 'spikes' of confirmed glyphosate resistance in fleabane, annual ryegrass and windmill grass. The number of resistant fleabane populations jumped from 8 to 49 populations.

This targeted survey showed glyphosate resistant BYG populations are well spread within the area surveyed from Dalby to Tamworth, with a greater concentration of cases between Goondiwindi and Narrabri.

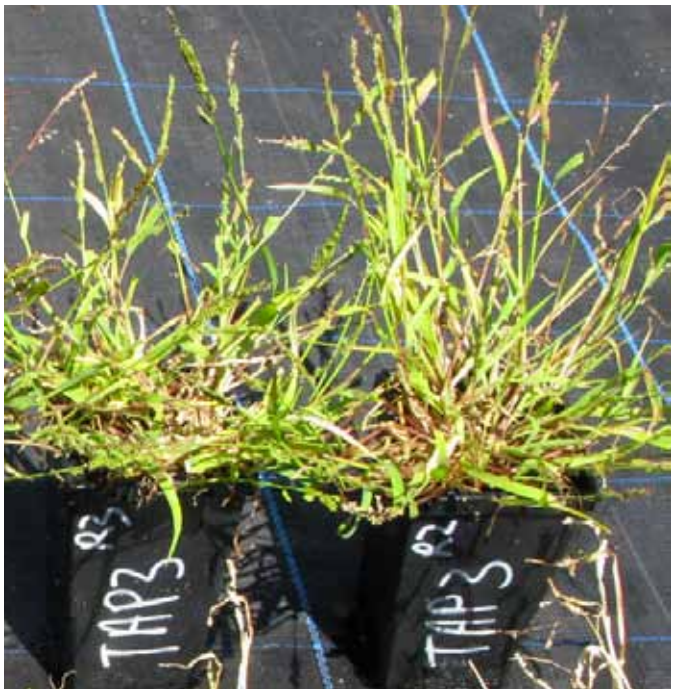
Some of the samples tested are more resistant than the 'resistant standard' collected from a confirmed resistance site. The 'standard resistant' population used has a 5 to 7 fold level of resistance. Seed collected from any surviving plants from resistance testing will be used for more comprehensive glyphosate rate response studies to determine relative levels of resistance.

It is likely many paddocks in the survey area have glyphosate resistance but escaped sampling because some growers are using the double knock tactic. Agronomists found it difficult to sample 'suspect' paddocks as the farmers had effectively controlled BYG with this technique. These paddocks will be visited next season when the testing service recommences.

It is important to continue the testing service to widen the area surveyed. Many parts of the central west slopes and plains region of NSW are prime candidates for glyphosate resistant BYG as they have a dominance of summer fallows, some effective summer rainfall and have BYG as a summer weed.

These surveys are financially supported by GRDC via two projects (National glyphosate resistance project and the northern IWM project).

For further enquiries regarding next seasons free testing service, please contact Tony Cook on 02 67 631250 at work, 0447 651607 on mobile or email tony.cook@dpi.nsw.gov.au



Fenceline trials up and running and ready to be viewed!! - WA Adviser Group Update

Some of the Northern Advisor Group at the fenceline site (Liebe Group post-seeding Field Walk) on July 25.

FENCELINE TRIALS UP AND RUNNING AND READY TO BE VIEWED!! - WA ADVISER GROUP UPDATE

The Western Australian farm advisor 'learning groups' have set up two fence line trials to identify alternative herbicides to control annual ryegrass and other weeds. Although the two trials differ slightly, most of the herbicide treatments are applied as either single herbicides (glyphosate, paraquat, Amitrole® T, glufosinate or Alliance®) or as a mixture of a residual herbicide with a knockdown such as paraquat. Each treatment will be assessed on its ability to control weeds and prevent seed set (especially in annual ryegrass).

One trial is based at the Esperance Downs Research Station and will be part of the program at the SEPWA Spring Field Day on September 13. The other trial is at Dalwallinu and will be part of the Liebe Group Field Day on September 12. Farmers are encouraged to come along and see the results of the trial and learn more about reducing the risk of glyphosate resistance on their farm.

FIELD EXCURSION AT THE INTERNATIONAL WEED SCIENCE CONGRESS IN CHINA

Steve Walker QAAFI

One of the highlights of the 6th International Weed Science Congress, held at Hangzhou in June, was the excursion to a research farm near Shaoxing. This gave the participants the opportunity to see another part of China during the hours drive from Hangzhou to Shaoxing through the delta of the Yangste River.

Hangzhou is a very modern, progressive and large city, with the world famous and beautiful West Lake in the old part of the city. Shaoxing is old and historical, famous for many aspects including the home of renowned Chinese scholars such as Lu Xun. In between there is a maze of canals, non-stop high rise buildings and other infra-structures, interspersed with vegetables and rice growing on every available square metre.

POLICE ESCORT - "Police in Hangzhou stopping traffic for a seamless tour".

Four bus loads of delegates visited a field demonstration of rice paddies infested with herbicide resistant weeds. They showed us three approaches:

1. ***chemical control***
2. ***biochemical control***
3. ***eco-control with ducks (not sure how many ducks per hectare was being used).***

From what we could see without wading through the mud and water, all methods seem to be very effective.

This excursion was very efficiently organised to move several hundred delegates from a 5-star hotel to rice paddies seamlessly and on-time. One of their methods was to have police at all major positions, to stop the traffic and allow our buses to navigate without any delays. We even had a police escort out front of the bus convoy for the full distance, with lights flashing on both the police car and all buses. This was my first experience being 'escorted' by the police!

DUCKS - Tasty biological control in rice paddies.

CONTACT

Andrew Storrie
givearats@agronomo.com.au
(08) 9842 3598