the northern
HERBICIDE RESISTANCE Reporter

A Newsletter keeping you up to date with research and development in herbicide resistance in the Northern Region

JUNE 2006

Phase II of the project – what can you expect?

The new northern region herbicide resistance team meet in Toowoomba

The GRDC has continued to support the collaborative team from NSW Department of Primary Industries and Queensland Department of Primary Industries & Fisheries, who managed the Northern Herbicide Resistance project from 2003 to 2005. Team members include Paul Moylan, Tony Cook and Andrew Storrie from NSW DPI and Michael Widderick, Steve Walker, Vikki Osten, Geoff Robinson, Alison Shields and Glen Wright from Qld DPI&F. The new northern herbicide resistance project started in July 2005 and will run until June 2008.

Herbicide resistance is increasingly becoming a concern for farmers in the northern grain region. Phase I of the project focussed on the prevention of herbicide resistance, and this will continue with a series of short-term and long-term field trials for the weeds identified as 'at risk' in phase I. In addition, the new phase will focus on the management of weed populations that are already resistant. We will focus on Group A resistant wild oat and Group M resistant annual ryegrass. In particular, we will assess management practices, which have lead to these resistances by conducting several case studies in the region, and we will also gather spatial information on how these populations spread.

In addition, an assessment of fleabane species distribution and current resistance status will be conducted during 2005-06. While no resistance has been identified in this species, difficulty in its control is often encountered. Fleabane samples from the northern grain region will be tested along side samples from WA, SA and southern NSW as a collaboration with the Weeds CRC.

Phase I of the project produced a large amount of information about herbicide resistance and prevention. Most of this information was distributed to farmers and agronomists in the form of our 6-monthly newsletter, which is continuing, and the region-specific 'stopping herbicide resistance' brochures. We will now also be distributing important information, as it comes to hand via e-mail in our new herbicide resistance E-lert.

In this issue ...

In phase II we will be interacting more on a face-to face level by having region-specific workshops with farmers and agronomists. Action learning modules will be used with farmer groups to explore herbicide resistance issues, and to build capacity in adopting new strategies to maintain flexible and profitable farming systems. Region-specific workshops will be held for agronomists where key Western Australian HR Initiative (WAHRI) researchers will be invited to participate.

Andrew Storrie, Project Leader

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Editorial

Welcome to the 7th edition of the reporter and the first edition for the second phase of this project. It has been almost 12 months since our last edition so there are plenty of issues to catch up on. I hope all are having a good 2006 so far and that the information we share with you in this publication can make the rest of it even better!

Since our last issue we have started work on the second phase of the project. We have maintained most of the same staff from the first phase, and much of the same focus. With our new project we have developed some new initiatives, like our 'E-lert' sent by e-mail when pertinent issues arise. We will also be having more extension activities where the team will be hitting the ground and sharing research findings in a practical and hands on way. Look out for notices about these future farmer and agronomist workshops.

The first run of winter field experiments has also been completed and the outcomes of these are provided in this issue of the reporter.

On behalf of the team, I would like to thank Steve Walker for his leadership in phase I of the project. Steve will stay on as an integral member of the project team, now lead by Andrew Storrie. I would also like to thank Kathryn Galea for her invaluable contribution as co-editor for the first 6 editions of this newsletter. Steve Walker will now take this role.

I hope that this publication and the other extension efforts of the project team are valued resources in the battle against herbicide resistance. Please feel welcome to contact any of the team members with any questions or suggestions as to how we can help you fight the battle.

Kind Regards

Michael Widderick

E-LERT ALERT

The Herbicide Resistance Project Team has gone technological!

A new initiative of the project is to send out herbicide resistance alerts via e-mail. The new e-mail system has been called 'The Northern Herbicide Resistance E-lert' and will be sent out on an as-needs basis to inform interested parties of new happenings in regard to herbicide resistance. The first issue of the E-lert was sent out in February and highlighted a current fleabane collection happening throughout Australia. The fleabane collected is to become part of a national glyphosate screen. If you would like to be added to the E-lert list, or missed out on the first issue of the E-lert, please e-mail Michael Widderick (michael.widderick@dpi.qld.gov.au).

NOW AVAILABLE New Brochures on Stopping Herbicide Resistance

As part of phase I of the northern herbicide resistance project, three brochures outlining herbicide resistance information for key 'at risk' weeds were produced. A region specific brochure has been developed each for southern Queensland, central Queensland and northern New South Wales. The brochures package together the research from phase I in an easy to understand and easy to apply way. While quite a number of these brochures have been distributed through the post, if you would like additional copies of any or all of these publications, please contact Michael Widderick (michael.widderick@dpi.qld.gov.au) with your postal address and quantity required. Any questions or feedback on these publications is most welcome.

How much will glyphosate resistance cost growers?

In phase I of the herbicide resistance project, the costs of weed control were estimated for a 'typical' grain paddock in the Central Highlands and Darling Downs in Queensland. For wheat/sorghum rotations, growers would spend on average, $48 per hectare each year for herbicides on the Highlands and $59 on the Downs.

The costs of weed control were also calculated for these growers, if a paddock was then infested with a summer grass, such as barnyard grass or sweet summer grass, which was resistant to glyphosate. This would necessitate the use of some alternative and additional herbicides to glyphosate, resulting in an annual increase of $36-52 per hectare.

For more information, contact Fred Chudleigh at DPI&F. (fred.chudleigh@dpi.qld.gov.au).
Steve Walker

Update on what's happening with glyphosate resistance nationally

The following is a recent media release from the Glyphosate Sustainability Working Group (GSWG).

Glyphosate resistant ryegrass has been confirmed at four new locations in Australia. The new populations bring the total number of populations to 44, with 24 of the cases in broadacre cropping. All are in annual ryegrass.

Group meets for their second national meeting. Photo: Emma Leonard

New populations from NSW come from a broadacre chemical fallow, an irrigation channel and a fenceline. The fourth new population comes from a vineyard in SA. There has been no increase in the number of glyphosate resistant populations in WA.

National Glyphosate Sustainability Working Group chairman Rick Llewellyn said that, while the new populations demonstrated the risk of too much reliance on glyphosate, the low number of new populations in broadacre cropping suggested preventative action taken by growers was making a difference.

"It's now 10 years since the first case of resistance to this valuable herbicide was discovered and many people had predicted much higher resistance levels by now," Dr Llewellyn said.

"We believe we are now seeing the positive pay-off from preventative action taken by the many growers who recognized their glyphosate use history had placed them at high risk of resistance and they did something about it."

The Glyphosate Sustainability Working Group has produced a guide listing a number of methods to reduce the risk of developing glyphosate resistance.

"The important thing now is for growers, who are entering into high risk situations such as no-till or winter fallow, to recognise the risks and how they can be reduced - we're clearly seeing that glyphosate resistance is not inevitable," Dr Llewellyn said.

Details of glyphosate resistant populations in Australia are listed on the Australian Glyphosate Resistance Register, compiled by Dr Chris Preston from the University of Adelaide. The register and information on how resistance can be managed is available from the national Glyphosate Sustainability Working Group (GSWG) website www.weeds.crc.org.au/glyphosate.

The GSWG is a collaborative initiative of herbicide companies, researchers, extension networks and agribusiness, supported by the Weeds CRC, AVCARE and the GRDC.

Steve Walker

Action, action we want action! - ALM

'ALM' stands for Action Learning Module. An ALM is a workshop where participants learn through doing, with hand-on activities designed to be fun, memorable and educational.

The project team are running herbicide resistance ALMs for farmers and agronomists across the northern grain region. The one-day events will help participants to better understand herbicide resistance and provide them with information on weed management alternatives that can be used to reduce the risk of resistance on their property. Those who participate will have access to the most current herbicide resistance information and experts from the region.

The first round of ALMs will be held in central Queensland in July and August (see Table for location and dates). Further ALMs will be held in southern Queensland and northern NSW but dates are yet to be set. More information about these ALMs will be sent via our new E-lert (see the notice on opposite page if you don't currently receive our E-lert).

If you would like further information about the central Queensland ALMs, please contact Vikki Osten (vikki.osten@dpi.qld.gov.au).

- ***Thurs 20 July, Biloela***
- ***Fri 21 July, Moura***
- ***Mon 24 July, Kilcummin***
- ***Wed 26 July, Capella***
- ***Fri 28 July, Gindie***

Update on management of fleabane

At the recent GRDC Grains Research Update held at Goondiwindi, the following 2 papers were presented on new research on controlling fleabane:

- ***'A strategic approach to managing flaxleaf fleabane' by Andrew Somervaille***
- ***'Managing fleabane in wheat' by Steve Walker and Hanwen Wu.***

These are available in the Update proceedings or on the GRDC website (www.grdc.com.au).

Steve Walker

New research towards a test for identifying glyphosate resistance in annual ryegrass

The CRC for Australian Weed Management (Weeds CRC) recently funded a new 12-month project to work on developing PCR based tests to identify markers associated with glyphosate resistance alleles in field populations of annual ryegrass.

The researchers at University of Adelaide will utilize AFLP technology and linkage analysis to identify polymorphisms associated with herbicide resistance and to elucidate whether the resistance maps to the same sites in different weed populations. This data will then be used to determine if a marker that is tightly linked to the gene of interest can be used to develop a PCR detection method for the presence of glyphosate resistance alleles. Linkage studies generated by AFLP analysis can be used to provide initial localisations for herbicide resistance genes, even if one has no prior information on which gene may be involved or its chromosomal location. Once such linkage patterns are identified, the researchers have the opportunity to apply the principles of marker assisted selection to the screening of populations for specific herbicide resistance by converting AFLP markers into codominant, simple PCR-based markers as a tool for detecting the type of herbicide resistance in very young plants or from seed.

The initial research, because of time constraints, may not provide a test that can be applied in the field for rapidly screening large numbers of weeds for glyphosate resistance using PCR technology, but it will provide a sound basis for the development of such a test in the future. The development of such a test will provide a useful tool for advisors and land mangers, when evaluating the status of herbicide resistance in weed populations and recommending strategies to combat the spread of resistance, because of the rapid turn around time in identifying the type of resistance present in a weed population.

For further information, contact Dr Jeanine Baker at the University of Adelaide (jeanine.baker@adelaide.edu.au).

Steve Walker

Is there potential for Group B resistance in wild oats?

Overuse it and lose it, Group B resistant wild oats may be coming your way.

Populations of wild oats have developed resistance to the newer Group B herbicide Hussar® in South Australia and Victoria. Group B resistance in wild oats appears to be also developing in northern NSW as a result of a long history of chlorsulfuron, triasulfuron and metsulfuron(Group B) use, combined with the increased use of Hussar® and Atlantis®. The risk is especially high in the western region, where Group B herbicides have been extensively used over the past 20 years.

Growers and agronomist are reporting declining wild oat control with Hussar®, which is a selective post-emergent Group B herbicide used to control wild oats and certain broadleaf weeds in wheat.

A number of growers in western NSW have suggested that control with Hussar® has declined after 3 applications. Trials conducted by NSW DPI over the last 2 years support this finding (Figure 1). The 3 trial sites had a long history of Group B herbicide usage and 2 previous applications of Hussar®. In western areas, winter cereal cropping predominates. It is common that paddocks have received at least 10-15 applications of Group B herbicides such as chlorsulfuron. One trial site has had 17 applications of Group B herbicides. Some growers also use a Group B herbicide in the fallow phase, adding to selection.

Testing of wild oats from the western region of northern NSW will be conducted this year by the NSW team to assess their susceptibility to Group B herbicides.

Paul Moylan

Poor control of wild oat in NSW with Hussar®

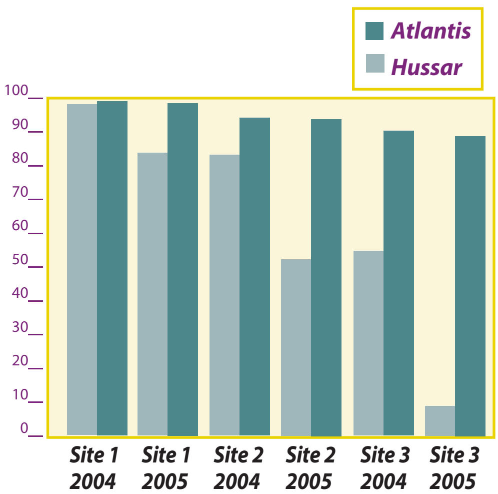

Figure 1. Control of Group A resistant wild oats with Group B herbicides at 3 trial sites in NSW 2004-2005. (Hussar® at 200g/ha and Atlantis® at 0.33L/ha)

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Testing for glyphosate resistance in fleabane

Fleabane has been one of the most difficult-to-control weeds, particularly in fallows of northern region farming systems in recent years. As well, there is concern by some growers and advisers that the weed may be developing resistance to glyphosate.

Flax-leaf fleabane (Conyza banariensis) collections from across Australia are being tested for resistance to glyphosate

A preliminary study at the University of Sydney indicated a Goondiwindi district fleabane population had developed glyphosate resistance. This finding has attracted some controversy as the weed has always been deemed by many as difficult to control with glyphosate alone.

However, a similar weed, Canadian fleabane, has developed glyphosate resistance, across more than 1 million hectares in the US since 2000 with several sites recorded in South Africa and Spain. See www.weedscience.org.

To address this concern, a national Weeds CRC project was launched this year to screen fleabane for glyphosate resistance for populations collected across the cropping regions of Australia.

Seeds are presently being collected from approximately 50 paddocks that are likely to have had a long history of glyphosate use, and from 10 non-paddock situations where use of glyphosate is unlikely. The collection sites will be mostly from northern NSW and southern Queensland, plus some from central Queensland, South Australia and Western Australia. During this winter, populations will be tested for glyphosate sensitivity using dose response pot trials, from which dose response relationships will be developed for each population. These will be compared between those with history of glyphosate use and those with minimal or no glyphosate use.

Findings will be published in a subsequent edition of the Herbicide Resistance Reporter.

For further information, contact Dr Steve Walker at DPI&F (steve.r.walker@dpi.qld.gov.au)

A Herbicide resistance model for the Northern Grain Region

Under a new GRDC funded project that started in May 2005, plant modeller David Thornby (QLD DPI&F) is developing a computer model of the evolution of herbicide resistance in weeds of the northern grain region.

A modelling approach is being used to help investigate the effects of typical agricultural practices in the region on the rate of evolution of glyphosate resistance in key weeds including barnyard grass and common sowthistle. Developing this model will allow rapid investigation of a wide range of farming practices and their impact on herbicide resistance evolution. Gathering such a wide range of data through field experiments would be time-consuming.

Similar models have been used successfully to provide recommendations for growers in South Australia and Western Australia to reduce the impact of herbicide resistance in annual ryegrass, and we aim to provide similar recommendations for our target weeds in the northern grain region. Significant changes to the SA and WA models are needed, because of the differences in climate and agricultural practices between these regions and our own.

Herbicide use practices, such as frequency of use and the complementary use of different mode of action groups, along with other agricultural practices such as tillage, are being incorporated into the computer model of weed growth. The weed growth model simulates the effects of competition between weeds and crops, and we have added sub-models to account for the effects of differing levels of annual germination rates, dormancy, and seed bank persistence. Our approach will take into account soil and climate variables, as well as crop rotations and other agricultural factors, in predicting the likelihood that a particular set of practices will result in a herbicide resistance problem.

We are working on producing a model that is able to simulate the growth and population dynamics of a wide range of northern region weed species, rather than a single target species. This will enable us to investigate the likely rates of evolution of herbicide resistance for any weed species of interest in the region, and to estimate the effects of recommended resistance management tactics on these weeds. To date, we have chosen the modelling tools required for the project, and have produced prototype models that are in the process of being set up to simulate barnyard grass as an example weed species.

We hope to produce both a set of recommendations for agricultural practices that will have a positive effect on the herbicide resistance problem, backed up by the model's predictions, and a tool that will enable scientists, agronomists and growers to better understand herbicide resistance and weed management practices. We anticipate using the model particularly in workshops to achieve this aim. The model is due for completion in late 2007, and communication of the model's findings will continue under this project until May 2008.

David Thornby
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Wild oat resistance prevention and management

Wild oat is a common winter weed throughout southern Queensland and northern NSW where populations resistant to Group A herbicides exist. The distribution of Group A resistance is currently small in Queensland, but there is a large potential for it to spread much further. Continued reliance on group A herbicides will increase the spread of Group A resistance by allowing resistant weeds to survive and set seed. Wild oat has also been identified as being at high risk of developing resistance to Group M (glyphosate), but no Group M resistant populations have been identified.

The project team conducted a series of field experiments to assess the effectiveness of herbicide alternatives to group A and M herbicides on wild oat at trial sites in southern Queensland and northern NSW.

Wheat

For susceptible wild oat populations, there are alternatives to Group A herbicides, that can be applied strategically to reduce the risk of Group A resistance.

Table 1. Response of susceptible wild oat in southern Queensland to different herbicide treatments (SST = selective spray topping, → = followed by). The average wild oat plant number was 69 (plants/m²) and seed production was 3167 (seed/m²) in the untreated plots.

Treatment (herbicide rate as product/ha)	MOA	Reduction in plant number %	Reduction in seed number %
Topik® (85mL)	A	74	99
Wildcat® (400mL)	A	94	100
Atlantis® (330mL)	B	21	99
Hussar® (200g)	B	19	74
Mataven® 90 (SST) (1.88 L)	K	0	96
Topik® (85 mL) →Mataven® 90 (SST) (1.88 L)	A→K	90	99

In the southern Queensland trial with a susceptible population, all treatments except Hussar® reduced wild oat seed production by 96 to 100% (Table 1). Wild oats were sprayed when 30% of the population was pre-tillering and 70% was at late tillering to jointing growth stage. Despite the good seed control, there were large differences between the treatments with reduction in wild oat plant number. Group A herbicides reduced wild oat numbers by 74-94% when applied alone, compared with the Group B alternatives which only provided 19-21% reduction.

Table 2. Group A (dim) resistant wild oat response to herbicide treatments in northern NSW. (+ = applied as mixture, → = followed by)

Treatment (herbicide rate as product/ha)	MOA	Reduction in plant number %
Topik® (200mL)	A ('fop')	56
Topik® (200mL) → Mataven® 90 (1.75L) SST	A→K	91
Achieve® (500g)	A ('dim')	0
Achieve® (500g) →Mataven® 90 (1.75L) SST	A→K	0
Mataven® 90 (1.75L)	K	0
Trifluralin (1L) + Avadex® Xtra (1L)	D+E	0
Trifluralin (1L) + Avadex® Xtra (1L) → Mataven® 90 (1.75L) SST	D+E→K	96
Trifluralin (1L) + Avadex® Xtra (1L) → Hussar® 90 (200g)	D+E→B	59

Note: Early post emergent Mataven® 90 applied at Z15; SST application @ Z32

In the NSW trial with a Group A wild oat resistant population, the weeds were effectively managed by introducing a range of other techniques, whereas Topik® applied alone (Group A 'fop') achieved only 56% control (Table 2). Group A and B herbicides were applied at the 5 leaf growth stage. Application of Mataven® 90 (Group K) as a selective spray topping 'SST' after Topik® resulted in 91% reduction in wild oat numbers, which is consistent with the SQ results. Selective spray topping was applied when the first tillers on wild oat plants were commencing elongation. Mataven® 90 applied as SST following the application of trifluralin + Avadex® Xtra achieved 96% control. Mataven® alone applied as SST did not reduce weed number. Counts on seed production in the next series of trials will provide useful information on the reduction of seed production of Group A resistant wild oat by Mataven® and other treatments.

Reduction in wild oat plants with Hussar® (Group B) was better in the NSW trial (59%) (Table 2) compared with 19% in southern Queensland (Table 1). This difference is likely due to weed size at spraying. Hussar® needs to be applied when wild oats are at the 1-3 leaf stage and to populations of less than 150 plants/m² for maximum effectiveness. Late applications will give suppression only, which can be confused with resistance.

Chickpeas

Group A resistant wild oats are difficult to manage in chickpea, due to limited selective herbicide options and the fact that chickpeas are poor competitors.

The alternatives are the pre-emergent use of trifluralin (Group D) and Avadex® Xtra (Group E) which can provide reasonable early control. However, survivors of this treatment and later germinations can not be controlled effectively with Group A herbicides. Good control can be achieved with glyphosate when applied at spray-out.

The best option is to NOT grow chickpeas if there is Group A resistant wild oats or paradoxa grass.

Fallow

Rotating from winter crop into summer (such as sorghum) allows wild oats to be controlled with alternative herbicides in fallow, such as Group M and Group L herbicides. Care should be taken not to place too much reliance on either of these herbicides, as over-reliance on any one mode of action can promote resistance toward that herbicide group.

Group M herbicides applied alone were effective in achieving 100% control of wild oat (Table 3). Applying Group M in a mix with an alternative herbicide group, such as Group G and C also achieved maximum control at the rates applied. Mixing with Group I herbicides will not improve control of wild oat, but will broaden the control spectrum. The benefit of adding a mix partner to a Group M herbicide is that the mix partner, provided it is applied at a high enough rate and is effective on that weed, should control any escapes from the Group M component of the mix. This will not only ensure that little or no seed is set, but will minimise the risk of developing Group M resistance.

Mixing of Group M herbicides with some other groups, especially Groups I and C, can cause a reduction in the effectiveness of weed control. Antagonism between herbicides can be overcome by applying herbicides at the rate recommended for each mix partner.

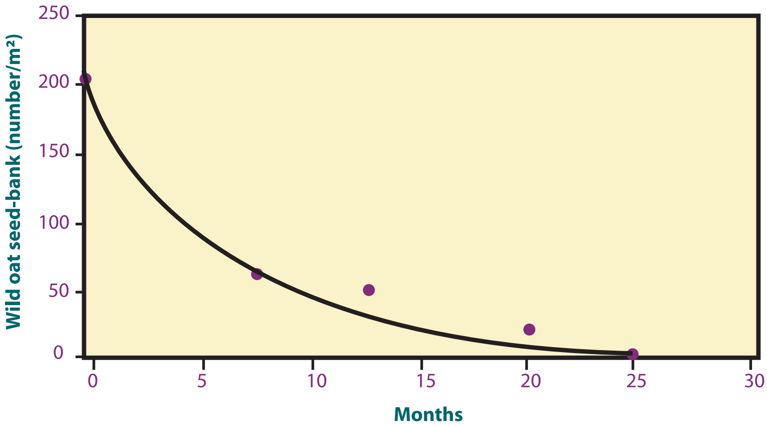
Group L herbicides were effective in controlling wild oat with up to 94% control. To ensure maximum effectiveness of Group L contact herbicides, they should be applied at a smaller droplet size and at a higher output volume to ensure optimal coverage of the target.

A water rate of 58L/ha was used for all treatments except Group L treatments, which were applied at 108L/ha. Approximately 10% of the wild oat plants were pre-tillering and the remainder early to mid-tillering when sprayed.

Table 3. Control of susceptible wild oat in fallow in southern Queensland. The average wild oat plant number was 97 (plants/m2)

Treatment	MOA	Control%
Glyphosate (0.8L)	M	100
Glyphosate (1.2L)	M	100
Glyphosate (1.6L)	M	100
Sprayseed® (1.6L)	L	94
Gramoxone® (1.2L)	L	93
Glyphosate (0.8L) + Starane® (0.5L)	M+I	100
Glyphosate (0.8L) + Surpass® (1.2L)	M+I	100
Glyphosate (0.8L + Cadence® (115g)	M+I	100
Glyphosate (0.8L) + Goal® (75ml)	M+G	100
Glyphosate (1.2L) + Starane® (0.5L)	M+I	100
Glyphosate (1.2L) + Surpass® (1.2L)	M+I	100
Glyphosate (1.2L) + Cadence® (115g)	M+I	100
Glyphosate (1.2L) + Goal® (75ml)	M+G	100
Glyphosate (1.6L) + Starane® (0.5L)	M+I	100
Glyphosate (1.6L) + Surpass® (1.2L)	M+I	100
Glyphosate (1.6L) + Cadence® (115g)	M+I	100
Glyphosate (1.6L) + Goal® (75ml)	M+G	100
Glyphosate (0.8L) + Atrazine (3L)	M+C	100
Glyphosate (1.6L) + Atrazine (3L)	M+C	100

Figure 1. Depletion of a Group A resistant wild oat seed bank in a northern NSW winter fallow using knockdown herbicides and not allowing any seed replenishment.



Crop rotation

Crop rotation allows for different management practices to be used. Rotating into a winter fallow and growing summer crops enables the use of knockdown herbicides from Groups L and M. In this situation, wild oat seed-bank was reduced from 200 to 1 seed per m² over 2 years (Figure 1) when 100% control was achieved in the fallows.

The northern NSW field trials have tested the impact of changing crop rotation on wild oat. The crop rotations tested were

- Rotation 1 - Wheat – chickpea – wheat
- Rotation 2 - Chickpea – wheat – sorghum.

Both rotations started in August 2003 and ended in November 2005. Over this time there was a 78% reduction in wild oat in rotation 1 and a 100% reduction in rotation 2. The improved control in the 2nd rotation is due mostly to two glyphosate applications and an atrazine application as a residual in the winter fallow.

Winter crop alternatives such as triazine tolerant (TT) or Clearfield™ canola may also be a viable rotational option. In addition, the use of wide rows and GPS steering allows use of inter-row shielded spraying of paraquat + diquat, (Group L). Utilising inter-row spraying and crop desiccation in northern NSW trials, wild oat numbers declined from 30 per 10m² in August to <1 plant per 10m² in November. Crop desiccation with glyphosate was highly effective in preventing seed set from very late germinations of wild oats and survivors from pre and post-emergent herbicide applications.

Further information on the management of wild oat in both crop and fallow can be found in our 'Stopping herbicide resistance' brochures for both southern Queensland and northern NSW. These brochures are available on the Weeds CRC website (www.weeds.crc.org.au/publications/other_products.html) or by contacting a project team member (details on the back of the reporter).

Michael Widderick, Paul Moylan

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