the northern
HERBICIDE RESISTANCE Reporter

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

World First!! Glyphosate Resistant Barnyard Grass *(Echinochloa colona)*

New discovery

Researchers strongly suspect there is at least one population of awnless barnyard grass resistant to glyphosate (up to 4 L/ha Roundup® Powermax). This is a world first.

The resistance test was conducted by Dr Peter Boutsalis, University of Adelaide, and he is planning further tests to verify results. A study of the paddock history and current situation with surviving barnyard grass plants strongly supports Dr Boutsalis' initial test results.

The resistant barnyard grass plants were found in a paddock with a long history of winter cropping and summer fallow weed control relying solely on glyphosate. Over a 5 year period the summer fallow (and therefore the barnyard grass) might have received between 15 and 20 glyphosate applications. This appears to be the "magic" range of applications when glyphosate resistance becomes a very high risk.

Why is barnyard grass a problem?

- A major weed of cropping
- Highly competitive weed of summer crops and fallows in NSW and Qld
- Can produce up to 42,000 seeds per plant
- Strong dormancy - many seeds won't germinate for one or two seasons
- Emergence decreases with burial depth, but seed survival increases
- Overseas, it is resistant to herbicide mode-of-action groups A, B and C
- Another population in northern NSW is resistant to atrazine (Group C)

What should growers do?

Assess your current situation

Are there barnyard grass plants that have survived one or more applications of glyphosate? Moisture or cold stress at the time of application can reduce the level of control and confuse the picture. If a sufficiently high rate of glyphosate was used under good conditions and the barnyard grass grew back, immediate action is required.

Immediate action

- SEED SET MUST BE STOPPED.
- Collect seed for a resistance test – half a cup and let dry in a paper bag.
- Don't cultivate – buried seed will survive for many years.
- Don't graze – stock will spread seed to other paddocks.
- Spray with a high rate of paraquat or Spray.Seed®. If the plants are large a second application might be necessary.
- Keep controlling new germinations until end of season.

Actions for next summer

- Keep paddock in fallow.
- Use a double knock tactic – glyphosate followed by paraquat or Spray.seed 2-3 days later.
- Use TOP RECOMMENDED RATES of paraquat or Spray.seed alone.
- Use a residual herbicide – Spray.seed plus Flame® - followed by wheat, barley or chickpeas.

For further information, contact Andrew Storrie (NSW DPI) on (02) 6763 1174 or andrew.storrie@dpi.nsw.gov.au

Andrew Storrie

Herbicide Resistance Explained

Would you like to learn more about herbicide resistance? If yes, please read on.

In July, August and September 2007, the herbicide resistance project team will be running hands-on workshops on herbicide resistance in southern Queensland and northern NSW. These 'Action Learning' workshops are targeted at farmers, however would also be beneficial for agronomists. The workshops will cover the following broad topics:

- ***What is herbicide resistance?***
- ***Where does herbicide resistance come from?***
- ***How can herbicide resistance be prevented?***
- ***How can herbicide resistance be managed?***
- ***Mode of Action groups***

During the workshops there is plenty of opportunity for sharing ideas and group interaction. Hands-on activities and demonstrations make this full-day event enjoyable and educational. Similar workshops were held in central Queensland with all participants rating the workshop highly. Workshops are planned for Dalby, Roma, Goondiwindi, Spring Ridge, Moree, Coonamble and Warren. Dates are to be finalised soon and will be advertised via our E-lert email system. If you require more information about these workshops, or would like to be added to the E-lert list, please contact Michael Widderick on (07) 46 398856 or michael.widderick@dpi.qld.gov.au

Michael Widderick

In this issue ...

Print Post Approved 424022/1517

Editorial

Welcome to the 9th issue of the Reporter. Since our last issue in October 2006, the New Year has been greeted with some major herbicide resistance happenings. Of greatest note is the verification of glyphosate resistant barnyard grass in the northern region. This is a world first and becomes the second weed in the region resistant to this important herbicide. In this issue you will find further information on this resistant population and information on how you can prevent resistance in your barnyard grass populations.

You will also be aware that the 2006 winter season sounded major alarm bells in regard to Group A resistance in wild oat. Many populations were ineffectively controlled with Group A herbicides and are strongly suspected as being resistant. In this issue we provide useful information on how you can plan to better manage these resistant weeds. In the coming winter season we also plan to test herbicide alternatives on resistant wild oat populations.

It is almost time for fleabane to rear its ugly head. We have included new information from our research which will provide you with greater insight into this troublesome weed and its management. Please read the article on the recent fleabane workshop which facilitated communication of information from key agronomists and researchers.

For southern Queensland and northern NSW readers, look out for the notice on action learning workshops which will be held in your region in July/August this year. If you are a farmer and you want to find out more about herbicide resistance and how to prevent and manage it, this is the event for you!! We will also be holding Agronomist workshops in Toowoomba and Tamworth in September with the aim of discussing up to date information on HR in Australia and overseas.

Remember, we welcome any feedback you may have on this publication or the research we are doing. We are here to help you and to this end will do whatever we can within our capacity. While we may not have all the answers we welcome enquiries.

Michael Widderick

UPDATE ON HERBICIDE RESISTANCE

At the recent CRDC Grains Research Updates held at Dubbo and Goondiwindi, the following presentations were made on herbicide resistance and weed management.

- *'How management responds when resistance drives the system' by Peter Newman (Dept of Agriculture and Food, WA)*
- *'Resistance management issues in Central NSW – glyphosate resistant weeds; Group A resistant wild oats; double knocking weeds in northern systems' by Andrew Storrie (NSW DPI)*
- *'Seed persistence of key northern region weeds' by Steve Walker (QLD DPI&F)*

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

Michael Widderick

Fleabane – Just What Are We Dealing With?

Fleabane has been making its mark on Australian farming systems in recent years. Originally, fleabane was primarily a weed of roadsides, where bare road shoulders enabled fleabane to germinate and flourish. Fleabane is now considered an important weed of reduced cultivation systems, from Albany 500 klms further west to Emerald.

Canadian Fleabane

On the world scene two fleabane species, Canadian fleabane ('horseweed' or 'mares-tail' in North America) and flax-leaf fleabane are gaining notoriety by developing resistance to glyphosate. Since the widespread adoption of Roundup Ready® crops in the USA, glyphosate-resistant Canadian fleabane *(Conyza canadensis)* has infested 44 000 ha from Delaware to Arkansas and Mississippi. Glyphosate-resistant flax-leaf fleabane *(C. bonariensis)* is also becoming an issue in the vineyards of Cape Province in South Africa.

With all this happening overseas, it is a good idea to review which species we have in Australia. Around the world there are 60 species, all of which are found in the temperate climate zones. In Australia there are 7 species recognised to date, all of which are naturalised and not native.

According to "The Flora of NSW Volume 3" (1992) the following species are found in NSW and other States:

- *Conyza bonariensis* – flax-leaf fleabane
- *Conyza leucantha*
- *Conyza chilensis*
- *Conyza sumatrensis* (also called *C. albida*) – tall fleabane
- *Conyza canadensis* – Canadian fleabane
- *Conyza parva*
- *Conyza bilbaoana*

Flax-leaf Fleabane

Survey results

A survey of fleabane conducted by the Northern Herbicide Resistance project team in 2006 (Table 1) showed that the main species in the cropping areas of northern NSW and southern Queensland are flax-leaf and tall fleabane. All specimens from South Australia and Western Australia were flax-leaf fleabane. The tall fleabane specimens were collected from the higher rainfall areas in the eastern zones in NSW and Queensland. One specimen from NSW (Mungindi) was considered an intermediate between flax-leaf and tall fleabane. No specimens of Canadian fleabane were collected, although Australia's Virtual Herbarium show a significant number of specimens have previously been collected from coastal Queensland and south-eastern NSW.

Table 1. Results of the 2006 fleabane survey

Species	Queensland	NSW	SA	WA
Flax-leaf fleabane *(C. bonariensis)*	35	41	6	4
Tall fleabane *(C. sumatrensis)*	6	3		
Intermediate species		1		

CONTINUED NEXT PAGE

Identification

The different species of fleabane can be distinguished by their botanical characteristics. As a guide, Table 2 highlights some of the major differences between the 3 main species. Examples of each species are shown in the photos. Identifying these species is probably best left to the experts at the various state herbaria.

Table 2. Characteristics of the main three fleabane species in the northern grain region.

Characteristic	Flax-leaf fleabane	Tall fleabane	Canadian fleabane
Mature plant height (m)	1	2	1.5
Stem branching	Unbranched below flower head	Single stem	Single stem
Inflorescence shape	Lateral branches over-topping main stem	Pyramid with lateral branches not over-topping main stem	Pyramidal
Floret colour	White to pink	Straw	Cream
Floret bracts	Densely hairy	Densely hairy	Hairless
Receptacle	Smooth pitted	Roughly pitted	Smooth pitted
Flowering time	Most of the year	December to August	Most of the year

Tall Fleabane

It is unknown whether there are any major agronomic differences between the species that would affect management, except the different flowering times, and possible response to glyphosate (see 'Glyphosate resistance in flaxleaf fleabane' article below). All three species have developed herbicide resistant populations in other parts of the world. Resistance in tall fleabane is still limited to paraquat, while the other two species have populations resistant to a number of modes of action, including glyphosate. This may be due to the limited range of countries that have tall fleabane, and their predominant use of paraquat for weed control.

Reference

Dauer, J.T., Mortenson, D.A. and Van Gessel, M.J. (2007) Temporal and spatial dynamics of long-distance Conyza canadensis seed dispersal. J. Applied Ecology. 44, 105-114

Andrew Storrie

Fleabane Problem Solving at Recent Workshop

Researchers and advisors met recently at a 2nd workshop on fleabane, to discuss effective management options for this difficult-to-control weed.

Held in Toowoomba in February, the workshop aimed to combine information gained by researchers and advisors since the previous workshop held in 2004, and prioritise future research issues.

Participants shared information on species identification, seed-bank dynamics, control in winter cereals, sorghum, cotton and fallow and glyphosate tolerance screening. Regional and industry experiences in managing the species from Queensland, New South Wales, Victoria, South Australia and Western Australia were also presented.

Discussion was also held on the needs for further research, including the impact of moisture stress on herbicide control, management of fence lines and, further work on double knock and split herbicide applications.

The workshop was attended by representatives of the Queensland DPI&F, New South Wales DPI, GRDC, CRDC, Northern Growers Alliance, Australian Cotton Growers Research Association, regional advisors and chemical companies.

The proceedings of the workshop will shortly be available on the Weeds CRC website (http://www.weeds.crc.org.au/publications/wshop_proceedings.html), along with a brochure on fleabane management.

Jeff Werth

Glyphosate Resistance in Flaxleaf Fleabane?

Some weed practitioners believe that populations of flaxleaf fleabane have become more difficult to control with glyphosate over time, while others state that this weed has always been very difficult to control particularly with glyphosate.

A recent pot experiment, described in the previous edition of the Reporter, investigated this controversy, and revealed some interesting findings.

All 21 flaxleaf fleabane populations, grown from seed collected from various crop and fallow paddocks in southern Queensland, responded very similarly, when they were sprayed with a range of glyphosate rates in the glasshouse. On average, seedlings biomass following treatment with 1.5 L/ha was 28% compared with the untreated (see Figure 1). Many weeds from these situations also survived the highest rate of 12 L/ha, although these plants were greatly reduced in size.

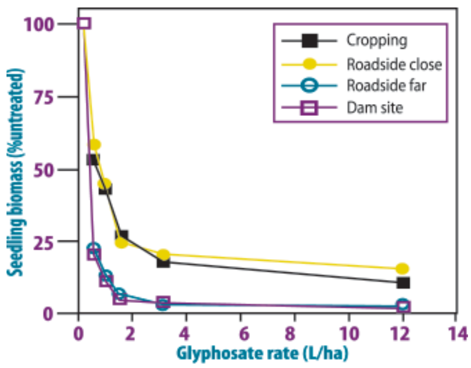


Figure 1. Response of flaxleaf fleabane populations to glyphosate. Seed were collected from cropping paddocks, roadsides close to cropping paddocks, roadsides remote to cropping paddocks, and a natural area near a dam

In contrast, all flaxleaf fleabane populations, grown from seed collected from non-cropping situations, were much more susceptible to this herbicide. For example, seedlings biomass following treatment with 1.5 L/ha was only 3-4% compared with the untreated, and all died after being sprayed with 12 L/ha. These populations are unlikely to have been exposed to any, or very limited, glyphosate spraying previously.

Interestingly, fleabane populations collected from roadsides throughout southern Queensland differed substantially, depending on their location. Those from sites within close proximity to cropping (less than 50m away) responded the same as those from nearby crop and fallow paddocks. In contrast, those collected from roadsides at greater distances from cropping (more than 200m) responded the same as those from non-cropping situations.

This indicates that flaxleaf fleabane populations that have been subjected to regular treatment with glyphosate are currently more tolerant to glyphosate than those populations from situations without a history of glyphosate use. Seeds or pollen from these more tolerant biotypes may have then moved short distances away from cropping paddocks to nearby roadsides.

Whether these more tolerant populations are glyphosate resistant will be investigated further. Stay tuned!

Steve Walker

The Genie is Out of the Bottle or "What can I do with my Group A resistant wild oats?"

The spring of 2006 saw herbicide resistant wild oats becoming a major talking point in the pubs of northern NSW. Many farmers found they had wasted $30-40/ha spraying chickpea crops with Group A herbicides such as haloxafop and sethoxydim, achieving very poor wild oat control. Was this a new phenomenon?

History of herbicide resistance in wild oats

The first case of Group A resistance in wild oats in Australia was in 1986 to diclofop in Western Australia. The first cases of Group A resistance in wild oats in the Northern Grain Region were found in 1996 between Moree and Goondiwindi. This was on two separate properties practicing a winter pulse-durum wheat rotation. Group A herbicides were use in both pulse and cereal crop, with no other tactic used to control the wild oats. Each paddock had received more than 8 applications of Group A herbicide. One of these properties also had infestations of Group A resistant paradoxa grass *(Phalaris paradoxa).*

The pulse-durum rotation was seen by growers as "the most profitable" rotation. However, Group A herbicides began not to work and yield reductions of over 50% resulted from the uncontrolled wild oats.

In 2003 a GRDC funded project with the University of Queensland found in a random survey of paddocks across southern Queensland and northern NSW that 10% of wild oats collected were resistant to Group A herbicides. This is a high percentage for a random survey.

Resistance to other Modes-of Action

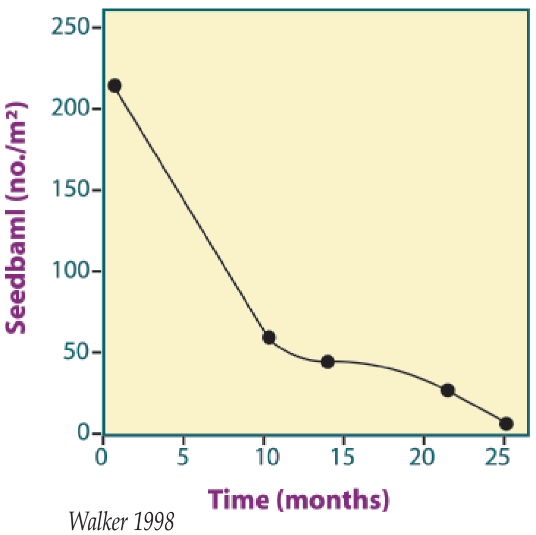
At least 9 populations of wild oats in NSW are resistant to Mataven® 90 (Group K) and a number of populations strongly resistant to Hussar® and developing resitance to Atlantis® (Group B).

At least one population is resistant to both Group A and K herbicides and possibly Group B herbicide as well.

The bottom line for managing herbicide resistance

Once a weed population has been driven to being predominantly resistant, the ratio of resistant to susceptible weeds will not change. The only thing that can be changed is the total number of weeds, that is, the size of the seed bank. The only way to reduce the seed bank size is to stop all new seed being added to the soil seedbank.

Figure 1. Reduction of Group A resistant wild oat seedbank with no further addition of seed, North Star



Walker 1998

RULES FOR MANAGEMENT

Prevent seed set of all weeds every season

Research studies show that half the wild oat seed in the soil disappears every six months. Figure 1 shows that with no further additions of seed the wild oat seedbank can be reduced to very low numbers within 2 years under no-till conditions. Cultivation will bury seed and extend the life of the seedbank.

Hit it hard and hit it early

Farmers that have been caught out with large numbers of wild oats that have set seed in 2006 have some hard decisions to make. Action to control seed set should have occurred in September 2006. The best, yet most difficult, technique in the situation of a "blow-out" is to spray-out the crop before weed seed set to prevent weed seeds entering the seedbank. However, the price of chickpeas in 2006 ruled out this option.

Work by Bill Roy and others in Western Australia on annual ryegrass showed that by "brown manuring" or cutting a crop for hay or silage, and totally preventing weed seed set actually gives an extended period of low weed numbers. Doing this for 2 years drives the seedbank numbers so low that 5 years without spraying was possible, if crop competition was increased.

Increase crop competition

Good basic agronomy and disease management, combined with optimum nutrition and the following factors, greatly improves crop competitiveness.

When Things Go Pear Shaped – Weeds With Multiple Resistance!

To effectively manage herbicide resistance a range of cultural and chemical strategies need to be employed. The ability to choose from a wide variety of options increases the chances of success. Multiple resistance, or the ability of a weed to survive more than one herbicide group that would normally kill that species, can dramatically reduce the control options available.

In the northern grain region, there are increasing reports of multiple resistant wild oats in northern NSW. The most common case is resistance to Groups A (for example Topik®, Achieve®, Wildcat®) and K (Mataven®90). Fortunately, in the last 4 to 6 years, new herbicides Atlantis® and Hussar® (Group B) were introduced. They work extremely well if applied to small wild oat plants (1 to 3 leaf stage), controlled a range of broad-leafed weed species and appeared to be the saviour for many farmers.

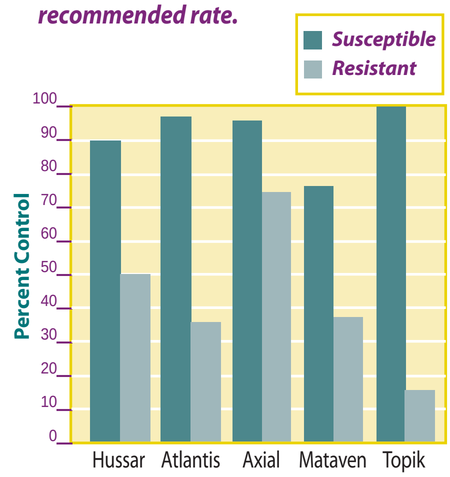
However, there were already concerns that early signs of Group B resistance had emerged in the last few years. An article by Paul Moylan in the Reporter in June 2006 titled, "Is there potential for Group B resistance in wild oats?" mentioned a trend of reduced control over time with Group B herbicides.

As a result, wild oat seed from a population suspected of having multiple resistance to Groups A, B and K was used in a pot experiment to test the levels of resistance. The experiment consisted of two wild oat populations, one from an area without a history of herbicide application (susceptible) and the other with a heavy reliance on all three herbicide groups (resistant). The susceptible population was used as a benchmark to ascertain the levels of control that is expected from successful herbicide application. Five herbicides were applied (Hussar®, Atlantis®, Topik®, Axial® and Mataven®90) at the recommended and double rates at the label recommended growth stages.

Assessments of the treatments (Figure 1, Photos 1 and 2) confirm the presence of multiple resistance to the three herbicide groups. Control of wild oat panicles was consistently high for the susceptible population (77 to 100% control). This contrasts with poor control for the resistant population (14 to 74% control).

Although some of these herbicides rely upon crop competition for improved control (Mataven®90,

Figure 1. Wild oat control 27 days after treatment with various herbicides at the recommended rate.



Hussar® and Atlantis®), the differences in control without a crop clearly demonstrate moderate to high levels of resistance.

The implications of multiple resistance are serious.

- **Sow a competitive crop and cultivar. Chickpeas have little competitive ability with weeds, while barley has been show to be very competitive in this region.**
- **Sow at the optimum time at the optimum depth for the cultivar.**
- **Reduce the row spacing of winter cereals. Planting rows for winter cereals wider than 30cm has severely reduced the competitive ability of these crops. Using narrower rows might require a late stubble burn to reduce trash. This will also allow the successful use of trifluralin and/or Avadex® Xtra.**
- **Increase sowing rates. Although a controversial suggestion in many circles, there is plenty of data to show that in most seasons increasing sowing rate of wheat to the optimum for yield does NOT increase the percentage of small grain over lower sowing rates.**

Are all Group A herbicides out?

The only way to know is to have a reputable resistance test done. If predominately 'fop' Group A herbicides have been used, the 'dim' herbicides may still be useful for one or two years.

Figure 2 shows the results of a trial near Moree where 'dim' Group A herbicides were still active, and some other MOA's worked. The best treatments were Mataven® L as an early post application and Achieve® (a dim) + selective spray-topping with Mataven® L. Wildcat® (a fop) + Mataven® SST gave poor control because Wildcat® gave no control. Select® gave lower levels of control as it killed the wheat and allowed a later germination of wild oats to establish.

Caution should be used in interpreting the results in Figure 2, because 'dim' Group A herbicides failed in this field in 2006. Therefore the ability to use a 'dim' instead of a 'fop' will give a short-term reprieve only.

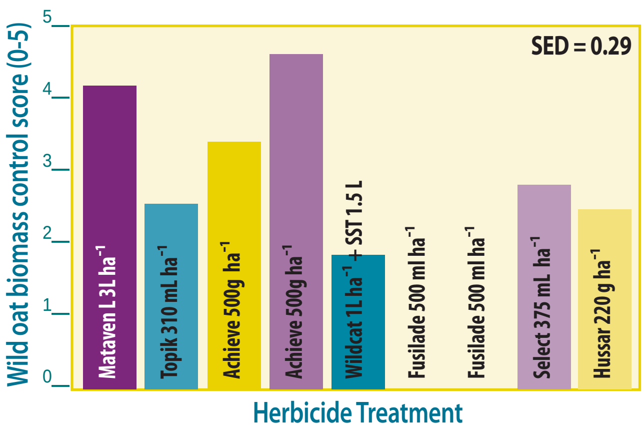


Figure 2. Control of 'fop' resistant wild oats with a range of post emergent herbicides in wheat, 2001. Control score: 0 = nil control; 4 = 80%; 5 = 100%;

Use another herbicide mode-of-action?

There are populations of wild oats in Northern NSW that are already resistant to Group A herbicides plus Mataven® 90 (Group K) as well as populations resistant to both Groups A and B.

Avadex® Xtra and trifluralin will still be effective. How to fit them into reduced tillage systems on heavy textured soils is the challenge. As these herbicides usually give 70-90% control, other tactics will need to be used to control the later germinations. This will be an option in cereals, but not chickpeas.

Conclusions

- **Wild oat populations MUST be tested for resistance to Groups A, B and K before the start of the season. Otherwise, fallow until a summer crop can be planted.**
- **Wild oats must be managed with competitive winter cereals in rows less than 35 cm. Introduce Avadex® +/- trifluralin as pre-emergent herbicides followed by any selective post-emergent herbicide that is still effective.**
- **Rotate to a winter fallow-summer crop for several years to deplete the wild oat seedbank.**
- **If growing chickpeas, the wild oat seed bank must be very low before planting. Delay sowing to allow control of wild oats with glyphosate before sowing. Use Avadex® Xtra and consider increasing the rate of simazine. DO NOT use Group A herbicides or Mataven® 90 in chickpeas. Desiccate crop with glyphosate.**

Andrew Storrie

Photo 1: Susceptible population (left to right - in columns) - untreated control, Topik®, Mataven®90, Axial®, Atlantis® and Hussar®. Treatments applied at the recommended rates.

With the loss of three herbicide groups (all post-emergence herbicides), the only available options are to use pre-emergence herbicides and rely upon cultural control strategies. Unfortunately these options are not readily adopted. A few farmers in this region are changing to the use of either Avadex®Xtra (Group E) or trifluralin (Group D) to keep wild oat numbers low and to prevent or delay resistance.

Rotating to summer crops is seen as one of the most useful strategies against winter grass weeds. However, this option is not viable in south-western areas of the northern grain belt where they are restricted to winter cropping.

Long fallowing could also be used on the affected areas, but the temptation to grow a profitable wheat crop is difficult to resist. Other potential winter crops include canola, chickpeas (conventional or wide row) or barley. These crops can rely upon different herbicides (mostly pre-emergence), or inter-row spraying (chickpeas) and barley is highly competitive with weeds. In addition, delayed sowing of crops in areas with higher wild oat populations and the use of double knock strategies can lessen the impact of resistance. Also, forage crops can be used and grazed heavily or cut just prior to wild oats flowering.

Photo 2: Resistant population (left to right - in columns) - untreated control, Topik®, Mataven®90, Axial®, Atlantis® and Hussar®. Treatments applied at the recommended rates.

To preserve the use of these new herbicides, Hussar® and Atlantis®, additional and alternative strategies must be used to ensure that no wild oat seed returns to the soil each season. Without seed production herbicide resistance cannot persist.

Tony Cook

Plan Now for Better Wild Oat (*Avena* spp.) Management

Three tactics were tested in a trial east of Coonamble with a high wild oat population with the aims of developing an effective integrated management plan to reduce the over reliance on Group A herbicides and to stop wild oat seed set. The tactics used were:

Tactic 1 - **Delayed application of knockdown herbicide to control main wild oat flush prior to planting wheat.**

Tactic 2 - **Use of pre-emergent Group D & E herbicides incorporated and not incorporated into the soil.**

Tactic 3 - **Selective use of post-emergent Group B & K herbicides.**

Tactic 1:

Initial wild oat numbers were high, approximately 100 plants/m². The overall glyphosate application (450g/L at 2L/ha) was deliberately delayed to ensure as many wild oats as possible were targeted. Although this tactic controlled the main flush, late germinations were not controlled, resulting in a population of 76 plants/m² by July.

Delayed application of knockdown herbicide is very effective when used in conjunction with additional weed management tactics. Pre-emergent herbicides are particularly beneficial if high weed numbers are expected.

Table 1. Control of wild oats in wheat using pre-emergent herbicides and post-emergent knockdown herbicides following an overall pre-plant application of glyphosate (450g/L at 2L/ha).

Pre-emergent treatment (24th May)	Wild oat control (18th July)		Post emergence treatment (18th July)	Wild oat control (4th October)		Crop yield
	Density (m²)	(%)		Density (m²)	(%)	(t/ha)
Trifluralin 1.5L/ha	3	96	Atlantis 0.33L/ha	3	96	1.3
Trifluralin 2L/ha	12	84	Atlantis 0.33L/ha	0.5	99	1.3
Trifluralin 0.8L/ha #	15	80	Atlantis 0.33L/ha	0.1	99.9	1.1
Trifluralin 1.2L/ha #	8	90	Atlantis 0.33L/ha	5	93	1.2
Avadex Xtra 1.6L/ha #	6	92	Atlantis 0.33L/ha	0	100	1.2
Avadex Xtra 2L/ha #	13	82	Atlantis 0.33L/ha	0.5	99	1.2
Trifluralin 0.8L/ha + Avadex Xtra 1.6L/ha #	2	97	Atlantis 0.33L/ha	0	100	1.1
Trifluralin 1.5L/ha + Avadex Xtra 1.6L/ha	5	93	Atlantis 0.33L/ha	0	100	1.1
Trifluralin 2L/ha + Avadex Xtra 2L/ha	7	91	Atlantis 0.33L/ha	0	100	1.3
Trifluralin 1.5L/ha + Avadex Xtra 1.6L/ha + Glean 20g/ha	2	97	Mataven® 90 2.5L/ha	0.4	99	1.1
Trifluralin 0.8L/ha + Avadex Xtra 1.6L/ha + Glean 20g/ha #	3	96	Nil	2.6	-	1.2
Nil	76	0	Nil	82		0.5
LSD (5%)	**20**					**0.2**

 # indicates treatment was incorporated. Unmarked treatments were not incorporated
Trifluralin 480 g/L formulation.

Tactic 2:

Trifluralin (Group D) and Avadex® Xtra (Group E) were applied at different rates, with and without incorporation in late May just prior to sowing. The residual activity of these treatments reduced the wild oat population considerably (Table 1). The best treatments were Trifluralin 0.8L/ha + Avadex® Xtra 1.6L/ha (incorporated), Trifluralin 1.5L/ha + Avadex® Xtra 1.6L/ha + Glean® 20g/ha (not incorporated) and Trifluralin 1.5L/ha (not incorporated) providing 96-97% control in July.

However, wild oat seed production can be high with up to 200 seeds per survivor of the pre-emergent treatments. Even with 6 plants/m², seed production could exceed 1200 seeds/m². These survivors must be controlled before they replenish the seed bank. Hence, a post-emergent herbicide is required to control any survivors.

Tactic 3:

The selective post-emergent herbicides Atlantis® (Group B) at 0.33L/ha and Mataven® 90 (Group K) at 2.5L/ha were applied 33 days after emergence. This tactic resulted in four treatments with zero wild oat seed production. Another was extremely low with 1 plant per 10m² (Table1).

Conclusions

Local research has shown that combining three management tactics, up to 100% reduction in wild oat numbers can be achieved in one year. Using delayed knockdown herbicide and pre-emergent herbicides without post-emergent herbicides allows late germinations and survivors to set seed. Not controlling the wild oat population resulted in a 60% reduction in crop yield from 1.3 to 0.5 t/ha.

These tactics can be incorporated into an integrated management plan to combat or prevent Group A resistant wild oats.

Paul Moylan

A Winter M & M Strategy for CQ Will Reduce Resistance Risk

With the prospect of autumn rain accompanied by opportunities to plant wheat and chickpea in Central Queensland this winter, growers need to consider mixing their herbicides if targeting turnip weed, charlock, African turnip weed and sowthistle. Level of control should be monitored and follow-up management should be applied to control survivors.

You may recall the herbicide risk assessment we conducted 5 years ago identified a couple of our cruciferous weeds (the turnips) and sowthistle as being at moderate to high risk of developing resistance to Group B herbicides (mainly metsulfuron-methyl or Ally®). This assessment was also supported by the University of Queensland random field survey within the region that found three populations of African turnip weed and two populations of sowthistle as being "insensitive" or having low level background resistance to Group B herbicides.

Many CQ growers only apply Ally® and don't consider using MCPA or 2,4-D unless Mexican poppy is present in paddocks. The continual sole reliance and use of Ally® over several years creates a selection pressure which could result in the appearance of resistant plants that will no longer be controlled by this cheap and once-effective herbicide. These resistant plants eventually may become resistant populations without using alternative management tactics. Remember, it has already happened in southern Queensland and northern New South Wales!

The risk of resistance can be greatly reduced, if growers mix their herbicides and monitor their levels of control. Controlling escapes to prevent seed set is the only way to guarantee that no herbicide resistance will develop. Most of the cruciferous weeds and sowthistle are susceptible to both 2,4-D and MCPA (both are Group I herbicides). Growers intending to apply Ally® this winter should also consider adding one of these other herbicides to the tank, irrespective of the presence of Mexican poppy, and then closely monitor their paddocks to ensure no seed set occurs. The additional herbicide needs to be added to the tank at a robust rate which would be sufficient to kill the target weeds if it where applied alone. Alternatively, 2,4-D or MCPA could be used without the addition of the Ally® – this reflects a rotation of herbicide mode of action groups, a strategy also known to be effective in avoiding development of herbicide resistance.

A mix it up and monitor strategy used this winter will preserve a very cost-effective herbicide!

Vikki Osten DPI&F, Emerald

Fine tuning the double knock technique for glyphosate resistant ryegrass

In the June 2005 edition of the Reporter, we discussed results from the NSW DPI experiments using the double knock technique on glyphosate resistant annual ryegrass. To summarise, the technique worked extremely well with 95 – 100% control.

The double knock technique is the use of a desiccant herbicide (eg. paraquat and Spray.seed®) generally applied 7 to 10 days after glyphosate to control glyphosate resistant individuals or to control susceptible survivors to prevent/delay the onset of glyphosate resistance.

It is not always practical or possible to apply the desiccant herbicide within this time frame due to rainfall, machinery breakdowns, other work priorities and shortage of labour. Consequently a field experiment investigated the effects of delayed application of the desiccant.

Results from last year's experiments using conventional double knock were excellent considering we sprayed annual ryegrass up to the early tillering stage. In the follow-up experiment treatments were applied to plants up to the mid-tillering stage.

As the data in Table 1 shows, control of annual ryegrass ranged from 89 to 97% with applications of the desiccant herbicide made to mid-tillering plants. The level of control did not decline with later applications because the rate of herbicide was increased to account for the greater size of annual ryegrass.

The Spray.seed® and the paraquat labels have directions stating that larger weeds require higher rates. Rates of Spray.seed® and paraquat were increased from 1.5L/ha to 2.5L/ha with later application dates or increasing weed size.

Table 1. Effectiveness of double knock treatments on glyphosate resistant annual ryegrass at Spring Ridge NSW. The following treatments followed an initial application of glyphosate (450g/L) at 1.2L/ha to annual ryegrass between 1 leaf and early tillering stage.

2nd application treatment	Days after initial application	ARG growth stage	% control
No herbicide			45
Paraquat (250g/L) 1.5L/ha	4	2 ½ leaf - early tillering	96
Spray.seed® 250 1.5L/ha	4	2 ½ leaf - early tillering	94
Paraquat (250g/L) 2.0L/ha	8	3 leaf - early tillering	97
Spray.seed® 250 2.0L/ha	8	3 leaf - early tillering	93
Paraquat (250g/L) 2.0L/ha	18	Early to mid tillering	96
Spray.seed® 250 2.0L/ha	18	Early to mid tillering	93
Paraquat (250g/L) 2.5L/ha	22	Mid-tillering	93
Spray.seed® 250 2.5L/ha	22	Mid-tilering	89

For further information contact Tony Cook (NSW DPI - Tamworth) on (02) 67631250.

When applying Group L herbicides, such as paraquat and Spray.seed®, it is important that they are applied to small weeds, if possible. A robust herbicide rate should also be applied. This latest experiment showed that there is some flexibility with the double knock technique if there are unforseen delays.

We plan to conduct a residual herbicide experiment on glyphosate resistant ryegrass during the 2007 winter season. Effective residual herbicides can be useful in winter fallows, as the double knock technique is primarily aimed for pre-sowing seedbed preparation. Reliable annual ryegrass control during a winter long fallow can not solely rely upon double knock. A good residual treatment will lessen the need to retreat paddocks every time ryegrass emerges.

Tony Cook

First Weed With Multiple Resistance to Both Glyphosate and Paraquat

An article recently published confirmed the world's first case of field-evolved multiple resistance to glyphosate and paraquat. The ryegrass biotype was also resistant to various Group A herbicides.

Seeds of this weed were collected from Tulbagh Valley in South Africa, where glyphosate had been used for over 25 years, paraquat for over 40 years, and Group A herbicides for only about 3 years.

Testing showed that the glyphosate LD50 for seedling mortality for the resistant biotype was 14 times greater than for a known susceptible, and the paraquat LD50 was 32 times greater. The biotype was resistant to all tested 'fop' herbicides, several 'dim' herbicides, but was susceptible to clethodim, as well as the tested Group B, C and D herbicides.

The mechanism for paraquat resistance was due to restricted paraquat translocation. This is thought to be due primarily to increased sequestration of paraquat into vacuoles of the cells, thus reducing paraquat damage and overall translocation.

The authors found two mechanisms endowing glyphosate resistance; mutation in the EPSPS gene and reduced translocation to the young growing leaves.

The accumulation of multiple resistance within the population is either as a result of sequential selection or due to cross pollination between individuals with different resistant mechanisms.

Whilst ryegrass is a species very prone to resistance, with extensive resistance to numerous herbicides, this case represents a 'wake-up call' that weeds can develop multiple resistance to important herbicides. This resistant weed is found on a number of farms in the Tulbagh Valley and presents a serious challenge for these growers to manage in the future.

Original article: 'Glyphosate, paraquat and ACCase multiple herbicide resistance evolved in a Lolium rigidum biotype' by Qin Yu, Andrew Cairns and Stephen Powles. Published in Planta (2007) 225: 499-513.

Steve Walker

Editors

Michael Widderick (QDPI & F)
Phone: 07 4639 8856
PO Box 2282 Toowoomba QLD 4350
Email: michael.widderick@dpi.qld.gov.au

Steve Walker (QDPI & F)
Phone: 07 4639 8838
PO Box 2282 Toowoomba QLD 4350
Email: steve.r.walker@dpi.qld.gov.au

For further information contact

Andrew Storrie (Project Leader - NSW DPI)
Phone: 02 6763 1174
4 Marsden Park Road Calala NSW 2340
Email: andrew.storrie@dpi.nsw.gov.au

Vikki Osten (QDPI & F)
Phone: 07 4983 7406
LMB 6 Emerald QLD 4720
Email: vikki.osten@dpi.qld.gov.au

IF YOU KNOW OF ANYONE INTERESTED IN RECEIVING THIS NEWSLETTER, PLEASE SEND THEIR CONTACT DETAILS TO THE EDITORS

the northern HERBICIDE RESISTANCE Reporter *is proudly supported by ...*

GRDC Grains Research & Development Corporation

Queensland Government Department of Primary Industries and Fisheries

NSW DEPARTMENT OF PRIMARY INDUSTRIES

CRC Weed management

the northern HERBICIDE RESISTANCE Reporter

If undeliverable, return to
PO Box 2282, Toowoomba Qld 4350
Print Post Approved 424022/1517

SURFACE MAIL

POSTAGE PAID AUSTRALIA