the northern
HERBICIDE RESISTANCE Reporter

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

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Editorial

Welcome to the last issue of the Northern Herbicide Resistance Reporter for phase II of the northern HR project. Phase II of the project is drawing to a close and finishes at the end of June this year. We have included in this issue a summary of some of our work, including the double-knock tactic and wild oat control. Also we have included an article on what you can expect from the team in the third phase of the project which will hopefully start in July 2008.

Now is an opportune time to have your input into what you feel are important issues in HR for the northern cropping region. In addition, we welcome feedback on this newsletter. Please do not hesitate to contact me about any related issues. My contact details are on the back page of the reporter.

I hope you enjoy this issue of the reporter and on behalf of the team, we look forward to future communications in our new project.

Michael Widderick

Phase three of the Herbicide Resistance Project - What to expect

The northern herbicide resistance project team are currently drawing to a close phase two of the project. If successful, phase three of the project will begin in July 2008 and continue until June 2011.

Phase three of the project will draw on the work from phases one and two and will continue to focus on the prevention of further herbicide resistance development as well as the management of current resistance. Three main areas will be covered in this project, namely developing tactics, understanding the ecology of resistant and at-risk weeds, and computer modelling of glyphosate resistance, all of which will be used to develop and refine preventive and management strategies.

Herbicide resistance prevention will evaluate weed management alternatives for key 'at risk' weeds, while herbicide resistance management will focus on the two priority areas of resistance, namely glyphosate resistance (existing and new cases) and resistance in wild oats. The project team will keep abreast of new cases of resistance through regular consultation with stakeholders. New cases of resistance will be addressed with containment and control in mind.

A thorough understanding of weed ecology is vital for devising effective weed management strategies. Currently, only limited data exist for this important topic. This new project will undertake in-depth ecological studies on seed-bank dynamics for different environmental and tillage systems, including seed persistence and spread, and options for accelerated seed-bank decline for target weeds. Such information will strengthen herbicide resistance prevention and management strategies and improve weed management overall in the long-term.

The glyphosate resistance model will be expanded to include additional 'at risk' weeds, such as liverseed grass and sowthistle. The model will also be extended to include other summer grain crops, such as mungbeans, and cotton, particularly herbicide tolerant cotton. The simulations will enable each weed and farming system to be rated for their relative risk of glyphosate resistance developing within certain time-frames. As well, the model will predict the impact of different preventive tactics. Another model, the Weed Seed Wizard, which is currently being developed within the Weeds CRC, will be evaluated for its suitability for predicting the effects of different management tactics on weed seed banks. The predictions from both models will greatly improve the content and strengthen the strategies for prevention and management of herbicide resistance.

We will continue to have a strong development and extension component, effectively delivering up-to-date herbicide resistant information and practical strategies to agronomists and farmers through workshops, newsletters and networks such as the QDPI&F Farming Systems projects and the Northern Grower Alliance. The northern herbicide resistance reporter will become an annual publication.

As always, if you have any relevant information or insights into herbicide resistance that would assist the project team, please feel free to contact us. Contact details are provided on the back page.

Michael Widderick

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Double knock is effective on a broad range of weeds

Double knock is a weed management strategy which refers to the 'Sequential application of two different control options on the same cohort, where the second option is designed to control the survivors of the first'.

The original incarnation of double-knock was Spray.Seed® followed by full disturbance sowing. Commonly the double-knock treatment involves 2 different herbicide treatments. However, it can also include non-chemical weed control tactics such as tillage and grazing. Other examples of double knock include:

- Spraying with Avadex® or Topik® or Wildcat® followed later in the season with ½ to ¾ rate of Mataven® for wild oat (selective spray-topping)
- Fallow treatment with a residual + paraquat, followed by treatment with a different knock-down herbicide through a Weedseeker® for barnyard grass

The main benefit of double knock is to control the seed set on survivors, which in turn

- Reduces weed pressure
- Reduces reliance on one weed control option
- Reduces the risk of herbicide resistance
- Can control low numbers of resistant weeds

Over the past 3 years, the northern herbicide resistance project team have tested the efficacy of various double knock strategies on key weeds in the region including annual ryegrass, barnyard grass, sweet summer grass and fleabane. In addition, David Thornby has been investigating the impact of the double-knock strategy on the glyphosate resistance risk of barnyard grass populations using computer modelling.

Annual Ryegrass

The presence of glyphosate resistance and the threat of additional resistances to other mode of action herbicides is ample reason to adopt the double knock technique for annual ryegrass.

A series of experiments by NSW DPI have investigated most aspects of the double knock technique on annual ryegrass. Initial research targeted basic combinations of knockdown herbicides with herbicides from many modes of action. In later trials, more effective herbicides were investigated for their herbicide rate and timing effects.

Table 1. Level of annual ryegrass control from different double knock treatments

Herbicide(s) and Timing(s)	Rate(s)/ha	Control (%)
Glyphosate 450 (T1)	1.2	44
Glyphosate 450 (T1) + paraquat (T2)	**1.2L + 1.5L**	**96**
Glyphosate 450 (T1) + Spray.seed® (T2)	1.2L + 1.5L	94
Glyphosate 450 (T1) + paraquat (T3)	**1.2L + 2.0L**	**97**
Glyphosate 450 (T1) + Spray.seed® (T3)	1.2L + 2.0L	93
Glyphosate 450 (T1) + paraquat (T4)	**1.2L + 2.0L**	**96**
Glyphosate 450 (T1) + Spray.seed® (T4)	1.2L + 2.0L	93
Glyphosate 450 (T1) + paraquat (T5)	**1.2L + 2.5L**	**93**
Glyphosate 450 (T1) + Spray.seed® (T5)	1.2L + 2.5L	89
Paraquat + Flame (T1)	**1.5L + 200mL**	**100**
Paraquat + Glean (T1)	1.5L + 20g	99.6
Paraquat + Dual Gold (T1)	**1.5L + 2.0L**	**99.7**
Paraquat + atrazine 500 (T1)	1.5L + 3.0L	99.9

Note T1 = 1 leaf to early tiller, T2 = 2 leaf to early tiller (4 days after T1), T3 = 3 leaf to early tiller (8 days after T1), T4 = early to mid-tiller (18 days after T1), T5 = mid-tiller (22 days after T1)

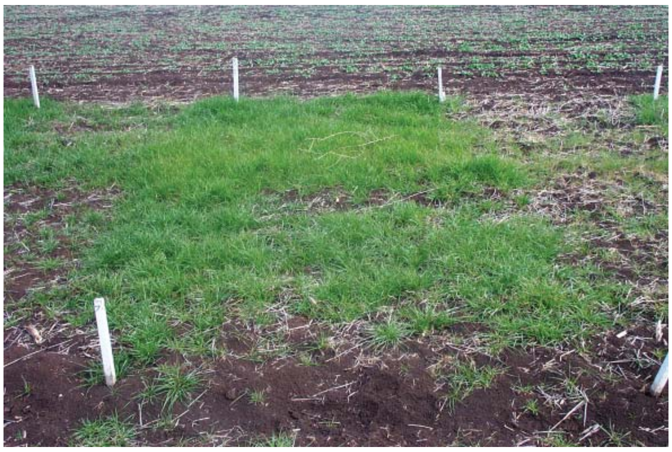
The following points summarise the findings of the work carried out. All work was done on fallow annual ryegrass predominantly using paraquat or Spray.Seed® as the second knock component.

- **The desiccant herbicide paraquat was slightly more effective than Spray.Seed®, when compared at equivalent rates of active ingredient *(Table 1)*.**
- **Stunting of plants followed glyphosate application (on glyphosate resistant individuals) and that allowed additional time between first and second knocks due to weeds staying small.**
- **Time between first and second knocks should NOT be measured in days, rather in plant growth stages for annual ryegrass, particularly if the second knock requires the use of a desiccant herbicide (paraquat or Spray.Seed®). The efficacy of these herbicides is strongly affected by weed growth stage, not a time period after a treatment.**
- **As a follow-on from the previous point, the rate of desiccant herbicide has to be adjusted upwards as the weed growth stage increases.**
- **Since annual ryegrass is a winter weed, growth rates are much slower than summer weeds and more time is allowed between knocks.**
- **Once annual ryegrass is larger than the early tillering stage (1 to 2 tillers), the rate of desiccant herbicide required for effective control increases significantly. Using the second knock at the mid tillering growth stage requires approximately double the rate of herbicide as treating weeds at the 2 to 3 leaf stage.**
- **Incorporating a residual herbicide in the double knock strategy improves control. For example, addition of Glean® with a desiccant herbicide gave excellent control and prevents additional germination of weeds if rainfall events occur between knocks or after the double knock strategy has finished.**

Barnyard Grass

No-till, winter cropping farming systems with a heavy and sustained reliance on glyphosate for barnyard grass control in the summer fallow have a high risk of selecting for glyphosate resistance in barnyard grass. Prevention of seed-set from survivors of glyphosate application is crucial for resistance prevention.

The double knock tactic is an effective method for preventing seed-set. A field experiment investigated the effects of the double knock tactic in controlling barnyard grass to prevent seed set. This experiment involved glyphosate and paraquat ***(Table 2)***. As this experiment was conducted in a very dry season, the few surviving plants were not able to produce



Glyphosate resistant annual ryegrass control with glyphosate 450 1.2L/ha (left), and glyphosate 450 1.2L/ha followed by paraquat 1.5L/ha using a double-knock approach (right)

seed due to severe moisture stress. However in a typical season, summer rains would enable substantial seed productions from the treatment that had 98% barnyard grass survival. The double knock treatments were able to achieve 100% control of barnyard grass, irrespective of the initial or follow-up herbicide rates.

The double knock tactic was also trialled by NSW DPI for its effectiveness on glyphosate resistant barnyard grass. Glyphosate, paraquat and SpraySeed® when used alone were unable to provide 100% control and completely stop seed-set. However when these herbicides were combined in the double knock tactic, total control was achieved, stopping seed-set ***(Table 3).***

Double knock is a very effective treatment for both susceptible and resistant barnyard grass. 100% kill is the best result and has benefit in regard to stopping seed set and the on-set and proliferation of herbicide resistance. An integrated weed management strategy incorporating the double knock tactic will aid in preventing or significantly delaying glyphosate resistance development in barnyard grass and driving the seed-bank population down to extremely low numbers.

Fleabane

In recent years flaxleaf fleabane *(Conyza bonariensis)* has become one of the most persistent and difficult to control weeds in northern no-till fallows. With individual plants capable of producing over 100,000 seeds, stopping all weeds from setting seed is a very desirable objective.

Fleabane is tolerant to glyphosate, and a number of post-emergent herbicide mixes

Table 2. Control achieved on glyphosate susceptible barnyard grass with the double knock tactic

Herbicide	Rate (L/ha)	Control (%)
glyphosate	0.8	98
glyphosate	1.6	100
paraquat	1.2	97
paraquat	2.0	99
glyphosate fb paraquat	0.8, 1.2	100
glyphosate fb paraquat	0.8, 2.0	100
glyphosate fb paraquat	1.6, 1.2	100
glyphosate fb paraquat	1.6, 2.0	100

Table 3. Control achieved on glyphosate resistant barnyard grass with the double knock tactic

Herbicide	Rate (L/ha)	Control(%)
glyphosate	1.5	90
glyphosate	2	95
paraquat	1.6	99
paraquat	2.4	99.8
Spray.Seed®	2.4	97.9
glyphosate fb paraquat	1.5, 2.4	100
glyphosate fb paraquat	2, 2.4	100
glyphosate fb Spray.Seed®	0.5, 2.4	100
glyphosate fb Spray.Seed®	2, 2.4	100

Table 4. Control of fleabane at Dalby in 2006. Plants were sprayed at 6-10 leaves for the first knock

First knock	Second knock	Days between treatments	Control (%)
glyphosate 450 2 L/ha	na	0	54
glyphosate 450 2 L/ha	Spray.Seed® 1.6 L/ha	7 14 21	95 96 87
glyphosate 450 2 L/ha	Spray.Seed® 2.4 L/ha	7 14 21	97 87 95
glyphosate 450 2 L/ha + 2,4-D 300 ipa® 1.5 L/ha	Spray.Seed® 1.6 L/ha	7 14 21	99 100 95
glyphosate 450 2 L/ha + 2,4-D 300 ipa® 1.5 L/ha	Spray.Seed® 2.4 L/ha	7 14 21	99 99 99
glyphosate 450 2 L/ha + 2,4-D 300 ipa® 3 L/ha	Spray.Seed® 2.4 L/ha	7 14 21	100 99 99
glyphosate 450 2 L/ha	2,4-D 625 1.5 L/ha	0 3 7	93 85 85
glyphosate 450 2 L/ha	2,4-D 625 3 L/ha	0 3 7	90 97 88

with glyphosate have been developed for the control of fleabane in winter fallow. However few of these were have been able to deliver effective control of this species.

In a trial conducted at Dalby ***(Table 4),*** the tolerance of fleabane to glyphosate was evident with only 55% control achieved in the glyphosate only treatment. Glyphosate followed by Spray. Seed® provided good control of plants. However as time between treatments increased, the level of control decreased.

The addition of 2,4-D 300 ipa® to the glyphosate spray provided better control, but again increased intervals between sprays reduced the level of control. Glyphosate and 2,4-D 300 ipa® followed by the higher rate of Spray. Seed® provided total control of plants in all cases. Spray.Seed® proved to be an effective tool in a double knock strategy for fleabane control.

The 2nd trial near Cecil Plains contained a denser population of fleabane and also showed a poor result for control achieved with glyphosate alone ***(Table 5).***

For the treatments containing 2,4-D, as the period between initial and follow-up applications increased, the level of control decreased. The combined glyphosate + 2,4-D 300 ipa® treatment was marginally better than the split application of glyphosate and 2,4-D® Amicide 625 (containing the same rate of 2,4-D) on the same day and one day later. At longer intervals between glyphosate and Amicide applications (3 and 5 days) fleabane control was considerably poorer.

Double knock using glyphosate followed by paraquat or Spray.Seed® was also trialled. At the same rate (L/ha), paraquat gave a higher level of control than Spray. Seed® in this trial. Timing of the follow-up application was also important for these herbicides. Highest control for these herbicides was achieved when they were applied at 5 and 7 days after glyphosate.

Glyphosate and glyphosate mixes with 2,4-D were applied at a water rate of 73 L/ha at 200 kPa through TT11001 flat fan nozzles. Follow-up applications of 2,4-D were applied in the same manner. Follow-up applications of paraquat and Spray.Seed® were applied at 100 L/ha at 200 kPa. Glyphosate was applied with a non-ionic wetting agent at a rate of 100mL/100L.

Sweet summer Grass

Like barnyard grass, no-till farming systems with a heavy use and continual reliance on glyphosate for grass control in the spring, summer and autumn fallows pose a high risk of selecting for glyphosate resistance in sweet summer grass. Prevention of seed-set from survivors of glyphosate applications is essential for resistance prevention.

The double knock has proved a very effective method for preventing seed-set. A field experiment conducted in Emerald in 2007 investigated the effects of the double knock tactic in controlling sweet summer grass to prevent seed set. This experiment involved glyphosate and paraquat ***(Table 6)***. This experiment was conducted in a wet season and plants were very lush and actively growing when treated. The double knock treatments were able to achieve 100% control of sweet summer grass provided the initial glyphosate knock was kept robust (1.0 L/ha). This allowed the paraquat (second) knock to be as low as 1.0 L/ha. Seed set prevention was 100% in these treatments.

Barnyard grass computer model

The QDPI&F glyphosate resistance model demonstrates the effects that different farming systems and weed control strategies have on the speed with which a barnyard grass population may become resistant to glyphosate. The model uses the crop model APSIM with specialised programming to simulate the seed bank and the whole weed life cycle.

It predicts that the farming system with the greatest risk of evolving glyphosate resistance in barnyard grass is one with no tillage, no summer cropping, and complete reliance on glyphosate in summer fallows to control each flush of barnyard grass that appears. In this high-risk scenario, the model predicts that 50% of the grass population could be glyphosate resistant within 15 to 17 years, with only minor differences between different locations in the northern region ***(Figure 1).***

Table 5. Control achieved on fleabane at Cecil Plains in 2007. Plants were sprayed at 6-10 leaves for the first knock.

First knock	Second knock	Days between treatments	Control (%)
glyphosate 450 2 L/ha	na	na	40
glyphosate 450 2 L/ha + 2,4-D 300 ipa 1.5 L/ha	na	na	87
glyphosate 450 2 L/ha	2,4-D 625 0.72 L/ha	0	88
		1	91
		3	69
		5	63
glyphosate 450 2 L/ha	paraquat 1.6 L/ha	1	83
		3	80
		5	92
		7	90
		14	67
glyphosate 450 2 L/ha	Spray.Seed® 1.6 L/ha	1	61
		3	58
		5	86
		7	85
		14	62

Table 6. Visual % control and seed set in sweet summer grass using the double knock (DK) tactic. Plants were early tillering when initially sprayed; second knock applied 13 days later.

Treatment Herbicide	Rate (L/ha)	% control 11 days after DK	Seedset no./m^2
nil	0	0	243832
glyphosate	0.5	99.3	32
glyphosate	1.0	97.7	25
paraquat	1.0	99.3	109
paraquat	1.5	98	485
paraquat	2.0	98.7	253
glyphosate fb paraquat	0.5 fb 1.0	98.7	4
glyphosate fb paraquat	1.0 fb1.0	100	0
glyphosate fb paraquat	0.5 fb 1.5	97.7	18
glyphosate fb paraquat	1.0 fb 1.5	100	0
glyphosate fb paraquat	0.5 fb 2.0	99.3	0
glyphosate fb paraquat	1.0 fb 2.0	100	0
LSD (P = 0.05)		2.1	192

It also shows that there's very little time to react between being able to notice a problem with poor control visually (perhaps between 10 and 30% of the population being resistant, depending on how clumped the resistant plants are) and a population that is 50% glyphosate resistant, or more.

Our modelling predicts that the double knock tactic will be of use in preventing or slowing the evolution of glyphosate resistance, depending on when it is first added to the weed management system, and how often it is used *(Figure 2)*.

In this set of simulations, we considered a grower who decided to use a two-year double knock intervention strategy, performing a double knock on every flush of barnyard grass that appeared for two years (either 8 and 9, 10 and 11, 11 and 12, or 12 and 13 years), after several years of high risk practices, and then following it up with a double knock on the main flush every year (annual) or every second year (biennial) afterwards. The earlier this intervention occurred, the greater its benefit is predicted to be, and if the intervention comes soon enough (after no more than 7 years of the high risk practices) glyphosate resistance can be avoided altogether within the 30 years of the simulation. Even where glyphosate resistance still occurs, the model predicts that annual double knocks on the largest flush will keep the population at very low levels. Other simulations show that if a farmer had been using double knock from the start of minimum- or no-till farming, using a double knock twice in every five years would be enough to sustain glyphosate usefulness for more than 30 years.

With regards to double knock, the messages from the model are:

- **don't wait to act; start using double knock now**
- **a system of annual chemical fallows using glyphosate and no summer cropping puts paddocks at high risk of glyphosate resistance within 15 years**
- **once you can see a problem in the paddock, it may be too late to fix it**
- **an intensive program of double knocks over two years, followed by annual or biennial double knocks on one flush per year, can delay the onset of glyphosate resistance and drive down the seedbank to manageable levels**

Double-knock is an effective tool for the management of a suite of weeds. It is effective in preventing seed set, thereby reducing future weed infestations and herbicide resistance risk.

Michael Widderick, David Thornby, Jeff Werth, Vikki Osten, Andrew Storrie and Tony Cook

Figure 1. Herbicide resistance simulation results comparing high risk practice at three northern region locations

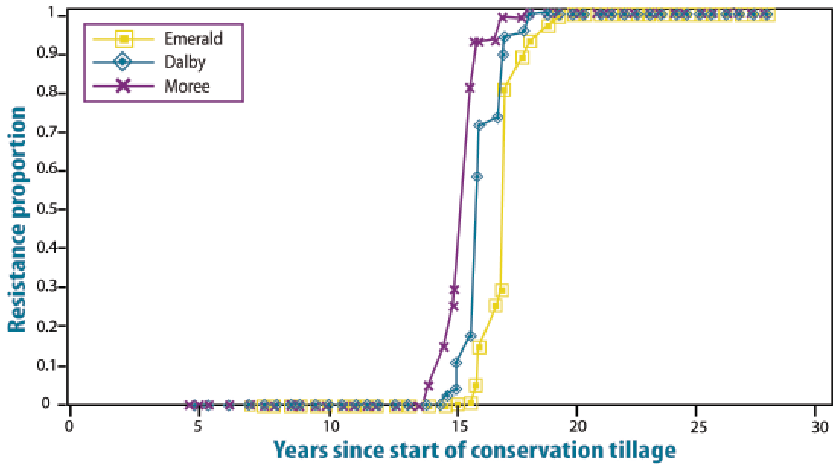
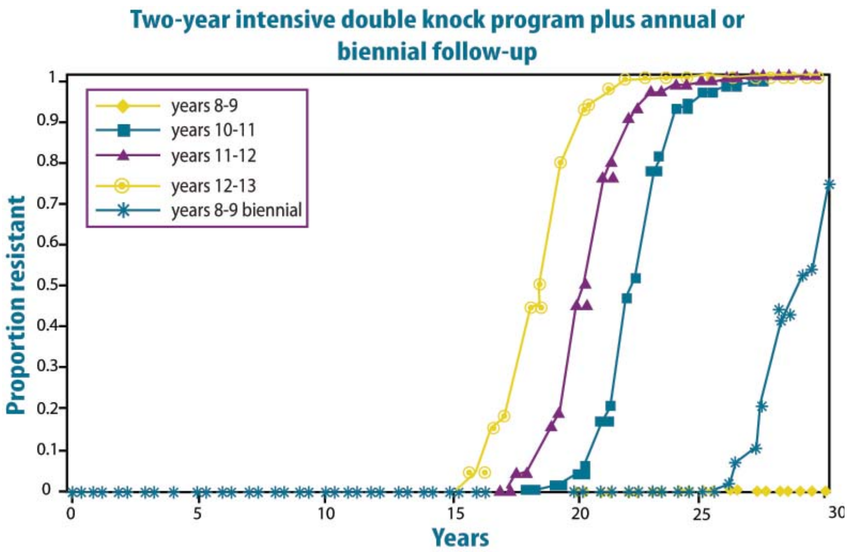


Figure 2. The impact of the double-knock tactic on lengthening the useful life of glyphosate



Do you want to know more about barnyard and liverseed grasses?

If you answered yes to this question, then you should check out the Queensland DPI&F's brochure on these grass species. The brochure is the culmination of several years of research and can be found at the following link (http://www.dpi.qld.gov.au/cps/rde/xbcr/dpi/Managing-barnyard-and-liverseed-grasses.pdf).

The brochure provides useful information on:

- Why these grasses are a problem,
- Identification,
- Time of emergence,
- Seed persistence characteristics,
- Strategic approaches to better management,
- Information about each stage of the weeds lifecycle,
- Tactics for both species to
  - Deplete the seed-bank
  - Control seedlings in fallow
  - Stop seed production
- Reducing the risk of glyphosate resistance
- Hints for better management with herbicides

The information in the brochure can not only aid in better managing the weeds in the short-term, but also into the future by assisting with strategies that will enable prolonged use of commonly used herbicides such as glyphosate. With the recent advent of glyphosate resistance in barnyard grass and the high risk of glyphosate resistance in liverseed grass, this brochure is worthwhile checking out.

Michael Widderick

Preserving our post-emergence wild oat herbicides

Post-emergence grass herbicides provide effective control of many grass weeds, particularly wild oats, the major winter weed of the northern grain region. Without these herbicides we would have to rely upon pre-emergence herbicides that generally give lower levels of control than post-emergence herbicides.

However, we are on the brink of losing these herbicides for wild oats due to the development of populations resistant to up to 3 herbicide modes-of-action (MOA's). Major changes to the farming system will be required if this 'multiple resistance' continues to spread, particularly if chickpeas are to be grown.

A 2007 survey conducted by the Northern Grower Alliance found that 85% of wild oat samples taken from paddocks thought to have a resistance problem (high-risk) had some level of herbicide resistance to commonly used cereal post-emergence herbicides. However 31% of samples had resistance to 2 different herbicide MOA groups (either A & B or A & Z) and 13% of the paddocks had serious three-way (multiple) resistance to groups A, B and Z.

This means losing all viable selective post-emergence options. *Table 1* shows the chemical options available for wild oat control in winter crops. Note that all post-emergence options are from MOA groups B, A & Z.

To prevent cases of multiple resistance in wild oats, an integrated approach is required to drive down wild oat seedbanks. Options to consider are the use of pre-emergence herbicides, competitive winter crops (barley), long fallowing, winter fodder crops, green and brown manuring and an increase in frequency of summer cropping.

Table 1. Registered options to control wild oats in winter crops

Winter Cereal	Winter Pulse	Pre or Post-em	Presence of herbicide resistance in northern grain region
Herbicide Group			
A (eg. Topik®)	A (eg. Verdict®)	Post-em	Yes (to fops, dims and dens)
B (eg. Atlantis®, Hussar®)	B (eg. Spinnaker®)	Post and Pre-em	Yes
	C (eg. simazine)	Pre-em	No
D (eg. trifluralin)	D (eg. Stomp®)	Pre-em	No
J (eg. Avadex®)	J (eg. Avadex®)	Pre-em	No
Z (eg. Mataven®)	-	Post-em	Yes

Please note that Group J was formerly Group E and Group Z was Group K.

Table 2. Seed production on wild oat treated with different herbicides, North Star 2007

Herbicide(s)	Rate of product/ha	Herbicide Group(s)	Wild oats seeds produced per m^2
Nil	----	----	91
Achieve®	380 g	A (dim)	44
Wildcat®	300 mL	A (fop)	123
Avadex® Xtra + TriflurX®	1.6 L + 1.5 L	J + D	22
Atlantis®	330 mL	B	4
Hussar®	200 g	B	2
Crusader®	500 mL	B	0
Avadex® Xtra + Hussar®	1.6 L + 200 g	J + B	0
Avadex® Xtra + Atlantis®	1.6 L + 330 mL	J + B	0
Avadex® Xtra + TriflurX® + Atlantis®	1.6 L + 1.5 L + 330 mL	J + D + B	0
Avadex® Xtra + Mataven® 90 (SST)	1.6 L + 1.87 L	J + Z	0
Hussar® + Mataven® 90 (SST)	200 g + 1.87 L	B + Z	0
Atlantis®+ Mataven® 90 (SST)	330 mL + 1.87 L	B + Z	0

SST = Selective spray-topping, using Mataven® 90 on wild oats at the jointing stage.

An experiment was completed in 2007 that investigated the effects of using pre-emergence herbicides in combination with post-emergence treatments on wild oats confirmed as having moderate to high 'fop' and 'dim' Group A resistance *(Table 2).*

This experiment shows the seed production of Group A resistant wild oats can be stopped. A combination of at least two different pre-emergence (Group D or J), early post-emergence (Group B) or late post-emergence (SST – Group Z) tactics must be used. A single herbicide application can be effective, but will never give the NECESSARY 100% seed set control. Control all survivors with late applications of Mataven®90 to ensure that no seed is returned to the soil.

Some growers have resistance to all post-emergence options. Cultural methods and pre-emergence herbicides will be their only choice. This requires serious changes to their cropping sequence and the inclusion of pre-emergence herbicides that may need incorporating (loss of zero-till).

Twenty two wild oat seeds/m^2 from the Avadex® Xtra + TriflurX® mixture will lead to an increase in the wild oat population in the next year. Use of pre-emergence herbicides MUST be coupled with other tactics, such as an effective selective spray topping.

Rotating to summer crops is effective, as lower 'resistance risk' knockdown herbicides can be used in the winter fallow to control wild oats. In areas with winter dominant rainfall, long fallowing, fodder crops and green and brown manuring can be used. In wide-row winter crops inter-row cultivation or inter-row spraying (with paraquat) will be essential.

Growers must get their wild oat tested for resistance so they know which herbicides still work. They should then seek expert advice about the best strategies for maximising the effective life of their remaining herbicides.

Remember, once the wild oat populations are resistant they will not revert to susceptible over time. Growers must start managing wild oat seed banks and continue to keep weed numbers as low as possible.

Tony Cook

Highlights from the symposium on 'Glyphosate Resistant Crops and Weeds: present and future'

A symposium of glyphosate resistant crops and weeds was held in Chicago at the end of March last year. The symposium gathered researchers from around the world to provide an update on the status of herbicide resistance crops and weeds around the world and the factors which have lead to resistance evolution in weeds.

Glyphosate is a very important herbicide, not only in Australian agricultural systems but worldwide, as it is effective on a wide range of weed species, easy and safe to use, and environmentally benign. In the past glyphosate was mainly used in fallows and non-crop areas. However, the development of transgenic technology enables it to be used to control weeds existing in an emerged crop. This new use for glyphosate creates benefits and concerns, which by now we are well aware of.

The symposium was divided up into four sections:

1. Glyphosate-resistant crops and their economic impacts
2. Evolved glyphosate resistant weeds and weed shifts
3. Resistance management and IPM aspects
4. Health and environmental aspects of glyphosate resistant crops

In the US and South America glyphosate has largely replaced other herbicides and tillage in glyphosate resistant cropping systems. Seven weeds have been confirmed resistant since the introduction of glyphosate-resistant soybean and cotton in the US in 1996. Weed shifts to species more tolerant of glyphosate have also been observed. Four weed species have evolved glyphosate resistance since the introduction of glyphosate-resistant soybeans in South America.

Canada stands as an example of how a diverse cropping system minimises the glyphosate selection pressure. In the western grain belt provinces, canola is the only glyphosate resistant crop in a rotation with wheat and barley. Glufosinate-resistant canola is also grown and competes directly with glyphosate-resistant canola. On average canola is grown only one year in four. In this system there are currently no known glyphosate resistant weeds, and the use of glyphosate resistant canola should remain sustainable.

Glyphosate-resistant cotton was introduced into Australia in 2000. However, to date Australian cotton growers have not encountered glyphosate resistance to the same extent as their colleagues overseas. This has mainly been due to the relatively small number of cotton growers in Australia, the influence of weed scientists, industry, growers and the Office of the Gene Technology Regulator (OGTR) along with lessons learnt from heliothis resistance to insecticides. As a result the use of herbicide tolerant cotton is regulated with a strong integrated weed management focus, aiming to minimise the risk of glyphosate resistance evolving.

The evolution of glyphosate resistant ryegrass in southern Australia has also influenced the cotton industry's proactive approach to minimise resistance evolution. This is a luxury that our colleagues overseas have not had, and they are relying on a reactive response rather than proactive. Nevertheless, the challenge of preventing/managing glyphosate resistance in our cropping systems is still relevant. It is important that weed scientists, growers, agronomists, industry and regulators continue to work together to be proactive in managing this challenge.

A special edition of Pest Management Science, Issue 64 (4), has been produced containing the papers presented at this symposium. This is available online at: http://www3.interscience.wiley.com/journal/117935712/grouphome/home.html

Jeff Werth

Changes to MOA labelling

The following article contains extracts from the Summer 2008 issue of the 'Grains Research Update – southern region' GRDC publication.

Herbicide mode of action (MOA) groupings and associated herbicide resistance management strategies have been revised to better address the issue of herbicide resistance in Australia.

As a result of the revision by CropLife Australia and APVMA, there are now six new herbicide groups – H, O, P, Q, R and Z – to allow more accurate grouping of herbicide products.

Only 26 current herbicide products (22 active ingredients) are affected by the changes. Of major impact in the northern region is the movement of Mataven® from Group K to Group Z, Balance® from Group F to Group H and Avadex® from Group E to Group J. Companies involved with these products have three years to update their labels to reflect the new mode of action groupings.

Always remember that herbicides labelled with the same letter code are from the same mode of action group notifying users that the herbicides work by similar means.

Widespread over-reliance on herbicides from the same MOA group predisposes many weed populations to herbicide resistance. Selection of resistant strains can occur in three to four years if no attention is paid to resistance management including rotation of herbicides from different MOA groups.

Visit the APVMA website (www.apvma.gov.au) for a complete list of registered products and mode of action groupings.

Details on MOA groups and Resistance Management Strategies can be found on the CropLife Australia website (www.croplifeaustralia.org.au).

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