



Barnyard grass and double knock

By Richard Daniels, Northern Grower Alliance

In early 2007, the first population of glyphosate resistant awnless barnyard grass was confirmed in northern NSW. The paddock had a long history of winter cropping combined with a heavy reliance on glyphosate in the summer fallow. This commercial experience, together with recent QDPI modeling, highlights that we are approaching a very dangerous situation due to the overuse of glyphosate.

The industry simply cannot afford to lose glyphosate and must rapidly adjust management to limit the selection pressure being imposed. With some considered changes we may be able to delay the onset of glyphosate resistance, rather than have to deal with the high costs of change once resistance is entrenched.

Two barnyard grass management approaches were investigated in NGA projects during the summer of 2007-08 – double knock applications and the use of residual herbicide.

Getting 'double knock' right

Earlier trials conducted by both QDPI and NSW DPI showed the potential benefits of a double knock application (glyphosate followed by paraquat or paraquat plus

diquat) for barnyard grass management.

Although the general principles of a double knock had been proven, the industry in the north was keen to validate the impact of the time between applications and to evaluate rate responses to the herbicide used for the second application.

Four timing and rate trials were conducted from November 2007 to January 2008 in southern Queensland and northern NSW. Tables 1 and 2 outline the various trial locations and treatments.

Figure 1 shows the surviving weed counts at the four sites, taken at three weeks after the first application. The key findings were:

- All double knock treatments provided better control than Roundup CT alone.

- Double knock treatments generally provided better control than Nuquat alone.
- Four to five day delay provided most consistent control closely followed by one day delay. The four to five day delay ...ii▷

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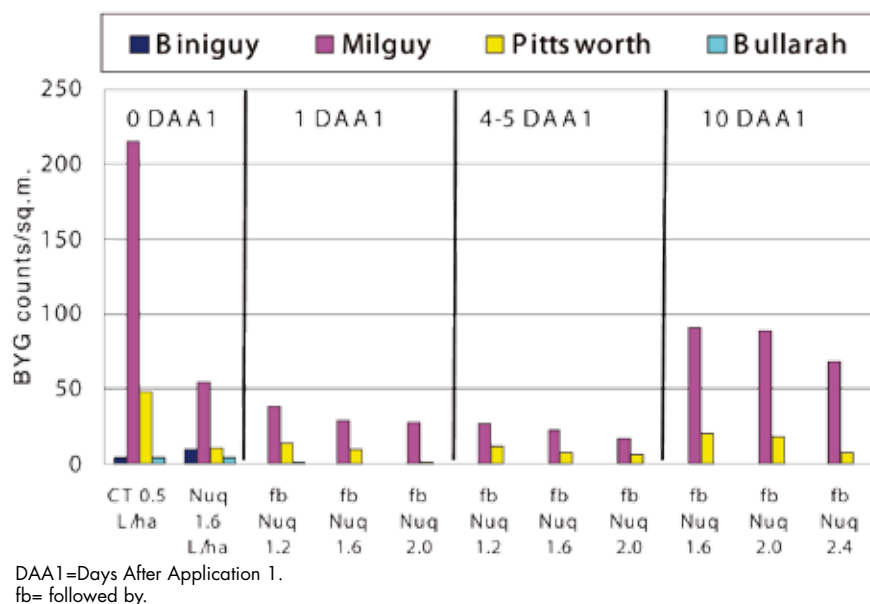
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FIGURE 1: Barnyard grass counts**TABLE 1: Double knock treatments**

Treatment number	Treatments			
	Timing 1 0 DAA1	Timing 2 1 DAA1	Timing 3 4-5 DAA1	Timing 4 10 DAA1
1	Untreated			
2	Roundup CT 0.5 L/ha*			
3	Nuquat 1.6 L/ha			
4	Roundup CT 0.5 L/ha*	Nuquat 1.2 L/ha		
5		Nuquat 1.6 L/ha		
6		Nuquat 2.0 L/ha		
7			Nuquat 1.2 L/ha	
8			Nuquat 1.6 L/ha	
9			Nuquat 2.0 L/ha	
10				Nuquat 1.6 L/ha
11				Nuquat 2.0 L/ha
12				Nuquat 2.4 L/ha

DAA1 = Days After Application 1

Treatments 2 and 3 were stand alone, Treatments 4-12 were double knock applications of Roundup CT followed by Nuquat at the rates/ timing specified. *Roundup CT was applied at 0.5L/ha in all trials to simulate a situation where resistance was developing.

TABLE 2: Trial locations and key details

Location	Final barnyard grass counts/m ²	Double knock interval (days)	Barnyard grass growth stages			
			Timing 1	Timing 2	Timing 3	Timing 4
Biniguy NSW	217	1, 5 or 10	2-6 leaf	2-6 leaf	4-7 leaf	6-8 leaf
Milguy NSW	438	1, 5 or 10	2-6 leaf	2-6 leaf	3-7 leaf	4-8 leaf
Pittsworth QLD	59	1, 5 or 10	Early-mid tillering	Early-mid tillering	Mid-late tillering	Late tillering-seed set
Bullarah NSW	79	1, 4 or 10	4 leaf	4 leaf	Early tillering	Mid tillering

Note: All trials were conducted in glyphosate susceptible populations. Roundup CT (glyphosate 450g/L a.i.) was applied at 0.5 L/ha in all trials at below label rate to simulate a situation where resistance to glyphosate was developing. This sub-lethal rate is below the recommended rate for control of barnyard grass. Nuquat (paraquat 250g/L a.i.) was applied at 1.6 L/ha as a stand alone in comparison to Roundup CT and then as the second knock in all trials. All treatments were applied at a water rate of ~75 L/ha with medium to coarse nozzles.

<i>i...BARNYARD GRASS

applications may have controlled new weeds that only emerged after the one day application was applied.

- Ten day delay effective at some sites but poor, as expected, when used on larger or stressed weeds.
- Dose response to Nuquat with 1.6 and 2.0 L/ha rate generally more robust than 1.2 L/ha.
- Not even double knock treatments gave complete barnyard grass control under very high weed burdens (Milguy) or on larger and stressed plants (Pittsworth). It's critical to go in early and hard.

So where does double knock fit?

Obviously double knock approaches will result in increased herbicide cost together with increased labour and application



Barnyard grass control at the Milguy site 13 days after the first application.
TOP: Nuquat alone @ 1.6 L/ha.
BOTTOM: Roundup CT @ 0.5 L/ha followed five days later with Nuquat @ 1.6 L/ha.

costs. But the alternative is to just keep on using glyphosate for every fallow spray which will only end up in tears for all.

Double knock is not an approach to consider, at least for economic reasons, for multiple germinations in the one paddock in the one season but there are a number of situations where it should be considered:

- In individual paddocks where glyphosate alone has been the primary barnyard grass management approach over many years.
- One application per season in the paddock with the highest barnyard grass population.
- On the first or second barnyard grass emergence flush in the spring/summer when the weed numbers are likely to be at their highest.

Other considerations

The primary focus of any weed control is to achieve a very high level of control and minimise (or if possible eliminate) any seed bank replenishment. Desiccants such as paraquat and paraquat plus diquat are not very effective on larger weeds. To ensure high levels of control it is critical that the glyphosate is applied to young weed stages and the desiccant is applied before weeds are too large or stressed. This requires close attention to timing particularly in paddocks with varying soil types.

RESIDUAL HERBICIDE FOR BARNYARD GRASS

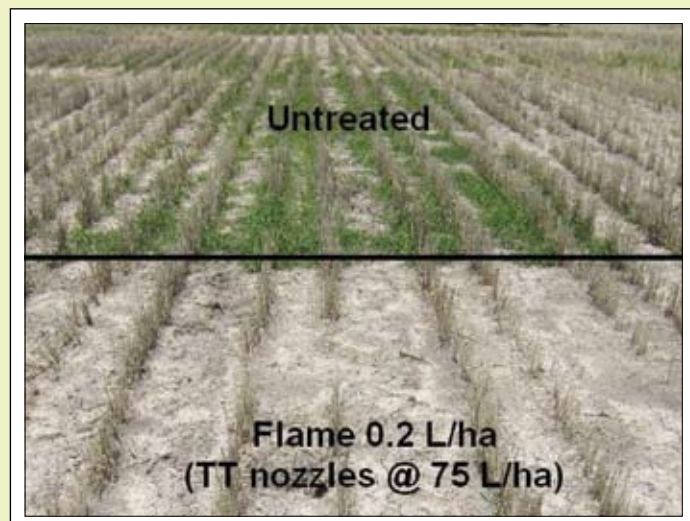
Barnyard grass is typified by multiple germinations during the spring/summer. This characteristic nearly always results in the need for multiple fallow sprays. Clearly an effective residual herbicide could allow a reduction in fallow sprays and reduce the selection pressure on glyphosate. Flame (active ingredient imazapic) is a product that can provide very effective residual control of a range of grasses and broadleaf weeds. But variability in performance has often been an issue.

What was done with the residual herbicide trials?

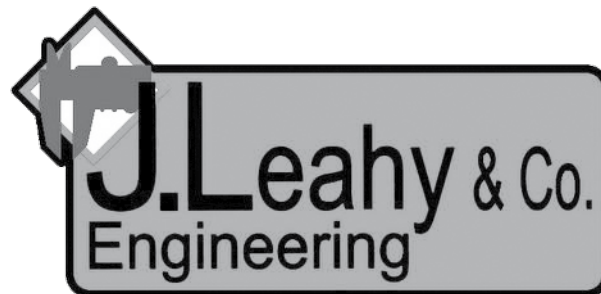
NGA conducted four trials in 2007–08 to investigate some simple application parameters and better understand their impact on levels of control. All trials were commenced during November 2007 and sprayed following a fallow spray or to bare dry soil.

Flame at 0.2 L/ha was applied at three water application volumes (50, 75 and 100 L/ha) and four droplet sizes (fine, medium, coarse, extremely coarse). This was achieved using XR, TT, AM

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The Bullarah trial site in early January 2008, 41 days after application of the residual herbicide to control barnyard grass.



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and TTi 110015 nozzles. All combinations of volume and droplet size were evaluated.

The surviving weed counts – taken eight to 12 weeks after application – showed that:

- Nozzle type/droplet size had NO impact on level of control.
- Application volume had NO impact on level of control.
- Greater than 95 per cent control was obtained at three of the four sites.
- Application PRIOR to weed germination appeared to be more important than application parameters.

Other considerations

Residuals, such as Flame, could be very useful in reducing the selection pressure on glyphosate but their cost, other weed spectrum and plant back profile must be considered. Although Flame was originally positioned as an option immediately following the harvest of a winter crop, the plantback period to a following summer crop may be of concern.

Use of Flame after winter crop harvest also means summer growing weeds are likely to have already commenced germination particularly in years of wetter harvests.

A safer and perhaps more effective position may be to use the herbicide during

the long fallow following a summer crop when application can occur early in the spring prior to the first flushes of summer weeds.

This may improve weed control and also allow a longer period for the residual to breakdown before the following winter crop.

TO SUM UP

Neither double knock or the use of residual herbicides is likely to be a mainstay of barnyard grass management. But it is important strategies such as these are considered and incorporated into management when appropriate to avoid the loss of a our key fallow tool – glyphosate. ■

THE COMMERCIAL VIEW

By Garry Onus, Agronomist – Landmark Moree

The development of glyphosate resistant barnyard grass has had huge implications on the management of the paddocks involved. Due to its presence, the extensive use of glyphosate as a fallow herbicide to target barnyard grass has been rendered relatively useless in these paddocks when used alone.



Garry Onus.

How the issue evolves and sneaks up on you

Many factors can contribute to the evolution of resistance in the population of barnyard grass including:

- The paddocks with the issue have varying soil types from heavy black earth to lighter red gravelly areas, and these have historically all been sprayed at the same time. Often weeds on the lighter soil are stressed by the time the spray operation is carried out and ordinary results are obtained.
- The extensive use of glyphosate alone over many years and the increased usage of inferior quality generic brands often leads to survivors in the weed population.
- Poor application of the herbicide (whether it be coverage issues, dust, climatic issues, etc) also often leads to survivors, which is not a good thing to have happening.

Implications of resistance on management

Once you recognise and accept that you have a herbicide resistance issue, the impact on the operations and planning on the farm are quite dramatic.

To try to overcome the problem there needs to be a concerted effort to stop the resistant barnyard grass population from setting seed – almost at any cost – in the first few years. The life of the soil seed bank for barnyard grass is not very long so we should be able to reduce the issue to manageable numbers.

From a management perspective, we need to schedule sprays based on soil type rather than whole paddock sprays. This can be a painful operation but very worthwhile.

We also need to incorporate a high frequency spray program

where we target small freshly emerged weeds with knockdown herbicides of varying groups. Often Group L herbicides (paraquat, diquat) are used in a double knock approach following a few days after a glyphosate application.

The use of residual herbicides such as Flame for fallow grass weed control is also proving very effective at taming the resistant population, particularly with the rise in the price of glyphosate last summer. The use of residuals such as atrazine, Stomp and Dual in various crops is also an option that works reasonably well.

The planning of the crop rotation is also critical to try to utilise herbicide groups other than Group M on the resistant population. The use of Group A herbicides such as Verdict in crops such as sunflowers and mungbeans is a viable alternative and works quite well.

Apart from the herbicide programs and options available when resistance exists, many cultural and farm hygiene issue need to be considered. Cultivation is probably not preferred as it buries the seed and prolongs the life of the seed bank in the soil. Sometimes a shallow tickle can help to stimulate germination of the barnyard grass and speed up the decline of the seed bank so long as the seedlings are controlled successfully.

There needs to be a focus on machinery hygiene and stock movements to avoid transporting the resistant population to other parts of the farm. Movement of water and feral animals can also spread the problem and need to be taken into consideration.

The way forward

Once you have the glyphosate resistance issue on the farm, the best way forward is an integrated approach involving many of the options outlined above. The most critical thing is to recognise and admit that you have the problem, then plan a sensible pathway forward. There is help available and plenty of research going on to help sort out options.

While the issue of glyphosate resistance in barnyard grass does create some problems and additional expense, it is not the end of the world. It is possible to continue economic cropping when you have the problem. But life would be a lot easier, and less costly if the resistance was not present.

So if you don't have resistance to glyphosate on your farm, take the time to plan your program so that you minimise the chances of it turning up. Act now!

RESEARCH VIEW – BARNYARD GRASS CONTROL ECOLOGY, DOUBLE KNOCK AND THE FUTURE

By Michael Widderick, QDPI&F Weed Research Scientist

Understanding the ecology of barnyard grass and effectively stopping seed set are two key aspects in achieving optimal control of this weed.

A GRDC-funded project between QDPI&F and NSW DPI identified barnyard grass as having the greatest risk for glyphosate resistance in the northern grains region.

In early 2007, the first case of glyphosate resistance was confirmed on a property at Bellata. With the ongoing threat of glyphosate resistance and the importance of limiting weed competition with crops, effective control of barnyard grass over the long term is vital.

On-going control of barnyard grass will require an integrated weed management (IWM) approach with two key goals in mind:

- Minimise the likelihood of resistance and minimise current; and,
- Future weed populations.

Why is understanding a weed's ecology important?

Having a thorough understanding of how a weed grows and its life cycle will assist in better targeted and more effective control efforts. For example, knowing when and how a weed species emerges will assist in optimal timing and choice of control options.

In the northern grains region there are two common species of barnyard grass, *Echinochloa colona* and *E. crus-galli*. The most



Michael Widderick.

common species is *E. colona*, awnless barnyard grass. Some key ecological characteristics that we know about *E. colona* are:

- Seedlings emerge between October and March when mean soil temperatures are 25–26°C.
- Seedlings predominantly emerge from the top two cm and few from five cm and 10 cm.
- Seedlings emerge as a series of flushes predominantly in the first two years after seed set.
- The first flush in any season is usually the biggest.
- Persistence of seeds is short, with only two to five per cent remaining after 24 months burial at 0–2 cm.
- Persistence of seeds increases with burial depth, with 20–24 per cent remaining after 24 months burial at 10 cm.

This means monitoring emergences will be important and repeated treatments targeting new flushes may be required. Seed persistence characteristics of barnyard grass show that seeds in the surface soil layers (0–2 cm) do not persist for long, so in a zero tillage environment effective control of plants with no seed replenishment should result in a quick reduction of seed numbers.

Conversely, seed burial through tillage will reduce emergence but promote seed persistence.

Why is stopping seed set important?

Stopping seed set on barnyard grass in one season will reduce the barnyard grass pressure in subsequent seasons. In addition, barnyard grass plants surviving an application of glyphosate may be resistant to this herbicide. Allowing these survivors to set seed would result in the spread of this resistance.

The double knock tactic is designed to control survivors of one treatment (first knock) with a follow-up treatment (second knock) and thereby minimise seed set on these survivors. Using the double knock tactic also takes the pressure off relying on one herbicide alone (eg. glyphosate) and thereby reduces the risk of resistance.

The most common incarnation of double knock is glyphosate followed by paraquat some five to 14 days later. In trials we have achieved 100 per cent control of barnyard grass when using the double knock tactic in southern Queensland.

LOOKING TO THE FUTURE

GRDC has recently funded continued work on herbicide resistance prevention and management in the NGR. This project will again be a joint effort between QDPI&F and NSW DPI and barnyard grass will be a major focus. Better understanding the weeds ecology and the double knock tactic will both be components of the project.

We will be investigating the impact of different cropping, crop residue levels, cultivation and soil moisture on seed emergence patterns and seed persistence in a seed bank ecology trial. The trial will also investigate options to accelerate seed-bank decline and will include both *E. colona* and *E. crus-galli* to assess species differences. Another trial will compare the ecology of glyphosate susceptible and resistant barnyard grasses and will include a test of fitness penalty.

We will be refining the double knock strategy and will include residual herbicides in either the first or second knock to look for improved long-term control.

Further information on barnyard grass ecology and control options can be found in a DPI&F publication 'Management of barnyard and liverseed grasses' which can be found at www.grdc.com.au/weedlinks ■

TABLE 1: Barnyard grass control with glyphosate and paraquat at different rates and weed sizes, and with double knock using glyphosate followed by (fb) paraquat one week later, when the weeds had grown from two to three leaves to one to three tillers

Herbicide	Product rate (ha)	Weed size	Control (%)
Glyphosate CT 450	0.8L	2–3 leaves	98
	0.8L	1–3 tillers	67
	1.6L	2–3 leaves	100
	1.6L	1–3 tillers	87
Paraquat	1.2L	2–3 leaves	97
	1.2L	1–3 tillers	82
	2.0L	2–3 leaves	99
	2.0L	1–3 tillers	93
Glyphosate CT450 0.8 L fb Paraquat 1.2 L	0.8L fb 1.2L	2–3 leaves fb 1–3 tillers	100
	0.8L fb 2.0L	2–3 leaves fb 1–3 tillers	100
Glyphosate CT450 0.8 L fb Paraquat 1.2 L	1.6L fb 1.2L	2–3 leaves fb 1–3 tillers	100
	1.6L fb 2.0L	2–3 leaves fb 1–3 tillers	100