

# TIPS & TACTICS

## MANAGING WILD OATS



### Control wild oats through crop rotations, smart herbicide use and minimising grain sample contamination.

Wild oats (*Avena* spp.) are among the world's most common and economically damaging weeds of cropping systems. There are two main species of wild oat: *Avena fatua* and *A. sterilis* subsp. *ludoviciana*. They are also known as 'black oats'.

Wild oats substantially reduces yields because it is a highly competitive weed, especially when emerging with the crop. Wild oat plants are well-adapted to infesting crops because they:

- are sometimes difficult to identify at the vegetative stage, having similar morphology to the crop and therefore are not managed effectively
- exhibit seed dormancy (staggered germination)
- can easily develop resistance to herbicides but is slower to develop resistance compared to other weeds like ryegrass
- produce many seeds, allowing the weed to persist long-term in paddocks.



Photo 1: Wild oats standing tall above a wheat crop.  
Source: Michael Walsh, University of Sydney.

### KEY POINTS

- At the individual plant level, wheat and wild oats are near equal competitors and left uncontrolled, wild oats can cause wheat yield losses as high as 80%.
- Integrated Weed Management—including correct use of herbicides and other effective agronomic and non-chemical tactics—is crucial for managing wild oats.
- In New South Wales (NSW) or Queensland (Qld), rotate to summer crops and use winter fallow in paddocks with large wild oat populations.
- Recent surveys show significant levels of herbicide resistance in wild oat populations.
- Group A herbicide resistance has been present in Australian populations since the mid-1980s. In the past 2 years Group A resistance has exploded in area and frequency in the Northern Region.
- Use mixes of pre- and post-emergent herbicides and change the Modes of Action each year.
- Avoid using Group A herbicides without first testing for resistance. Wild oats can also be resistant to Group B and Group Z herbicides.
- Unlike many other weeds, wild oats tend to grow in patches meaning more targeted monitoring and management is achievable (Photo 1, Photo 2).



Photo 2: Patches of wild oat in a chickpea crop. Source: Tony Cook, NSW Department of Primary Industries.

## How widespread is the wild oats problem?

Wild oats is, overall, the most widespread weed across the Northern Region and the most competitive grass weed in cereal crops.

Impacting around 600,000 hectares across the region, it is estimated the revenue losses from wild oats are \$4.5 million annually (Llewellyn et al. 2016).

The incidence of wild oat infestation is decreasing overall in the Northern Region. However, the infestations, when they do occur, are becoming a more persistent problem.

## Herbicide resistance

Herbicide resistance is one of the greatest threats to the sustainability of Australia's current grain production systems.

A reliance on herbicides in Australian grain systems has led to the development of resistance across many of the herbicide Mode of Action (MoA) groups.

Wild oats has to-date been found to be resistant to Group A, B, Z herbicides, in some cases the plants are resistant to multiple groups/sub-groups. Resistance to glyphosate has also been identified as a key threat in wild oats, and a range of other summer and winter grass and broadleaf weeds.

Read more in: 'Section 3: Herbicide resistance [Integrated Weed Management Hub](#)'.



## Managing wild oats: Key strategies

There are many strategies that can be used to manage wild oats and research is ongoing into the effectiveness of these (Table 1).

As of 2018, the updated advice is to keep these five overarching strategies front of mind and to use these to complement WeedSmart's general rules for weed management. See: 'Driving Down Weed Numbers'.

### Rotate to summer crop/winter fallow and explore other agronomic options

The most effective strategy in the Northern Region, where available, is to rotate to summer crops and use alternative herbicides or cultivation to control wild oats in the winter fallow.

Multiple seasons of summer cropping will be required to get a large population under control. Two successive winter

## MODE OF ACTION MATTERS!

The main reason resistance has developed is because of the repeated and often uninterrupted use of herbicides with the same MoA.

fallows are required to reduce seedbanks by 99%. Summer cropping or long fallowing is a high priority strategy.

### Can grazing help?

Wild oats can be managed by some extent by grazing. Grazing pressure needs to be very high and maintained when wild oats are at the early reproductive stages. (Short timeframes of high stocking rates will only trim the wild oats; they are capable of re-shooting and setting seed quickly.) Grazing to reduce

Table 1: List of tactics that could be used in combination as an integrated weed management approach to reduce the impact of wild oats and maintain the usefulness of effective herbicides.

Tactic to control wild oats	Likely control % (range)	Ease of incorporating into farming system
Crop choice and sequence	95 (30–99)	Easy to moderate
Improving crop competition	70 (20–99)	Easy to moderate
Herbicide-tolerant crops	90 (80–99)	Easy
Burning crop residues	40 (0–80)#	Moderate to hard
Inversion ploughing	50 (40–60)#	Moderate to hard
Autumn tickle	40 (30–60)	Easy to moderate
Fallow and pre-sowing cultivation	40 (0–80)#	Easy to moderate
Knockdown herbicides for fallow & pre-sowing control	80 (70–90)	Easy
Double knock-down (double-knock)	99 (99–100)#	Easy to moderate
Pre-emergence herbicides	80 (70–90)	Easy to moderate
Selective post-emergent herbicides	80 (70–90)	Easy
Spray-topping with selective herbicides	90 (60–99)	Easy
Crop-topping with non-selective herbicides	30 (10–50)#	Easy
Pasture spray-topping	80 (70–90)	Moderate
Silage and hay: crops and pastures	97 (95–99)	Moderate to hard
Renovation crops: green or brown manuring, mulching etc.	95 (85–99)#	Moderate
Grazing: actively managing weeds in pastures	75 (60–80)	Moderate to hard
Weed seed collection at harvest	70 (20–80)	Hard
Sow weed-free seed	85 (50–99)#	Moderate

This table of tactics includes 19 different options. Many of these may not be applicable to your farm, but there are likely to be at least 6 to 8 that should be considered.

Source: Adapted from Cook et al. (2014).

Note that the original table was created from information sourced from: T McGillion and A Storrie Eds. (2006) Integrated Weed Management in Australian Cropping Systems (A training resource for farm advisors), Section 6: Weeds, weed 1 annual ryegrass (p151) and weed 18 wild oats (p200).

#: no reference in IWM manual, so estimate was made by Cook et al. (2014).

seed set may be only useful on limited areas where livestock is readily available.

### Are there other tactics to consider?

Other tactics to consider adding to crop rotations include:

- Use weed-free seed. Choose your 'cleanest' paddock for retaining planting seed and preferably grade it to ensure you are not 'planting' wild oats into the next crop.
- Delaying sowing coupled with effective control of seedlings to drive down the weed seedbank prior to planting.
- Rotating to dense pasture may be useful as it provides plant competition to outcompete the wild oats and allows for other tactics such as cutting for hay (Photo 3).
- Strategic cultivation can be a useful tool to control a large flush emergence of wild oat seedlings. However, cultivation may in fact prolong seedbank life so its usefulness is limited to control only emerged plants. This is in contrast to other shallow germinating weeds such as fleabane or sowthistle which will not emerge from deeper in the soil; seed burial is therefore more useful for those weeds.

### Smart herbicide use

#### High priority: Pre-emergent or residual herbicides

Herbicides considered pre-emergent or residual are applied prior to crop and weed emergence. They provide extended control of germinating or emerging weeds.

Although pre-emergent herbicides are an important management tool, they rarely provide complete control and a combination of pre-emergent and post-emergent is the best option (Wu and Koetz 2014; Cook et al. 2014) (see 'Lower priority: Knockdown control' section below).

The performance of pre-emergent herbicides will vary by herbicide use patterns, the nature of the chemical itself, the rates applied, the weather conditions, soil moisture, the properties of the soil and the rate of uptake by the weed. The distribution of wild oat seeds in the soil profile is also important to consider. Group J herbicide - triallate is recognised as the most effective option for control of wild oat populations in a cultivated system (where wild oat seeds are found throughout the depth



Photo 3: A pasture phase may allow weed seedset to be reduced to lower levels through a range of tactics such as competition, hay, spray-topping and grazing. Source: GRDC.

of cultivation). However, this use pattern requires full incorporation and generally a two-pass incorporation is more effective than a single pass. The extra incorporation costs, loss of planting moisture and inconsistency of control mean this use pattern is less frequently adopted under northern conditions. Triallate may allow for non-incorporation at higher use rates.

In recent years, new registrations for the use of triallate have been established where the herbicides are only incorporated through the planting operation (also known as 'Incorporate by Sowing (IBS)'). This approach appears most effective in minimum tillage situations where the majority of wild oat seeds are found near the soil surface. However there are still a number of limitations to this approach:

1. Requires a tyne planter to ensure soil throw effectively covers the applied herbicide.
2. Poor levels of weed control are often found within the planting row crop row because the herbicide-treated soil is thrown or removed during the planting operation.
3. Sowing speed is very important to ensure adequate soil throw to incorporate the herbicide. But avoid soil being moved into the next planting row where crop safety issues may occur, particularly in cereals.

Key herbicides registered for this use pattern are triallate or trifluralin. These products can be applied alone or in a mixture. Other herbicides from Groups J and D, and from Group K are also worth considering. To find out more about pre-emergent residual herbicides that provide

control and suppression of wild oats, refer to GrowNotes™ Technical: Herbicide Use: <https://grdc.com.au/grownotes-herbicide-use>.

## DRIVING DOWN WEED NUMBERS

The general 'Big 6' WeedSmart tactics recommended to drive down weed numbers and reduce the impact of herbicide resistance are:

1. Rotate crops and pastures.
2. Mix and rotate herbicides.
3. Increase crop competition.
4. Use the double-knock.  
(Note that specific to wild oats, utilise a pre-emergent herbicide and then follow up with a post-emergent to control any survivors.)
5. Stop weed seedset.
6. Implement harvest weed seed control.

Visit [weedsmart.org.au](https://weedsmart.org.au)



Weed control is generally improved by mixtures. Pre-emergent herbicides can provide 40–80% reduction in wild oat numbers in zero tillage farming systems with minimal incorporation (Price and Daniel, 2017).

Other herbicides such as pyroxasulfone (registered for wild oats suppression in wheat and triticale) or certain terbuthylazine products (registered for wild oats suppression in wheat, barley, oats and various broadleaf crops) could be useful when combined with crop competition. However, follow up with a post-emergent option will still be required.

### Lower priority: post-emergent herbicide control

Although post-emergent control of wild oats remains a priority in managing the weed seedbank (particularly following residual herbicide use), the focus for growers, and the wider industry, needs to be on other aspects of weed management.

Group A herbicides: (Aryloxyphenoxypropionates [Fops], Cyclohexanediones [Dims] and Phenylpyrazoles [Dens]) have provided highly effective wild oats control in the past, however resistance is now widespread in the Northern Region.

This has been caused by overdependence on Group A herbicides, often together with a predominantly winter crop rotation. Monitoring the level of efficacy of wild oat patches at the individual paddock level is important. This may allow alternative strategies to be rapidly implemented to reduce or avoid seedbank replenishment.

Recent resistance surveys show that the focus should not only be on Group A. For example, in central NSW resistance surveys (Street and O'Brien 2016), 69% of samples showed resistance to the Z Group herbicide Flamprop-m-methyl. This was higher than Haloxypol, a Group A herbicide and up from 51% of samples resistant in 2013.

Testing for herbicide resistance is vital and may reveal alternative Group A herbicides that are still effective.

#### Additional herbicide tips:

- Group A, Dim chemistry: the addition of ammonium sulphate can improve efficacy, particularly in high bicarbonate water sources (Price and Daniel, 2017).
- Group B products can be used to target small wild oats in cereal crops.

- Group Z: Flamprop-m-methyl (wheat) and Group A, Den: Pinoxaden + cloquintocet-mexyl (wheat and barley) can be useful as a harvest aid or for salvage weed control.
- It is worth considering using non-selective knockdown herbicides, such as glyphosate (Group M), to treat small wild oat patches in crops. Although some crop is sacrificed, longer term benefits of halting seed production and the prevention of weed patch spread is likely to reduce wild oat problems the following year.
- In chickpeas there are no post-emergent alternatives to the Group A. But growers do have the option of using glyphosate (Group M) as a preharvest desiccant (note that only certain products are registered for this use) which may reduce wild oat seedset and viability.

Always use herbicides at the recommended label rate and refer to the Australian Pesticides and Veterinary Medicines Authority for the latest updates and regulations: <https://apvma.gov.au/>. Also refer to GrowNotes™ Technical: Herbicide Use: <https://grdc.com.au/grownotes-herbicide-use>.

### Enhance crop competition

Recent research has shown that using crop competition can be effective in managing wild oats in wheat crops (Walsh 2017, Figure 1). Recent research shows that growing a competitive crop may significantly reduce weed numbers,

biomass and seed production in crop while providing increases in grain yield.

Over many years several studies have identified the benefits of increasing crop competition on wild oats management specifically in relation to reducing seed production and improving herbicide efficacy. Further research in this area is exploring the impact of early wheat planting and row spacing on wild oat populations.

### Attack the seedbank and prevent seedset

The focus on wild oats weed control must include seedbank management by stopping seedset and keeping weed numbers low.

The most effective approach to targeting the wild oats seedbank is to prevent the input of fresh seed.

Wild oats has a relatively short-lived seedbank (3–4 years) and a seed half-life of about 6 months so preventing seedbank replenishment will potentially eliminate this weed in a relatively short period of time.

Seedset control can be achieved using an appropriate herbicide applied from the jointing (GS 31) to booting stages (GS 40–49). Check for resistance first and follow the label instructions.

Wild oat is easily spread as a contaminant of grain, hay and machinery. Combined with other practices, delaying harvest can help reduce seed movement in the paddock and grain sample, as the delay means a greater proportion of the wild oat seeds will have shed onto the ground.

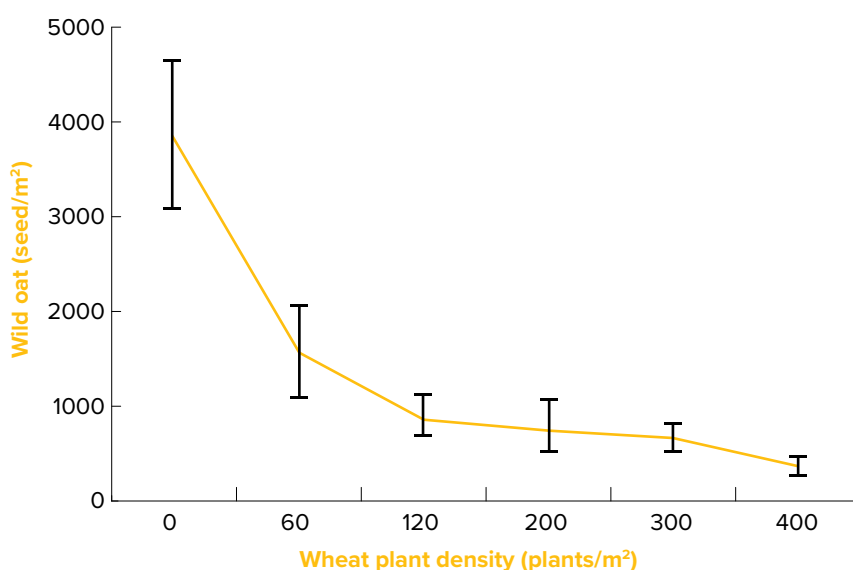


Figure 1: Influence of increasing wheat plant density on wild oats seed production. There was a 40% reduction in wild oat seed production by increasing wheat plant density from 60 to 120 plants/m². Source: Walsh 2017.

## HERBICIDE RESISTANCE/ SUSCEPTIBILITY TESTING SERVICES

Two commercial testing services are available in Australia to determine the level of herbicide resistance in your paddocks.

### Charles Sturt University

- Herbicide resistance/susceptibility tests for wild oats (as well as annual ryegrass, barley grass, brome grass, and wild radish).
- The best time to collect suspected resistant weed seed is when it is close to maturity, which often occurs before the crop is to be harvested.
- Samples must be received before 1st April to be tested for the upcoming season.
- More information at: <http://www.csu.edu.au/weedresearchgroup/herbicide-resistance>.

### Peter Boutsalis, Plant Science Consulting

- Two types of herbicide resistance/susceptibility tests are offered: 1) Seed Test 2) The Quick Test.
- To test for pre-emergent herbicide resistance you must use the Seed Test. Seed tests take about 12 weeks.
- The herbicide resistance/susceptibility Quick Test is suitable for post-emergent herbicides such as glyphosate or in-crop selective herbicides. The Quick Test will work on plants from seedlings to advanced tillering as long as the plants are green and healthy.
- More information: <http://www.plantscienceconsulting.com.au/>

## Keep an eye on new technology and consider harvest weed seed control (HWSC)

New technology to control weeds is being developed and tested; refer to the 'Resources' section.

Harvest Weed Seed Control (HWSC), in particular, has been an effective weed control strategy and is widely adopted in Western Australia and increasingly in South Australia, Victoria and southern NSW.

Harvest weed seed control involves collecting or destroying weed seeds that are present at harvest. There are currently six HWSC tools being used by Australian grain growers: narrow windrow burning; chaff carts; chaff tramlining or chaff decks; bale direct systems; chaff lining; and the new integrated Harrington Seed Destructor (a newer version of the original Harrington Seed Destructor), see feature box 'Harrington Seed Destructor'.

Brassica weeds (e.g. wild radish, mustards, wild turnip) and annual ryegrass are successfully controlled by HWSC and it can have significant impact on wild oats. Note, these methods are more effective on late germinating wild oat plants where the amount of shedding before harvest is limited.

Research in the Northern Region has shown that the success of HWSC is dependent on weed seed retention at harvest (Widderick et al. 2014). The average percentages of wild oat seed retained per plant at maturity vary: in wheat it was 69% and in chickpea 93%. Often the majority of seed is retained at the earliest harvest times. Any delays in harvest will see the effectiveness of HWSC decline quickly.

Read more at: Harvest weed seed control – the holy grail, <https://weedsmart.org.au/the-big-6/harvest-weed-seed-control-holy-grail/>

## INTEGRATED HARRINGTON SEED DESTROYER (IHSD)

The Integrated Harrington Seed Destructor (IHSD) is a unique weed seed control system that smashes the chaff and weed seed fraction as it exits the harvester, destroying seed viability and returning the crushed fraction to the paddock (Photo 4). Australian Herbicide Resistance Initiative (AHRI) research has shown that the HSD consistently destroys 95% of annual ryegrass, wild radish, wild oats and brome grass seed present in the chaff fraction (Walsh and Newman 2013).



Photo 4: A) Integrated Harrington Seed Destructor (IHSD). B) A collection of IHSDs on the manufacturing floor before being installed into the rear of combine harvesters. Source: A) Michael Walsh. B) <http://www.ihsd.com>

## Identifying and monitoring wild oats

Wild oats tend to grow in discrete patches (Photo 5) at low to moderate densities (up to 100 plants/m<sup>2</sup>). In high densities they can grow at 500 plants/m<sup>2</sup>. Wild oat seeds are large in size and as they mature fall direct to the ground, resulting in patches forming in paddocks.

These factors present an opportunity for growers to identify and manage oats paddock-by-paddock.

Revisit paddocks 2–3 weeks after spraying herbicides to determine how effective the treatment has been.

### Seeds

Wild oat seeds (Photo 6) are usually dark but can vary through to cream. Hairiness of seeds also varies. Wild oats produce a large number of seeds. In northern NSW maximum seedset has been approximately 225 seeds/plant for low densities and less than 50 seeds/plant for densities above 50 plants/m<sup>2</sup>.

Up to 20,000 seeds/m<sup>2</sup> can be produced by uncontrolled infestations (Storrie 2014).

It is very important to remember that the first flush of wild oats can contribute to 90–95% of total seed production. As such, it is vital to control the first few use incursions of wild oats with effective pre- and post-emergence herbicides.

### Plants

The seedling leaves emerge rolled and are twisted anticlockwise, the opposite direction to wheat and barley. Wild oat plants have a large ligule with no auricles, and the leaves tend to be hairy with a slight bluish hue (Photo 7).

### Can be confused with...

In the seedling phase, wild oat can be confused with all *Bromus* species, which have tubular leaf sheaths and hairy leaves and sheaths. Wild oat plants exhibit a rolled sheath and few hairs on the leaves.

Seedling wild oats are often attached to the seed, so it is worth digging up seedlings carefully and identifying this way.



Photo 5: Wild oat plants between rows in a grain crop. Source: Emma Leonard, AgriKnowHow



Photo 6: Wild oat (*Avena fatua*) seeds. Source: Geoff Sainty.



Photo 7: Wild oat ligule. Note the absence of auricles. Easily confused with brome grasses. Source: A. Storrie, NSW Department of Primary Industries.

## GROWNOTES™

GrowNotes™ — your one-stop shop for regional trial results and best practice recommendations:  
[www.grdc.com.au/GrowNotes](http://www.grdc.com.au/GrowNotes).



## FAQS

### Why is it that I can often kill wild oats with grass sprays but the ryegrass in the same paddock is resistant?

Ryegrass can be more difficult to remove as it is often prevalent in a much higher density than wild oats, resulting in different selection pressures to wild oats. However, genetics could be at play too.

Recent research by Australian Herbicide Resistance Initiative (AHRI) found that the genetics are very different between these two weeds. Ryegrass must cross pollinate to reproduce and it has two copies of each gene (diploid). Wild oats is more like wheat, it mostly self-pollinates (88–100% self-pollination) and it has six copies of every gene (hexaploid). In ryegrass, a single gene mutation causes ryegrass to be resistant to a

grass herbicide but it will have only a minor effect on wild oats. This is because the resistance gene in wild oats is diluted by the susceptible genes due to there being six copies of each gene. Read more at: <https://ahri.uwa.edu.au/why-do-wild-oats-develop-resistance-slowly/>.

### Is there any new technology/research that may assist with wild oat management?

Currently GRDC are investing research into better surveillance of weeds either in fallows or crops. Images, gathered by ground-based vehicles, drones or satellites, can be analysed for spectral and shape signatures specific for wild oats. The idea is this technology can be used to apply herbicides more accurately to individual weeds. There is currently optical spray technology in

place for fallow weeds, but there is a need for more discerning technology for weed recognition within crops.

### Are there any pests or diseases associated with wild oat?

Wild oats is a major host of Cereal Cyst Nematode (*Heterodera avenae*) and Root Lesion Nematode (*Pratylenchus neglectus*). It carries Stem Nematode (*Ditylenchus dipsaci*) and is a poor host of Root lesion Nematode (*Pratylenchus thorneii*) but still allows some build-up of numbers ([http://www.herbiguide.com.au/Descriptions/hg\\_Wild\\_Oat.htm](http://www.herbiguide.com.au/Descriptions/hg_Wild_Oat.htm)).

The weed also carries other nematodes; the bacteria associated with annual ryegrass toxicity; rusts of cultivated oats, root diseases (e.g. Rhizoctonia) and Crown Rot.

## RESOURCES

M Congreve (2016) Advances in weed management webinar Ecology and management of wild oats. GRDC video, <https://www.youtube.com/watch?v=V8Vgy1ROIA8>.

GRDC (2015) Controlling Black Oats. GRDC Radio, featuring Chris Preston, Southern Update, 29 October 2015, <https://grdc.com.au/news-and-media/podcasts/grdc-radio-southern/2015/10/103-south>.

GRDC (2018) Integrated Weed Management Hub. GRDC, <https://grdc.com.au/resources-and-publications/iwmhub>.

GRDC (2018) GrowNotes™ Technical: Herbicide Use. GRDC, <https://grdc.com.au/resources-and-publications/grownotes/technical-manuals/herbicide-use>

## MORE INFORMATION

Michael Widderick  
Queensland Department of  
Agriculture and Fisheries  
michael.widderick@daf.qld.gov.au  
07 4529 1325

Tony Cook  
New South Wales Department of  
Primary Industries  
tony.cook@dpi.nsw.gov.au  
0447 651 607

Hanwen Wu  
New South Wales Department of  
Primary Industries  
hanwen.wu@dpi.nsw.gov.au  
02 6938 1602

Richard Daniel  
Northern Grower Alliance  
richard.daniel@nga.org.au  
07 4639 5344

Maurie Street  
Grain Orana Alliance  
maurie.street@grainorana.com.au  
0400 066 201

Peter Newman  
Australian Herbicide Resistance  
Initiative  
08 9964 1170  
petern@planfarm.com.au

Michael Walsh  
Plant Breeding Institute, The  
University of Sydney  
02 6799 2201  
m.j.walsh@sydney.edu.au

## REFERENCES

M Walsh (2017) The challenge of managing Wild Oats in northern region cropping. GRDC Update paper, <https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2017/03/the-challenge-of-managing-wild-oats-in-northern-region-cropping>.

M Street and B O'Brien (2016) Report on the 2014 GOA Herbicide Resistance Survey. Grain Orana Alliance, <https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2016/02/goaherbicideresistancesurvey2014>.

T Cook, G Brooke, M Widderick and M Street (2014) Herbicides and weeds regional issues trials and developments. GRDC Update Paper, <https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2014/03/herbicides-and-weeds-regional-issues-trials-and-developments>.

H Wu and E Koetz (2014) Long-term seedbank management of wild oats in southern New South Wales. Plant Protection Quarterly Vol.29(4) 2014.

R Llewellyn, D Ronning, M Clarke, A Mayfield, S Walker, J Ouzman (2016) Impact of weeds on Australian grain production: the cost of weeds to Australian grain growers and the adoption of weed management and tillage practices. GRDC and CSIRO, [www.grdc.com.au/ImpactOfWeeds](http://www.grdc.com.au/ImpactOfWeeds).

AM Storrie (Ed.) (2014) Integrated weed management in Australian cropping systems. GRDC, ISBN 978-1-921779-61-9, [www.grdc.com.au/IWMM](http://www.grdc.com.au/IWMM).

MJ Widderick, M Keenan, MJ Walsh (2014) Harvest weed seed control: is there a role in northern region farming systems?. In Baker, M., (Ed.), 19th Australasian Weeds Conference-Science, Community and Food Security: the Weed Challenge. Tasmanian Weed Society, Hobart, Australia, <http://caws.org.au/awc/2014/awc201411531.pdf>.

R Daniel (2016) Wild Oat Herbicide Resistance – How real is the threat? Northern Grower Alliance (NGA), <http://www.nga.org.au/results-and-publications/download/16/grdc-update-papers-weeds/wild-oat-management-1/grdc-grower-update-paper-bellata-august-2008.pdf>.

L Price and R Daniel (2017) Practical strategies for problem weeds; glyphosate resistant barnyard, liverseed grass and sowthistle, Group A resistant wild oats and feathertop Rhodes grass. GRDC Update Paper, <https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2017/07/practical-strategies-for-problem-weeds-glyphosate-resistant-barnyard-liverseed-grass-and-sowthistle-group-a-resistant-wild-oats-and-feathertop-rhodes-grass2>.

M Walsh and P Newman (2013) Cart crush or cremate weed seeds to manage resistance. GroundCover™ Supplement Issue 104: Herbicide resistance, May–June 2013, <https://grdc.com.au/resources-and-publications/groundcover/ground-cover-supplements/gcs104/cart-crush-or-cremate-weed-seeds-to-manage-resistance>.

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