## List of herbicide resistant weeds in Australia

| Grass weeds | Groups | Sites |
|---|---|---|
| Annual ryegrass (*Lolium rigidum*)<br>Annual ryegrass (*Lolium rigidum*)<br>Annual ryegrass (*Lolium rigidum*)<br>Annual ryegrass (*Lolium rigidum*)<br>Annual ryegrass (*Lolium rigidum*)<br>Annual ryegrass (*Lolium rigidum*)<br>Annual ryegrass (*Lolium rigidum*)<br>Annual ryegrass (*Lolium rigidum*)<br>Annual ryegrass (*Lolium rigidum*) | A<br>B<br>C<br>D<br>J<br>K<br>L<br>M<br>Q | >20,000<br>>20,000<br>>50<br>>5000<br>>50<br>20<br>20<br>>1000<br>3 |
| Annual veld grass (*Ehrharta longiflora*) | A | 6 |
| Awnless barnyard grass (*Echinochloa colona*) | M | >200 |
| Barnyard grass (*Echinochloa crus-galli*) | C | 1 |
| Barley grass (*Hordeum* spp.)<br>Barley grass (*Hordeum* spp.)<br>Barley grass (*Hordeum* spp.)<br>Barley grass (*Hordeum* spp.) | A<br>B<br>L<br>M | >200<br>>200<br>>100<br>2 |
| Brome grass (*Bromus* spp.)<br>Brome grass (*Bromus* spp.)<br>Brome grass (*Bromus* spp.)<br>Brome grass (*Bromus* spp.) | A<br>B<br>C<br>M | >200<br>>1000<br>1<br>5 |
| Crabgrass (*Digitaria sanguinalis*)<br>Crabgrass (*Digitaria sanguinalis*) | A<br>B | 2<br>1 |
| Crowsfoot grass (*Eleusine indica*) | A<br>L | 1<br>5 |
| Feathertop Rhodes grass (*Chloris virgata*) | M | 10 |
| Giant Parramatta grass (*Sporobolus fertilis*) | J | 6 |
| Johnson grass (Sorghum halepense) | M | 1 |
| Lesser Canary grass (*Phalaris minor*)<br>Lesser Canary grass (*Phalaris minor*) | A<br>B | 20<br>10 |

| | | |
|---|---|---|
| Liverseed grass (*Urochloa panicoides*) Liverseed grass (*Urochloa panicoides*) | C<br>M | 7<br>4 |
| Paradoxa grass (*Phalaris paradoxa*)<br>Paradoxa grass (*Phalaris paradoxa*) | A<br>B | 7<br>4 |
| Serrated tussock (*Nassella trichotoma*) | J | 2 |
| Silver grass / Squirrel-tailed fescue (*Vulpia bromoides*)<br>Silver grass / Squirrel-tailed fescue (*Vulpia bromoides*) | C<br>L | 3<br>1 |
| Sweet summer grass (*Brachiaria eruciformis*) | M | 1 |
| Wild oat (*Avena* spp.)<br>Wild oat (*Avena* spp.)<br>Wild oat (*Avena* spp.)<br>Wild oat (*Avena* spp.) | A<br>B<br>M<br>Z | >5000<br>>200<br>2<br>>200 |
| Windmill grass (*Chloris truncata*) | M | 13 |
| Winter grass / Annual poa (Poa annua)<br>Winter grass / Annual poa (Poa annua)<br>Winter grass / Annual poa (Poa annua)<br>Winter grass / Annual poa (Poa annua)<br>Winter grass / Annual poa (Poa annua)<br>Winter grass / Annual poa (Poa annua)<br>Winter grass / Annual poa (Poa annua) | A<br>B<br>C<br>D<br>J<br>M<br>Z | 3<br>20<br>10<br>>100<br>10<br>10<br>3 |

| **Broadleaf weeds** | **Groups** | **Sites** |
|---|---|---|
| African turnip weed (*Sisymbrium thellungii*) | B | 2 |
| Arrowhead (*Sagittaria montevidensis*) | B | 20 |
| Bedstraw / Cleavers (*Galium aparine*) | B | 3 |
| Black bindweed (*Fallopia convolvulus*) | B | 2 |
| Blackberry nightshade (*Solanum nigrum*) | L | 2 |
| Calomba daisy (*Oncosiphon suffruticosum*) | B | 2 |
| Capeweed (*Arctotheca calendula*)<br>Capeweed (*Arctotheca calendula*) | I<br>L | 1<br>1 |

| | | |
|---|---|---|
| Charlock (*Sinapis arvensis*) | B | 2 |
| Common sowthistle (*Sonchus oleraceus*)<br>Common sowthistle (*Sonchus oleraceus*)<br>Common sowthistle (*Sonchus oleraceus*) | B<br>I<br>M | >10000<br>>50<br>>50 |
| Dense-flowered fumitory (*Fumaria densiflora*) | D | 2 |
| Dirty Dora (*Cyperus difformis*) | B | >50 |
| Flax-leaf fleabane (*Conyza bonariensis*)<br>Flax-leaf fleabane (*Conyza bonariensis*)<br>Flax-leaf fleabane (*Conyza bonariensis*) | B<br>L<br>M | >100<br>1<br>>100 |
| Iceplant (*Mesembryanthemum crystallinum*) | B | 2 |
| Indian hedge mustard (*Sisymbrium orientale*)<br>Indian hedge mustard (*Sisymbrium orientale*)<br>Indian hedge mustard (*Sisymbrium orientale*)<br>Indian hedge mustard (*Sisymbrium orientale*) | B<br>C<br>F<br>I | >1000<br>16<br>>50<br>>50 |
| Lincoln weed / Sand rocket (*Diplotaxis tenuifolia*) | B | 20 |
| Paterson's curse (*Echium plantagineum*) | B | 2 |
| Pennsylvania cudweed (*Gamochaeta pensylvanica*) | L | 2 |
| Prickly lettuce (*Lactuca serriola*)<br>Prickly lettuce (*Lactuca serriola*) | B<br>M | >2000<br>1 |
| Small square weed (*Mitracarpus hirtus*) | L | 1 |
| Starfruit (*Damasonium minus*) | B | 5 |
| Stinging nettle / Dwarf nettle (*Urtica urens*) | C | 1 |
| Tall Fleabane (*Conyza sumatrensis*) | M | 10 |
| Tridax daisy (*Tridax procumbens*) | M | 1 |
| Turnip weed (*Rapistrum rugosum*) | B | 3 |
| Wild radish (*Raphanus raphanistrum*)<br>Wild radish (*Raphanus raphanistrum*)<br>Wild radish (*Raphanus raphanistrum*)<br>Wild radish (*Raphanus raphanistrum*) | B<br>C<br>F<br>I | >5000<br>>20<br>>1000<br>>1000 |

| | | |
|---|---|---|
| Wild radish (*Raphanus raphanistrum*) | M | 3 |
| Wild turnip / Mediterranean turnip (*Brassica tournefortii*) | B | >100 |
| Willow leaf lettuce (*Lactuca saligna*) | M | 2 |

*CropLife acknowledges the assistance of Dr Chris Preston (University of Adelaide) in compiling this list. If you suspect a case of herbicide resistance that is not on this list please notify Dr Preston at christopher.preston@adelaide.edu.au so that he can maintain a register of herbicide resistance in Australia.*

*These observations are independent of registered label claims for these herbicide mode of action groups.*

## WEED SPECIES WITH HIGH RISK OF DEVELOPING HERBICIDE RESISTANCE

Some weed species have been identified as having a high risk of herbicide resistance development. The weeds listed below fall into this category and more information on their management can be found in the links provided.

### Annual ryegrass (*Lolium rigidum*)

Annual ryegrass (*Lolium rigidum*) is the most important and costly weed to Australian winter crops with an estimated yield loss of $34.1 million to the Southern region. Ryegrass remains the major weed in terms of the cost of herbicide resistance with the cost being greater than the sum of all other forms of resistance (Rick Llewellyn, GRDC project code CSA 00043).

Herbicide resistance has been confirmed in annual ryegrass in Australia in approximately 50,000 populations across nine modes of action; Groups A, B, C, D, J, K, L, M, Q (croplife.org.au). Resistance to Groups A and B are particularly widespread with more than an estimated 40,000 populations of ryegrass affected.

Herbicide resistance has developed in annual ryegrass due to its biology, including the high level of seed production, combined with high frequency of herbicide use.

Management should include a mix of herbicide and cultural strategies along with resistance testing to manage populations pro-actively.

Refer to GRDC's *Integrated Weed Management Manual* for further information: https://grdc.com.au/resources-and-publications/all-publications/publications/2014/07/iwmm

Refer to CropLife Australia's Herbicide Resistant Weeds list for further information: https://www.croplife.org.au/wp-content/uploads/2019/06/Herbicide-Resistant-Weeds.pdf

## Wild Oats (*Avena* spp.)

Wild oats (*Avena* spp.) is the most important winter cropping weed in northern New South Wales and southern Queensland. It is second in importance to annual ryegrass in most of the southern region and a significant weed in much of Western Australia.

Group A herbicide resistance has been present in Australian populations of wild oats since the mid-1980s and is now common in the majority of winter crop growing regions with more than 5000 populations of Wild oats affected. Resistance has also been confirmed to Group B and Group Z with more than 200 populations of wild oats affected

The incidence of Group A 'dim' (e.g. Achieve®) resistance in wild oats continues to increase.

Group Z (flamprop methyl) resistance is also now common in the northern NSW and southern Queensland growing regions. Much of the resistance to flamprop methyl is also cross-resistant with Group A herbicides with one in three 'fop' resistant wild oat populations being observed to also have Group Z resistance. Group B resistance in wild oats has also been increasing over the past decade to levels where it is also common in the northern winter crop growing regions.

Reducing the seed bank is essential for effective management of wild oats. Effective management must take place over many years due to the persistence of viable wild oat seeds in the soil. It is also important to conduct a resistance test for all key herbicides when an herbicide strategy employed is no longer completely effective. A resistance test is useful to develop or modify an herbicide strategy to prevent the build-up of resistant populations.

Refer to GRDC's *Integrated Weed Management Manual* for further information: https://grdc.com.au/resources-and-publications/all-publications/publications/2014/07/iwmm

Refer to CropLife Australia's Herbicide Resistant Weeds list for further information: https://www.croplife.org.au/wp-content/uploads/2019/06/Herbicide-Resistant-Weeds.pdf

### Brome grass (*Bromus spp.*)

Brome grass occurs in both high and low rainfall areas across Australia and is a highly competitive weed in pasture and cropping systems. The two most common species are *Bromus diandrus* and *Bromus rigidus* and they are an increasing problem in cereal crops.

Herbicide resistance is known to occur in three modes of action (Groups A, B, and M) across more than 1000 populations in Australia. Resistance to these modes of action is not surprising considering the strong adoption of grass selective herbicides (Group A) in the 1980s and 1990s; followed by a move to sulfonylureas and imidazolinones (Group B) in the 2000s to present day.

Brome grass has a later germination pattern compared with other grass weeds, such as annual

ryegrass or barley grass. Plants germinating in winter or early spring mean it's difficult to gain effective control with pre-sow knockdown herbicides or pre-emergent herbicides.

Further information can be found on the GRDC website: https://grdc.com.au/resources-and-publications/all-publications/factsheets/2011/05/brome-grass

Refer to GRDC's *Integrated Weed Management Manual* for further information: https://grdc.com.au/resources-and-publications/all-publications/publications/2014/07/iwmm

Refer to CropLife Australia's Herbicide Resistant Weeds list for further information: https://www.croplife.org.au/wp-content/uploads/2019/06/Herbicide-Resistant-Weeds.pdf

**Barley grass (*Hordeum* spp.)**

Barley grass is the widely used name for *Hordeum glaucum* and *Hordeum leporinum*. Barley grasses are annual species dominant in the winter rainfall (southern) areas of the cropping belt of Australia.

There are over 200 populations of barley grass resistant to Group B herbicides and over 200 populations resistant to Group A herbicides (mostly 'fop' but also some populations resistant to 'dim' herbicides plus some cross-resistance to 'dim' herbicides). There are also more than 100 populations resistant to Group L herbicides (paraquat and diquat) and at least one population resistant to Group M (glyphosate)

Barley grasses are commonly a problem in low rainfall cropping environments where cereals are grown in long succession and dry sowing is routinely practiced. In these environments, barley grasses are becoming more problematic as an increasing number of populations have evolved to have longer seed dormancy. This enables barley grasses to escape knockdown herbicides pre-sowing and then germinate in-crop, where there are limited herbicide options.

In cropping systems, low-disturbance disc equipment favours barley grasses compared with knife point and conventional sowing systems. This is the opposite situation to wild oats and annual ryegrass, which are less viable if left on the soil surface.

There is no evidence indicating that barley grasses produce a persistent seed-bank. Over 99 per cent of seeds germinate in the first year after seed-set. Where activities such as pasture spray-topping are correctly timed, field observations indicate that control will be very high (as evidenced by reduced autumn germinations).

Refer to GRDC's *Integrated Weed Management Manual* for further information: https://grdc.com.au/resources-and-publications/all-publications/publications/2014/07/iwmm

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### Barnyard grass (*Echinochloa* spp.)

Of the top five weeds considered to be most troublesome to world agriculture, two belong to the genus *Echinochloa;*[1] *Echinochloa colona* (awnless barnyard grass) and *Echinochloa crus-gralli* (barnyard grass). Barnyard grasses have increased in prevalence in Australia over the last 20 years with the greater adoption of minimum tillage systems. These grass species are problematic because they are prolific seeders, are not consistently controlled with commonly used herbicides, and can be highly competitive.

At least 200 populations of awnless barnyard grass have confirmed resistance to glyphosate. Tactics against this weed need to change from glyphosate alone.

At least one population of barnyard grass is also confirmed resistant to Group C herbicides. Further information on barnyard grass can be accessed at the following sites:

- https://grdc.com.au/resources-and-publications/all-publications/publications/2014/07/iwmm
- https://www.daf.qld.gov.au/__data/assets/pdf_file/0008/55277/Managing-barnyard-and-liverseed-grasses.pdf
- Refer to CropLife Australia's Herbicide Resistant Weeds list for further information: https://www.croplife.org.au/wp-content/uploads/2019/06/Herbicide-Resistant-Weeds.pdf

### Fleabane (*Conyza* spp.)

Fleabane is a woody weed that presents a major problem to broadacre and horticulture growers, particularly in fallow situations and where there is limited cultivation. The most common species of fleabane in Australia is flaxleaf fleabane (*Conyza bonariensis*), a widespread problem in southern Queensland and northern New South Wales, but also prevalent in southern and western states in summer. Tall fleabane (*Conyza sumatrensis*) is also now emerging in Western Australia.

Fleabane is notoriously difficult to control with herbicides due to a natural tolerance to glyphosate. Incidences of resistance to Groups B, C and L have been recorded globally. Currently in Australia, resistance has been confirmed in approximately 200 populations to Groups B, L and M herbicides. Because of this, fleabane can be managed effectively with residual herbicides applied both in fallow and in-crop.

It is recommended to use an integrated weed management approach when targeting fleabane, incorporating non-chemical means such as crop competition.

[1] Storrie, AM (ed) (2014). *Integrated weed management in Australian cropping systems.* Grains Research and Development Corporation

Further information can be accessed on the following sites:

- https://www.agric.wa.gov.au/grains-research-development/fleabane
- https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update- papers/2015/07/farming-systems-strategies-to-manage-fleabane-and-feathertop-rhodes-grass
- https://www.daf.qld.gov.au/ data/assets/pdf_file/0005/65903/Flaxleaf-fleabane.pdf
- Refer to CropLife Australia's Herbicide Resistant Weeds list for further information: https://www.croplife.org.au/wp-content/uploads/2019/06/Herbicide-Resistant-Weeds.pdf

**Common sowthistle (*Sonchus oleraceus*)**

Common sowthistle, or milk thistle (*Sonchus oleraceus*), is a weed of broadacre and horticulture regions across Australia.

It is an important weed for the following reasons:

- Populations are increasing;
- It has become less seasonal in occurrence, with germination associated with sufficient soil moisture across a range of soil temperatures;
- It is a prolific seed producer; and
- There is widespread resistance (greater than 10,000 populations) to a range of (once very effective) Group B herbicides, with recently identified isolated populations resistant to Group I (5 populations) and Group M (1 population) herbicides.

Sowthistle seed is dispersed by wind, but typically most seed falls within a few metres of the parent plant. Seed typically germinates from near the soil surface. If seed is not buried it generally does not persist for more than one season.

Preventing seed set is an important tactic of an integrated weed management strategy. It is suggested that growers monitor the performance of herbicides applied in fallow, especially glyphosate-based applications.

While herbicides from Group I remain generally very effective, the identification of (as yet very isolated) populations that are resistant are of concern due to the reliance on this mode of action group.

**References:**

Widderick M, Walker S (Leslie Research Centre, Toowoomba), (2009). Fact Sheet: Management of

common sowthistle.

Further information can be accessed on the following sites:

- https://grdc.com.au/resources-and-publications/all-publications/publications/2014/07/iwmm
- WeedSmart
- Australian Glyphosate Sustainability Working Group
- CropLife Australia's Herbicide Resistant Weeds list for further information: https://www.croplife.org.au/wp-content/uploads/2019/06/Herbicide-Resistant-Weeds.pdf

**Wild radish (*Raphanus raphanistrum*)**

Wild radish (*Raphanus raphanistrum*) is one of the most widespread and competitive weeds of grain cropping and horticulture in Australia. It is the most costly broadleaf weed nationally in terms of yield loss in winter broadacre crops 1.

Wild radish has developed resistance to 5 herbicide modes of action including Groups B, C, F, I and M. Whilst resistance to some herbicides has been slow to develop e.g., Group C (less than 20 populations), or has been discovered only recently e.g., Group M (3 populations), resistance to Group B (more than 5000 populations), Group F (more than 1000 populations) and Group I (more than 1000 populations) is now widespread. Increasingly, wild radish populations are developing resistance to multiple modes of action.

Reducing the seed bank is essential for effective management of wild radish. Effective management must take place over many years due to the persistence of viable wild radish seeds in the soil. It is also important to conduct a resistance test for all key herbicides when an herbicide strategy employed is no longer completely effective. A resistance test is useful to develop or modify an herbicide strategy to prevent the build-up of resistant populations.

**References**

Llewellyn RS, Ronning D, Ouzman J, Walker S, Mayfield A and Clarke M (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 Report for GRDC. CSIRO, Australia.

Refer to GRDC's *Integrated Weed Management Manual* for further information: https://grdc.com.au/resources-and-publications/all-publications/publications/2014/07/iwmm

Refer to CropLife Australia's Herbicide Resistant Weeds list for further information: https://www.croplife.org.au/wp-content/uploads/2019/06/Herbicide-Resistant-Weeds.pdf

**Prickly lettuce (*Lactuca serriola*)**

Prickly lettuce (*Lactuca serriola*) is a weed of cereal and pulse crops, orchards, vines and non-crop areas.

It is self-compatible and self-pollinated with little evidence of interspecific hybridisation. Seed production of this species is high but varies according to growing conditions. The seeds are light, windborne via a pappus, germinate readily, have no primary dormancy and have a short-lived seed bank1.

Sulfonylurea-resistant prickly lettuce was first reported from a continuous no-till winter wheat crop in 1987. As of June 2018, there are reported to be over 2,000 populations resistant to Group B herbicides. There is one reported case of Group M (glyphosate) resistance.

**References**

Spread of resistance to acetolactate synthase inhibiting herbicides in a wind borne, self-pollinated weed, Lactuca serriola L. (prickly lettuce). Jeanine Baker, Yi Qing Lu and Christopher Preston pp. 519-521. Australian Weeds Conference 2015.

Further information can be accessed on the following sites:

- Queensland Government: https://keyserver.lucidcentral.org/weeds/data/media/Html/lactuca_serriola.htm
- Agriculture Victoria: http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/sip_salt_prickly_lettuce
- CropLife Australia's Herbicide Resistant Weeds list for further information: https://www.croplife.org.au/wp-content/uploads/2019/06/Herbicide-Resistant-Weeds.pdf

**Indian hedge mustard (*Sisymbrium orientale*)**

Indian hedge mustard (*Sisymbrium orientale*) is a widespread, introduced weed of many regions of Australia.

There are significant populations resistant to Group B (more than 1000 populations), Group I (50 populations) and some resistant to both groups. There are also small populations (less than 50) resistant to Group C and Group F herbicides. The first cases of Group B resistance were confirmed

in the early 1990s in New South Wales, South Australia and southern Queensland. These collections were growing in continuously cropped wheat paddocks where chlorsulfuron had been applied for between 6-10 years. Random weed surveys across western South Australia, on the Eyre Peninsula in 2009, and western Victoria in 2010 revealed that 52 per cent and 35 per cent, respectively, of Indian hedge mustard populations were resistant to chlorsulfuron. Also, 57 per cent and 38 per cent of the samples from South Australia and western Victoria, respectively, were also resistant to metosulam.

The first case of 2,4 D resistance in Indian hedge mustard was identified in 2007 in South Australia. Subsequent directed surveys in this region identified 12 Indian hedge mustard populations occurring on seven farms with resistance to both 2,4-D and Group B herbicides. Resistance to Group B and I herbicides is of particular concern as it limits weed control options.

Because its seeds have a relatively short innate dormancy and germinate more readily in seasons with good rainfall, Indian hedge mustard germinates during autumn to winter. In these seasons effective control can be achieved by pre-sowing knockdown herbicides. However, in seasons when opening rains are late, there can be a serious infestation of Indian hedge mustard in sown crops as it continues to emerge after post-emergent herbicides have been applied.

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**Mediterranean / Wild turnip (*Brassica tournefortii*)**

Wild turnip (*Brassica tournefortii*) is a weed common in southern and central Queensland, many parts of New South Wales, Victoria, Tasmania and South Australia, and in southern and central Western Australia. This weed can germinate at any time of the year, though most germination occurs either in autumn or spring.

Like other brassica weeds, there are numerous (greater than 100) populations of wild turnip that have evolved resistance to Group B herbicides. Resistance to Group B herbicides was first confirmed in South Australia and West Australia in 1996. Herbicide usage records show that resistance has developed after 3-10 years of selection with chlorsulfuron.

Refer to GRDC's *Integrated Weed Management Manual* for further information: https://grdc.com.au/resources-and-publications/all-publications/publications/2014/07/iwmm

Refer to CropLife Australia's Herbicide Resistant Weeds list for further information: https://www.croplife.org.au/wp-content/uploads/2019/06/Herbicide-Resistant-Weeds.pdf