MANAGING THE WEED SEEDBANK FACT SHEET

GRDC Grains Research & Development Corporation

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Managing weeds – it starts with the seeds

Exhausting the seedbank is the key to integrated weed management (IWM) strategies. There are numerous techniques to deplete the seedbank, depending on the farming system, location and weed threat.

KEY POINTS

- No single management technique provides 100 per cent weed seed control. A combination of techniques need to be employed throughout the year.
- Decisions about which tool to use should be based on the weed species, rotation, farming system, budget and market opportunities.
- As some seeds can last in the soil for several years, back-to-back years of weed control need to be employed to drive numbers down.
- Manage weed blowouts before the seed goes into seedbank.
- The computer-based models RIM and Weed Seed Wizard help predict the amount of weed seeds emerging each year.

IWM strategies

Management of weed seed-set offers the most practical long-term management of hard to control weeds, including wild oats, wild radish and annual ryegrass. Control tactics include destroying or burying set seeds, encouraging germination, strategic herbicide use and crop agronomy.

There is not a single IWM program ideal for all conditions. The suite of tactics chosen depends on the soil type, rainfall pattern, crop rotation, equipment available, budget and farmer preference.

The first step is to identify the problem weeds and develop a multi-year approach to their management. The next step is to control weeds that survive early weed control or germinate in-crop and set-seed reinfesting the seedbank.

PHOTO: EMMA LEONARD

Once the weed seedbank has been reduced, the use of crop competition is one of the best tools to combat weed germination and seed-set, particularly for annual ryegrass. Strong crop competition, combined with rotating herbicide modes of action and the use of appropriate agronomy for crop nutrition and disease are the best methods of keeping seedbanks low.

Where weed populations are high or seedbank life is long, multiple years of seed-set control are required to drive populations down.

Resistance

Weed resistance can develop as a result of overuse of any single strategy.

Herbicides remain the least risky option for weed control and are used by most farmers. However, rotating herbicide mode of action groups and reducing reliance on herbicide control by the use of physical and biological control techniques will help slow the development of herbicide resistance.

IWM is not a replacement for herbicides but adds other control strategies throughout the season in order to create a system that maintains weeds at low levels while minimising current and future financial risks.

Preventing weed seed-set

When managing weed seed-set the best results are obtained if control occurs before the point where mature weed seeds are formed. Monitoring and managing regrowth is essential.

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Seedbank management tools

The choice of control tactics needs to consider the weed species, population size and on-farm management options in relation to rotation, expenditure, machinery and labour availability, market opportunities and future plans for the paddock. Tactics can be divided into prevention of weed seed-set, destroying weed seeds and encouraging germination for timely control (Table 1). In addition, good crop agronomy, herbicide rotation and farm hygiene all help effective weed control and/or prevent large weed populations becoming established. No single management technique provides 100 per cent control and generally a combination of techniques needs to be employed throughout the year.

Prior to, or at, seeding

Long fallow

While a fallow period between two crops or a crop and pasture phase is designed to conserve soil moisture and nutrients, it also makes an ideal time for repeated and focused weed control. The lack of crop competition during the fallow means large numbers of weed seeds germinate. If left unchecked these weeds can set high numbers of seeds per plant. Non-selective herbicides and cultivation are the most relied on control methods; however, the use of any single method will lead to a shift in weed species adapted to that control method. Rotation of chemical and physical control methods through the fallow period is essential. The use of residual herbicides and weed scouting can save one or two applications of non-selective herbicides as future weed germinations are reduced.

Crop competition

Crop choice, seeding rate and row spacing all influence a crop's ability to compete with weeds.

Species with rapid establishment and good early vigour such as barley or oats as a pasture/hay crop are the most effective at suppressing weed growth. Of the cereals wheat, especially durum, is the least competitive. Increasing seeding rates to achieve 200 rather than 100 wheat plants/m², was found to halve the annual ryegrass biomass. Another study found increasing wheat plant densities from 40 to 200 plants/m², produced a 100-fold reduction in annual ryegrass biomass. Reductions in biomass in response to increased seeding rates have also been reported for wild oats and paradoxa grass.

TABLE 1 Average percentage control of the annual ryegrass seedbank from the use of different control methods, based on expert opinion and research trials

Preventing weed seed-set	% control	Destroying weed seeds	% control	Encouraging germination	% control	Other
Multiple mowings	95	Strategic burning	40	Pre-sowing cultivation followed by control	50	Synchronising nutrient applications with crop growth
Hay, silage, green/brown manure with follow-up control	90	Minimising seed burial/ predation	40	Autumn tickle followed by control	35	Wide-row cropping
Long fallow with controls	75	Deep seed burial	N/A	Delayed seeding/ double-knock	20*	Herbicide rotation
Pasture or crop-topping/ weed-wiping	70					Farm hygiene
Grass control in pastures/ strategic grazing	70					
Weed seed collection at harvest	60					
High seeding rates/crop competition	40					
Swathing/windrowing	35					

*Improved control over one herbicide application

SOURCE: Dr David Minkey, WANTFA, Dr Christopher Preston, The University of Adelaide and Professor Stephen Powles, WAHRI.

Increasing sowing rates in pulses has not been found to provide the same competitive effect.

During the growing season

Mowing, hay and silage

The use of multiple mowings, silage or hay combined with a follow-up non-selective herbicide or heavy grazing to remove any late germinating plants provides excellent levels of control for several weed species. Timing is essential and cutting when grass weeds are flowering prevents viable weed seeds returning to the paddock or entering the hay (Table 2). Weed seeds are considered to be rendered unviable by ensiling. The spikelets of barley grass and silver grass make them unsuitable for hay or silage. If annual ryegrass toxicity is present the hay or silage should not be fed to stock.

TABLE 2 Effect of grazing by wethers (10 DSE/ha) and cutting times on species composition of a mixed annual grass/sub clover/perennial grass pasture in the third spring (year three) after cutting or grazing in each of the two previous springs (Kaiser et al 2004)

Species	Initial pasture composition (%)	Grazing only	Grazed then cut in spring (no control of regrowth)			
			Early Oct (silage)	Late Oct	Early Nov	Late Nov
	(% of species in pasture in year 3)					
Phalaris + cocksfoot	15.9	15.4	18.4	14.2	14.1	16.6
Sub clover	31.4	18.1	36.6	11.6	15.6	19.9
Naturalised clovers	3.9	0.5	4.5	0.3	4.0	6.6
Annual ryegrass	25.1	17.7	28.3	52.8	9.8	9.2
Vulpia (silver grass)	16.4	26.3	2.0	10.3	53.2	41.3
Great brome	1.0	14.1	2.1	0.2	1.3	3.9
Barley grass	0.3	4.8	0.2	0	0.4	0.1
Paterson's curse	3.5	0.3	6.9	4.4	1.4	1.5
Other broadleaf weeds	2.3	2.7	1.2	6.0	0.8	0.2

Green or brown manure

Incorporating green plant material, usually with an offset disc or brown manuring by using a non-selective herbicide, can result in high levels of weed control. Operations must occur at or before flowering to ensure viable weed seeds have not been set. When a follow-up herbicide control is used after brown manuring an alternative herbicide mode of action group should be used, for example glyphosate followed by paraquat.

Crop-topping

This the most common method of in-crop weed control resulting in the prevention of weed seed-set. It is effective for annual ryegrass, but much less useful on wild radish and other early maturing weeds.

Non-selective herbicides are used to control grass and broadleaf weeds. Application timing must be when weed seeds are immature and withholding periods before harvest must be observed.

To be most effective, crop-topping needs to be planned at the start of the season. It works best with early maturing pulse varieties which are at the later stages of seed production when weeds are flowering or weed seeds are immature. Applied prior to pulse seed maturity, crop-topping can significantly reduce yield and quality.

Crop-topping for wild radish control in current lupin varieties is not recommended because of the closely matched rate of development of crop and weed.

If grain is intended for use as seed or for sprouting crop-topping should not be performed.

Inter-row

The use of mechanical weed control in wider crop rows using ±2cm autosteer for inter-row weed control has been shown to suppress and delay weed growth on the inter-row but provides no control of weeds growing in the crop row. In the majority of broadacre crops, non-selective herbicides are not registered for use inter-row.

Spray grazing

Grazing can be coupled with hay and silage-making, mowing and pasture spray-topping for increased weed control. When used in conjunction with herbicides grazing can effectively manage weeds. Spray-grazing refers to the use of sub-lethal rates of selective herbicides (often phenoxy-based) to increase the palatability of broadleaf weeds for preferential grazing. It is usually undertaken in autumn or early winter and is especially beneficial for the control of erodium, capeweed, Paterson's curse and wild radish. High stocking rates up to four times the normal rate for the area are required for spray-grazing to work effectively. Weeds that are not killed by spraying alone will recover in two to three weeks and show normal growth if they are not grazed heavily after spraying.

At harvest

Weed seed collection at harvest

Ryegrass and wild radish both reach maturity at a similar time to wheat, lupins and canola. As the majority of seeds are retained on the plant they enter the harvester. Up to 80 per cent of wild radish seeds have been found to be collected in the grain sample, while more than 95 per cent of annual ryegrass seed that enters the harvester has been found to exit with the chaff. Therefore, seed cleaning and chaff carts or direct baling of chaff offer alternative methods to reduce the amount of weed seeds entering the seedbank.

Chaff collected by chaff carts is generally burnt or used as livestock feed.

Destroying weed seeds

Strategic burning

Destroying weed seeds by burning requires exposure to temperatures of 400ºC (ryegrass) and 500ºC (wild radish) for 10 seconds. In wheat stubbles of three to six tonne per hectare of biomass, soil surface temperatures of between 300 and 400ºC were recorded for between 30 and 50 seconds. These temperatures and durations increased with more stubble.

Concentrating stubble and weed seeds into windrows increases the effective biomass. Burning windrows is more effective for wild radish, where trials found 80 per cent of seed was destroyed compared to only 20 per cent in burnt standing stubble. For annual ryegrass 99 per cent of seed was destroyed by windrow-burning compared to 80 per cent in standing stubble. Burning windrows can be time consuming but results in only about 10 per cent of the paddock being burnt, reducing the risk of soil erosion.

Minimising seed burial

The level of soil disturbance has been shown to affect the percentage of the seedbank that emerged in the following crop (Table 3). Small-seeded weeds, such as silvergrass, emerged in much greater numbers in no-till seeding compared to two passes with a wide shear. Under minimum tillage larger seeded species such as bedstraw, wild radish and annual ryegrass showed greater germination.

Low disturbance discs leave more weed seeds on the surface while other single pass seeding equipment will bury seeds in the inter-row, resulting in delayed germination in the crop.

Another advantage of minimising seed burial is the seeds may be removed by insects, especially ants. In trials, with a seedbank of annual ryegrass (2000 seeds/m^2) and wild radish (1000 seeds/m^2) predation resulted in 81 per cent of the annual ryegrass seeds and 46 per cent of the wild radish seeds being destroyed. Reduced tillage, stubble retention and minimal use of broad spectrum insecticides can help encourage populations of insect predators.

TABLE 3 The influence of no-till with a knife point and a minimum tillage system using two passes with a wide shear on weed emergence and depth of emergence

Species	Total emergence %		Av. Depth of emergence (mm)	
	Min-till	No-till	Min-till	No-till
Wild oats	45	32	24	13
Annual Ryegrass	30*	11	15*	5
Silvergrass	4	12*	4	3
Wild turnip	10*	6	18	12
Wild radish	3	1	12	12
Mallow	6	8*	16	11
Turnip weed	2	6*	23*	12
Bedstraw	14*	9	37*	28
Indian hedge mustard	2	17*	3	3
Common sowthistle	6	14*	8	7

*denotes species with a significantly higher emergence or greater average depth of emergence.
SOURCE: The University of Adelaide

Encouraging germination

Cultivation

As previously reported, tillage can have a negative and positive effect on weed germination. This is because most weed species have a narrow depth preference for successful emergence (Tables 3 and 4).

A shallow cultivation, 'autumn tickle' using a range of equipment including tined implements, heavy harrows, pinwheel (stubble) rakes and disc chains can stimulate some weeds to germinate by placing them in contact with moist soil (Table 3).

Deep seed burial using inversion ploughing can prevent weed germination and has been used for herbicide resistant populations. Cultivation can be used as a non-herbicide component of a double-knock.

Delayed seeding

Early seeding has been recognised as a key component in securing yield in cereal and broadacre crops. The yield penalty from delaying sowing by up to two weeks after the opening rains may be justified by improved weed control.

Delayed seeding not only provides time for more weeds to germinate but also creates an opportunity to use two non-selective herbicides (glyphosate and paraquat) known as a double-knock ensuring control of glyphosate survivors. Best results have been recorded when paraquat is applied one to five days after the application of glyphosate.

This double-knock has been found to consistently improve the pre-seeding control of annual weeds by between 10 and 20 per cent over the application of a single knockdown herbicide.

TABLE 4 Persistence of three weed species after one and two years of burial in a non-disturbed soil at different burial depths. Estimated persistence is given for years three and four

	Depth (cm)	Persistence (% of seed sown)			
		1 year	2 year	3 year	4 year
Barnyard grass	0-2	13	2	<1	<0.1
	10	40	19	11	5
Liverseed grass	0-2	24	1	<1	<0.1
	10	67	21	11	5
Bladder ketmia	0-2	71	38	27	17
	10	72	64	47	37

SOURCE: Queensland Primary Industries and Fisheries

Electronic tools

Ryegrass Integrated Management (RIM)

RIM is a computer package that allows many different combinations of weed treatments and their predicted impacts on ryegrass populations, crop yields and long-term economic outcomes to be observed. A wide variety of chemical and non-chemical weed treatment options are included, so that as chemicals are lost to herbicide resistance, the next best substitute can be identified. For availability see Useful resources.

The Weed Seed Wizard

The Weed Seed Wizard is an interactive computer-based system that provides an insight into the hidden weed seedbank and helps in the coordinated long-term management of weeds. The Wizard is currently under development, but a prototype version can be downloaded from Weedlinks on the GRDC website. The Wizard encourages users to simulate paddock or weed management options while illustrating the impact of those decisions on the current and predicted seed bank and weed populations.

Compared to RIM, the Wizard has a wide range of weed species from both Northern and Southern cropping areas; more detailed representation of dormancy and weed ecology; and allows predictions to be driven by actual weather data and soil information for particular seasons and locations.

Useful resources:

Weeds CRC	**www.weeds.crc.org.au (no longer updated)**
West Australian Herbicide Resistance Initiative (WAHRI)	**www.wahri.uwa.edu.au**
Grains research update papers	**www.grdc.com.au**
David Pannell, UWA RIM Software	**david.pannell@uwa.edu.au**
Asst Prof Michael Samm Renton, Weed Seed Wizard	**michael.renton@cyllene.uwa.edu.au**
GRDC Weedlinks	**www.grdc.com.au/weedlinks**
Integrated Weed Management in Australian cropping systems	**WAHRI, www.wahri.uwa.edu.au**

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