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GRDC GROWNOTES™

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

FABA BEAN

SECTION 6

WEED CONTROL

INTEGRATED WEED MANAGEMENT IN FABA BEAN | SPECIFIC WEED ISSUES FOR FABA BEANS | HERBICIDE PERFORMANCE | HERBICIDE DAMAGE IN PULSE CROPS | PLANNING YOUR WEED CONTROL STRATEGY | HERBICIDES EXPLAINED | CROP DAMAGE CAUSED BY HERBICIDES | LEGAL CONSIDERATIONS OF PESTICIDE USE | GETTING BEST RESULTS FROM HERBICIDES | WEED CONTROL REQUIRES A PLANNED APPROACH | POST-EMERGENT GRASS-WEED CONTROL | OTHER WEED-CONTROL STRATEGIES | REFERENCES AND FURTHER READING

Weed control

VIDEOS

http://www.grdc.com.au/Media-Centre/Media-News/North/2013/05/Harvest-weed-seed-control-key-to-overcoming-resistance

MORE INFORMATION

http://ahri.uwa.edu.au/wp-content/uploads/2015/11/Michael-Walsh_HWSC_compressed.pdf

http://www.grdc.com.au/~/media/25C653C167C24A9A98C3451DFD16506C.pdf

http://www.grdc.com.au/uploads/documents/GRDC_HerbicideCard.pdf

http://www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds/publications/nhrr

http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/155148/herbicide-resistance-brochure.pdf

Weeds are estimated to cost Australian agriculture A$2.5–4.5 billion per annum. For winter cropping systems alone, the cost is $1.3 billion, equivalent to ~20% of the gross value of the Australian wheat crop. Consequently, any practice that can reduce the weed burden is likely to generate substantial economic benefits to growers and the grains industry. See more at: www.grdc.com.au/weedlinks. [1]

Weed control is essential if crops are to make full use of stored summer rainfall, and in order to prevent weed seeds from contaminating the grain sample at harvest. Weed management should be planned well before planting and options considered such as chemical and non-chemical control. [2]

The Grains Research and Development Corporation (GRDC) supports integrated weed management. Download the Integrated Weed Manual.

Weed control is important, because weeds can:

- rob the soil of valuable stored moisture
- rob the soil of nutrients
- cause issues at sowing time, restricting access for planting rigs (especially vine-type weeds such as melons, tarvine or bindweed, which wrap around tines)
- cause problems at harvest
- increase moisture levels of the grain sample (green weeds)
- contaminate the sample
- prevent some crops being grown where in-crop herbicide options are limited, i.e. broadleaf crops
- be toxic to stock
- carry disease
- host insects

6.1 Integrated weed management in faba bean

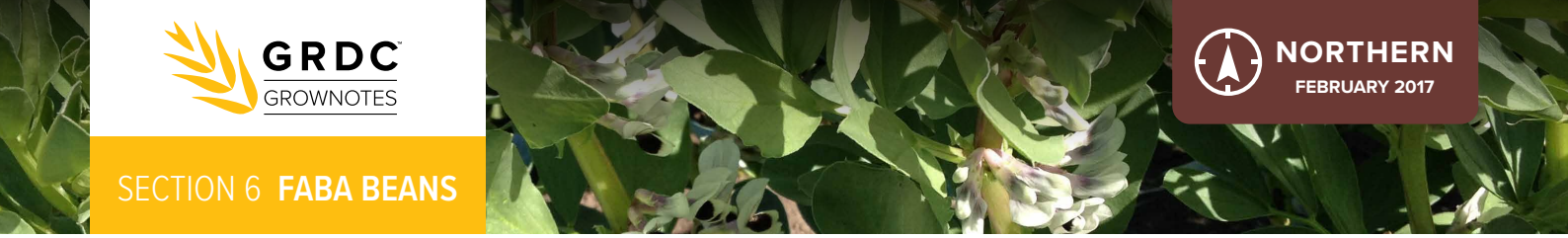
Good weed control management is vital to successful and profitable crop production. Yield losses caused by weeds can vary enormously from almost negligible to a complete loss.

Weeds lower crop yields by competing for soil moisture, nutrients, space and light. They can also carry diseases and viruses that can infect crops. This competition reduces grain yield and quality, and can impede harvesting. Some weeds can restrict cropping options because herbicides for control are sometimes limited. Thoroughly investigate which weed species are likely to germinate in a paddock before sowing crops and determine the availability of suitable herbicide options.

Weed control is a numbers game, and growers should aim to reduce weed numbers and keep them low with an ongoing management program. A weed-management program should make the most of rotations and hence opportunities to use selective herbicides from a different herbicide group in each crop in the rotation to reduce weed presence in the following crop. Care should be taken in planning a cropping rotation to avoid herbicide resistance, or growing a crop that may become a ‘weed’,

1 GRDC (2005) Integrated weed management: the mini manual. Weed Links, GRDC, www.grdc.com.au/weedlinks

2 QDAF (2012) Wheat—planting information. Department of Agriculture, Fisheries and Forestry, Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/wheat/planting-information



MORE INFORMATION

http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/431269/Fleabane-management-in-crop-rotations.pdf

http://www.dpi.nsw.gov.au/agriculture/broadacre/guides/ngrt-results

For further information on resistance management strategies refer to Integrated Weed Management Manual on the following websites: www.croplifeaustralia.org.au

www.glyphosateresistance.org.au

MORE INFORMATION

www.croplifeaustralia.org.au

www.glyphosateresistance.org.au

www.weedsmart.org.au

http://www.youtube.com/playlist?list=PL2PndQdkNRHGRipNhkDYN_2dJWAY1-oH9W

Ground Cover: SA trial assesses different weed strategies

GRDC Update Paper: Herbicides for control of clethodim-resistant annual ryegrass

or lead to uncontrolled weeds that cannot be controlled with selective herbicides in the subsequent crop.

An integrated weed-management system (IWM) system combining all available methods is the key to successful control of weeds (Table 1).

In-crop weed control

A wide range of pre-emergent and early post-emergent herbicides is available for grass weed control in faba bean. With broadleaf weeds, post-emergent options are very limited. Weeds should be removed from crops early, and certainly no later than 6 weeks after sowing if yield losses are to be minimised. Yield responses will depend on weed species, weed and crop density and seasonal conditions. The stage of growth of the weed and the crop are vital factors to consider when planning the use of post-emergent herbicides. Read herbicide labels carefully for these details and information on the best conditions for spraying.

Herbicide resistance

Herbicide resistance continues to develop and become more widespread. It is one of the biggest agronomic threats to the sustainability of our cropping systems. However, this problem can be managed through good crop rotations, rotating herbicide groups, and by combining both chemical and non-chemical methods of weed control.

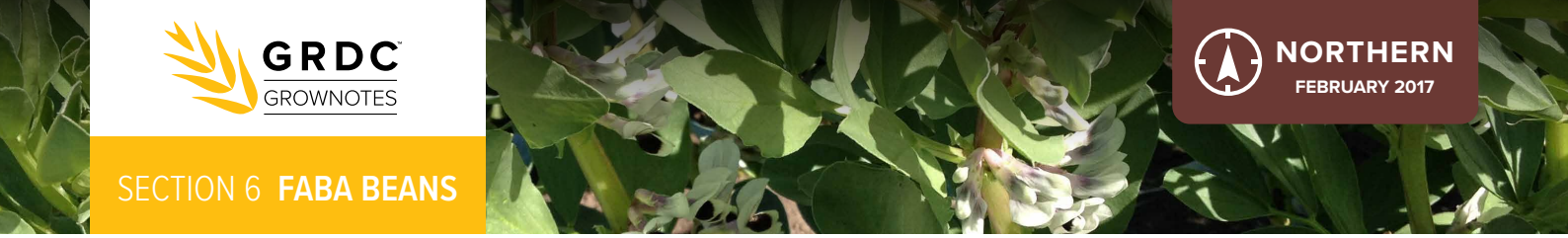
In general, options for broadleaved weed control with selective herbicides in faba beans are limited, compared with the treatments available for use in cereal crops. [3]

Table 1: *Weed control options for integrated weed management (IWM).*

	Herbicidal	Non-herbicidal
Crop phase	• Crop topping in pulse/legume crops • Knockdown herbicides, e.g. double-knock strategy before sowing • Selective herbicides before and/or after sowing, but ensure escapes do not set seed • Utilising moderate resistance-risk herbicides • Delayed sowing (as late as spring in some cases) with weeds controlled in the interim • Brown manure crops	• Rotate crops • Rotate varieties • Grow a dense and competitive crop • Cultivation • Green manure crops • Delay sowing • Cut crops for hay/silage • Burn stubbles/windrows • Collect weed seeds at harvest and remove or burn • Destroy weed seeds harvested (use of Harrington seed destructor)
Pasture phase	• Spray topping • Winter cleaning • Selective herbicides but ensure escapes do not set seed	• Good pasture competition • Hay making or silage • Cultivated fallow • Grazing

Keep yourself informed and be pro-active in the prevention and management of herbicide resistance.

3 Southern/Western Faba & Broad Bean—Best Management Practices Training Course. Module 5—Weed Management. 2013. GRDC/Pulse Australia.



Crop rotation

A well-managed rotation in each paddock, which alternates pastures, broadleaf and cereal crops, is a very useful technique for controlling weeds. For example, grass weeds are more easily and cheaply controlled chemically in broadleaf crops, whereas broadleaf weeds are much easier to control in cereal crops. Good crop rotation management can substantially reduce the cost of controlling weeds with chemicals.

Pulses grown in rotation with cereal crops offer opportunities to control grassy weeds easily with selective herbicides that cannot be used in the cereal years. An effective kill of grassy weeds in pulse crops will reduce root disease carryover and provide a 'break crop' benefit in following cereal crops. Grass-control herbicides can control most grassy weeds in pulses. Volunteer cereals can also be controlled with some of these herbicides.

Good agronomic practice

Use of weed-free seed (preferably registered or certified) and sowing on time with optimal plant populations and adequate nutrition all contribute to good weed control management. Some crops and varieties are more competitive against weeds than others. All weeds growing in a paddock should be controlled before the crop emerges. Large weeds that have not been controlled prior to or by the sowing operation prove most difficult and often impossible to remedy with in-crop herbicides.

Timely cultivation

Timely cultivation is a valuable method for killing weeds and preparing seedbeds. Some growers use varying combinations of mechanical and chemical weed control to manage their fallows or stubbles. Increasing numbers of growers are using knockdown herbicides instead of cultivation for fallow commencement, as well as pre-planting weed control in the autumn. These practices are providing clear benefits to soil structure, as well as more timely and effective weed control.

6.2 Specific weed issues for faba beans

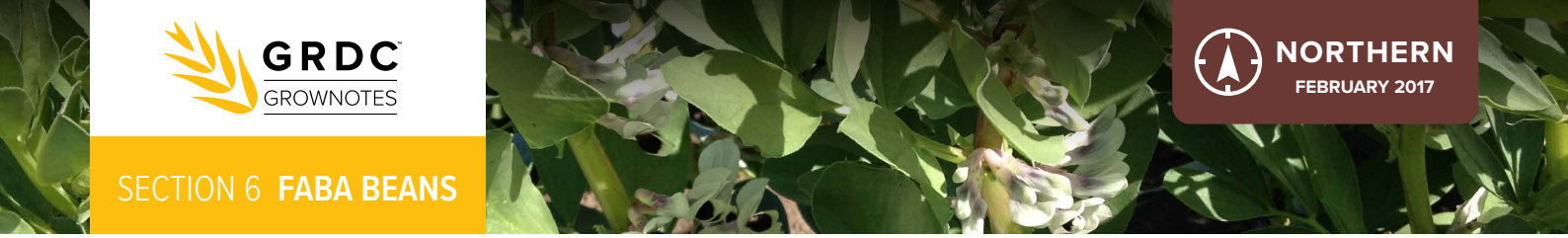
Problem weeds or issues in faba beans that require special attention or are difficult to fully control include:

- Annual ryegrass that is resistant to group A products ('dims' and 'fops'), particularly where high rates of clethodim are required.
- Annual ryegrass that is resistant to trifluralin.
- Crop topping cannot always be conducted in a timely manner to be safe for the beans and at the optimum stage for preventing ryegrass seed set. These late germinations of weeds (e.g. ryegrass, brome grass) would safely be prevented from setting seed by crop-topping in many earlier maturing pulses.
- Snail and other medic.
- Wild radish. There are no safe post-emergent treatments available.
- Hoary cress, soursob and tares.
- Faba beans are reasonably poor competitors with weeds initially because of slow germination, low plant populations and an extended period before ground is covered at canopy closure. [4]

MORE INFORMATION

GRDC Update Paper: Managing resistant ryegrass in break crops and new herbicides for resistant ryegrass

4 Southern/Western Faba & Broad Bean—Best Management Practices Training Course. Module 5—Weed Management. 2013. GRDC/ Pulse Australia.



6.3 Herbicide performance

Cha racteristics that determine herbicide performance and activity are:

- herbicide uptake—how and where the chemical is taken up by the plant
- herbicide solubility—how readily it dissolves or leaches in soil water
- herbicide adsorption—how much is lost by binding to the soil
- herbicide persistence—how long it lasts on the soil, affected by:
  - » volatility, i.e. loss to the atmosphere
  - » leaching potential, i.e. amount lost below the root-zone
  - » decomposition by light

Understanding these factors will assist in ensuring more effective herbicide use. For best performance, pre-sowing and pre-emergence herbicides should be placed in the top 0–7.5 cm of soil. They must enter the germinating weed seedling in order to kill it. These herbicides can be mixed in by cultivation, rainfall or sprinkler irrigation, depending on the herbicide.

Poor herbicide efficacy can occur under dry conditions at application. Some soil-active herbicides (e.g. Terbyne® or simazine) can damage faba beans where wetter conditions favour greater activity and leaching.

6.4 Herbicide damage in pulse crops

The risk of crop damage from herbicide application should be balanced against the potential yield loss from weed competition. In heavy weed infestations, some herbicide crop damage can be tolerated, as it is easily offset by the yield loss avoided by removing competing weeds.

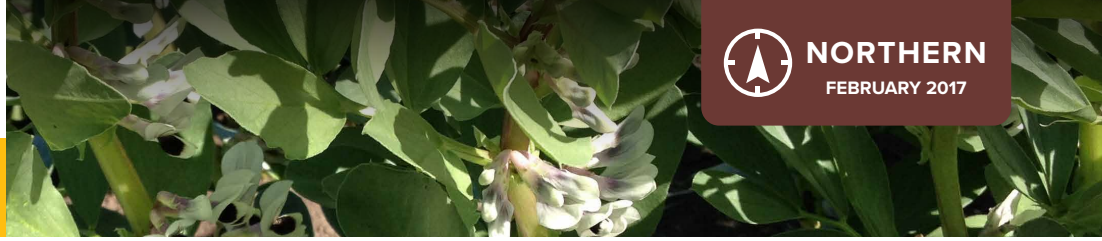
If herbicide is applied to dry soils, the risk of movement and crop damage is increased greatly after rainfall, particularly if the soil is left ridged and herbicide washes into the seed row. Incorporation by sowing (IBS) may be more appropriate in dry conditions, or a split application to minimise risk. Post sowing pre-emergent (PSPE) herbicides should be applied to moist soil regardless of the sowing time.

Herbicides move more readily in soils with low organic matter, and with more sand, silt or gravel. Herbicide movement is much less in soils with higher organic matter and higher clay contents. Damage from leaching is also greater where herbicides are applied to dry, cloddy soils than to soils that have been rolled and are moist on top from recent rainfall.

The relative leaching potentials presented in Table 2 show that metribuzin leaches at almost three times the rate of simazine and seven times the rate of diuron.

Table 2: *Relative leaching of some soil-active herbicides (where 1 is the least leaching).*

Chemical	Example of product	Leaching index
Pendimethalin	Stomp®	1
Trifluralin	Treflan®	1
Diuron	Diuron 900DF	2
Prometryn	Prometryn 900DF	3–4
Simazine	Simazine 900 WDG	5
Metolachlor	Dual®	6
Atrazine	Atrazine 900 WG	10
Metribuzin	Lexone®, Sencor®	14



The relative tolerance of the crop type and variety will also affect crop damage from these herbicides. For example, lupins are more tolerant to simazine than are the other pulses. For more specific details on soil-active herbicides and the risk of crop damage in your cropping situation, seek advice from an experienced agronomist. [5]

6.5 Planning your weed control strategy

1. Know your weed species. Ask your local adviser or service provider, or use the Sydney Botanic Gardens plant identification service, which is free in most cases (see link).
2. Conduct in-crop weed audits prior to harvest to know which weeds will be problematic the following year.
3. Ensure that seed is kept from a clean paddock.
4. Have a crop-rotation plan that considers not just crop type being grown but also the weed control options this crop system may offer, e.g. grass control with triazine-tolerant (TT) canola.

MORE INFORMATION

The Royal Botanic Gardens Plant Identification & Botanical Information Service: http://www.rbgsyd.nsw.gov.au/plant_info/identifying_plants/plant_identification_service

6.6 Herbicides explained

6.6.1 Residual *v.* non-residual

Residual herbicides remain active in the soil for an extended period (months) and can act on successive weed germinations. Residual herbicides must be absorbed through the roots or shoots, or both. Examples of residual herbicides include imazapyr, chlorsulfuron, atrazine and simazine.

The persistence of residual herbicides is determined by a range of factors including application rate, soil texture, organic matter levels, soil pH, rainfall/irrigation, temperature and the herbicide's characteristics.

Persistence of herbicides will affect the enterprise's sequence, such as a rotation of crops, e.g. wheat–barley–chickpeas–canola–wheat.

Non-residual herbicides, such as the non-selective paraquat and glyphosate, have little or no soil activity and they are quickly deactivated in the soil. They are either broken down or bound to soil particles, becoming less available to growing plants. They also may have little or no ability to be absorbed by roots.

MORE INFORMATION

https://grdc.com.au/Resources/Publications/2014/07/Integrated-Weed-Management-Manual

6.6.2 Post-emergent and pre-emergent

These terms refer to the target and timing of herbicide application. Post-emergent refers to foliar application of the herbicide after the target weeds have emerged from the soil, whereas pre-emergent refers to application of the herbicide to the soil before the weeds have emerged. [6]

6.7 Crop damage caused by herbicides

Symptoms of crop injury from herbicides do not always mean that a grain yield loss will occur. Recognition of crop injury symptoms allows the cause of the injury to be identified and possibly prevented in future crops. The type of injury depends on how the herbicide works in the plant, the site and seasonal conditions.

Herbicide injury may be obvious (e.g. scorched leaves) or it may be more subtle (e.g. poor establishment or delayed maturity). Herbicide crop-injury symptoms can easily be confused with symptoms produced by other causes, such as frost, disease or nutrition.

5 Southern/Western Faba & Broad Bean—Best Management Practices Training Course. Module 5—Weed Management. 2013. GRDC/Pulse Australia.

6 GRDC Integrated weed management, Section 4: Tactics for managing weed populations, http://www.grdc.com.au/~/media/A4C48127FF8A4B0CA7DFD67547A5B716.pdf

Care should be taken when using crop oils and penetrants with herbicides, as these can increase the uptake of active chemicals and exceed crop tolerance. Always follow the herbicide label.

Pulse crops can be severely damaged by some herbicides present as soil residues from previous applications, contaminants in spray equipment or spray drift onto the crop or by incorrect use of the herbicide.

Herbicide efficacy and crop safety of the new crop can suffer if the soil is dry at application time.

Taking some general precautions can help to reduce the likelihood of crop damage with residual herbicide use:

- Do not apply if rain is imminent.
- Maintain at least 7.5–10 cm soil coverage.
- Avoid leaving a furrow or depression above the seed that could allow water (and chemical) to concentrate around the seed/seedling.
- Avoid leaving an exposed, open slot over the seed with disc-openers and avoid a cloddy, rough tilth with tined openers.

Damage to faba beans from various herbicides is depicted in Figures 1–20.

MORE INFORMATION

'Field crop herbicide injury: The Ute Guide' and 'Faba bean: The Ute Guide'. Both are available from: http://www.grdc.com.au/Resources/Bookshop

Figure 1: *Crops grown on lighter soils are more prone to simazine (Group C) damage.*

Photo: A. Mayfield, Grain Legume Handbook

Figure 2: *High rates of simazine can damage faba beans, lower leaves turn black and die back from the edge.*

Photo: A. Mayfield, Grain Legume Handbook

Figure 3: *Herbicide damage affecting emergence and survival of seedlings.*

Photo: W. Hawthorne, Pulse Australia

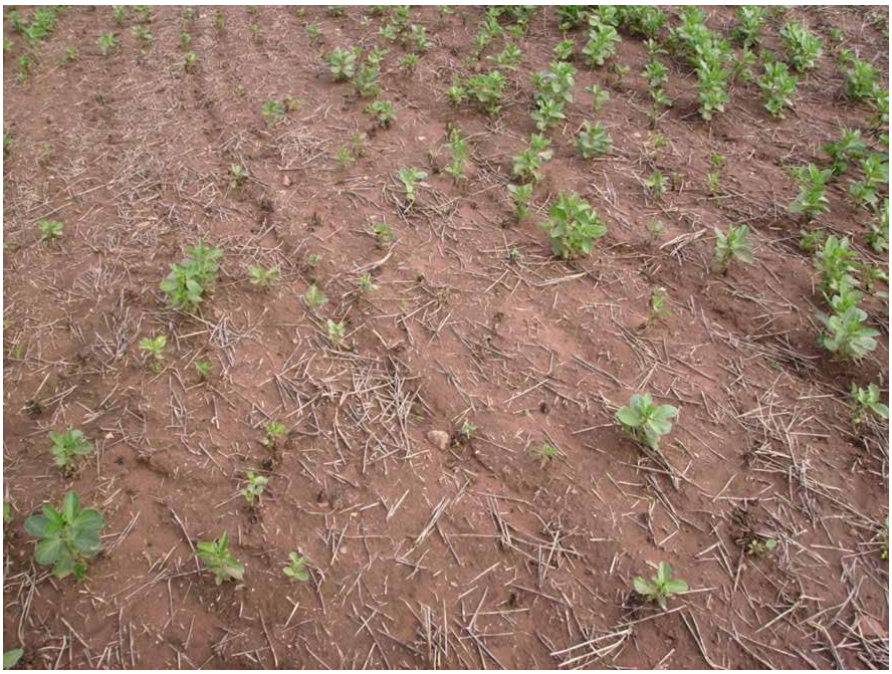


Figure 4: *Damage on headland where higher rate on inside of spray boom when turning.*

Photo: W. Hawthorne, Pulse Australia

Figure 5: *Bean seedlings affected by Lontrel® residue (Group I) in soil.*

Photo: W. Hawthorne, Pulse Australia

Figure 6: *Beans are susceptible to Tordon® or Lontrel® residue in soil. Note the stem distortion and severe leaf curl.*

Photo: A. Mayfield, Grain Legume Handbook

Figure 7: *Trifluralin (Group D) injury (left) causing stunted growth. It can also cause development of multiple growing points.*

Photo: C. Preston, Univ. of Adelaide

Figure 8: *Trifluralin injury (left) in the field, causing stunted growth.*

Photo: A. Mayfield, Grain Legume Handbook

Figure 9: *Damage (left) from Dual Gold® (metachlor, Group K).*

Photo: C. Preston, Univ. of Adelaide

Figure 10: *Chemical leaf spotting from oils in a Group A herbicide applied post-emergent. Note that spots are numerous, small, irregular in shape and differ on top and bottom sides of leaf.*

Photo: R. Kimber, SARDI

Figure 11: *Group A chemical leaf spotting on lower leaves after application of a grass herbicide. Do not confuse this with Cercospora or ascochyta leaf diseases.*

Photo: R. Kimber, SARDI

Figure 12: *Leaf spotting caused by MCPB herbicide (Group I) can be confused with ascochyta and chocolate spot infections in beans.*

Photo: A. Mayfield, Grain Legume Handbook

Figure 13: *Spinnaker damage (Group B).*

Photo: W. Hawthorne, Pulse Australia

Figure 14: *Symptoms of Brodal® (diflufenican, Group F) damage, white–pale yellow leaves with yellow blotches.*

Photo: A. Mayfield, Grain Legume Handbook

Figure 15: *.2,4-D (Group I) spray drift causing narrow leaves with crinkled edges.*

Photo: A. Mayfield, Grain Legume Handbook

Figure 16: *Damage from Lontrel® drift (Group I).*

Photo: T. Bray, formerly Pulse Australia

Figure 17: *Leaf spotting from spray droplets of Affinity® (carfentrazone, Group G).*

Photo: C. Preston, Univ. of Adelaide

Figure 18: *Leaf spotting from spray droplets of paraquat (Group L).*

Photo: C Preston, Univ. of Adelaide

Figure 19: *Leaf damage and plant set-back from post-emergent application of Spray.Seed® (paraquat plus diquat, Group L).*

Photo: W. Hawthorne, Pulse Australia

Figure 20: *Group M. Limp leaves and yellowing after glyphosate application. Young leaves are stunted and twisted.*

Photo: C. Preston, Univ. of Adelaide

6.7.1 Tolerance of faba bean varieties to herbicides

At present there are no post-emergent herbicide options for faba beans.

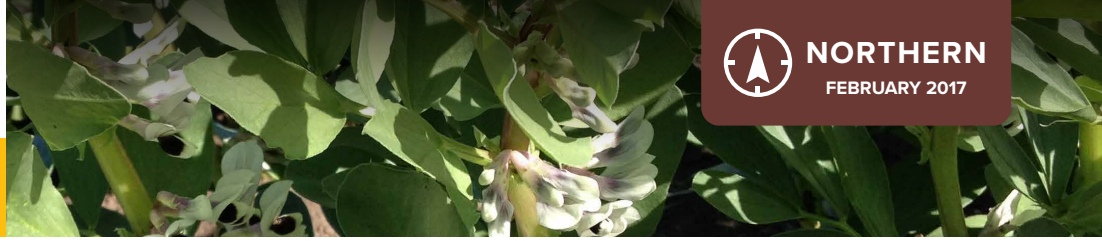
Faba varieties do differ in their herbicide tolerance, depending on season, soil type and rate of application. Herbicide labels generally do not reflect these subtleties.

PBA Rana(ᵺ) shows performance similar to all current varieties of faba beans at label recommended rates of registered herbicides based on visual observations from National Variety Trials (NVT) and Pulse Breeding Australia (PBA) breeding trials conducted on a range of soil types.

Herbicide tolerance trials in South Australia (alkaline sandy loam soils) show that herbicides commonly used in faba beans can be used with some degree of safety or

PODCAST

GRDC podcast: Faba bean revolution



risk. Nura() has exhibited greater sensitivity to imazethapyr (e.g. Spinnaker®) in some herbicide-tolerance trials in South Australia. However, all varieties exhibit some yield loss to imazethapyr (Table 3).

In South Australian herbicide-tolerance trials (2000–10) as reported by NVT, simazine applied post-emergence can be more damaging than when applied PSPE, especially with the variety Farah(). Simazine does have a narrow safety margin or some yield loss (to 21%) at standard rates.

Raptor® (imazamox) has a narrow safety margin in all faba bean varieties. It can be applied under APVMA permit. Field experience is that damage is more severe under moisture stress and conditions of slow growth. It should be considered a salvage option more so than a routine application.

Diuron has been safe in Farah() and Nura() over seven or eight trials, but check current registration status with broadacre crops.

Severe seasonal effects on herbicide activity occur, so work is ongoing to validate findings under differing seasonal conditions. See Variety Management Packages (VMPs) at www.pulseaus.com.au, and the NVT website http://www.nvtonline.com.au. [7]

Table 3: *Faba bean herbicide tolerance as reported by NVT, South Australia.*

Variety	Years	Diuron® (diuron)	Simazine		Lexone® (metribuzin)	Spinnaker® (imazathapyr)	Raptor®A (imazamox)	Terbyne® (terbuthylazine)
		2000–10	2000–10	2001–08	2003–10	2000–10	2003–10	2009–10
Farah()	2002–08	Safe (7)	Narrow (1/7)	6–18% (3/7)	Safe (6)	28–39% (2/3)	Narrow (3/6)	–
Fiesta	2000–07	Narrow (1/8)	18% (1/8)	21% (1/7)	S (5)	11–32% (2/8)	Narrow (4/5)	–
Fiord	2000–02	Narrow (1/3)	Narrow (2/3)	Narrow (1/2)	–	18–30% (2/3)	–	–
Nura()	2003–10	Safe (8)	Narrow (1/8)	Narrow (1/6)	Safe (8)	10–53% (4/8)	Narrow (8/8)	Safe (2)
Rate		1.0 L/ha	1.5 L/ha	1.5 L/ha	280 g/ha	85 g/ha	45 g/ha	1.0 kg/ha
Application		PSPE	PSPE	6 weeks	PSPE	PSPE	3–4 leaf	PSPE

Safe, No significant yield reductions at recommended rates or higher in 2+ trials (no. of trials in parentheses); Narrow, narrow margin, significant yield reductions at higher than recommended rate in 1+ trials (X of Y trials in parentheses), but not at recommended rate; X%, percentage yield reduction (warning), significant yield reduction at recommended rate in 1 trial only; X–Y%, percentage range yield reductions (warning), significant yield reductions at recommended rate in 2+ trials

A Denotes use under APVMA permit. This use is not endorsed by this data and no responsibility will be taken for its interpretation.

MORE INFORMATION

http://www.dpi.nsw.gov.au/archive/agriculture-today-stories/ag-today-archives/september-2011/broadleaf-weed-trial-in-faba-beans

6.7.2 Contamination of spray equipment

The importance of cleaning and decontaminating spray equipment for the application of herbicides cannot be over-stressed. Traces of sulfonylurea herbicides (such as chlorsulfuron, metsulfuron or triasulfuron) and carfentrazone (Affinity®) in spray equipment can cause severe damage to faba beans and other legumes when activated by grass control herbicides (Table 4).

7 Southern/Western Faba & Broad Bean—Best Management Practices Training Course. Module 5—Weed Management. 2013. GRDC/Pulse Australia.

Table 4: *Product labels usually detail decontamination and cleaning procedures for each product.*

Herbicide	Rate of agent/100 L water	Instructions for cleaning and decontamination
Roundup® CT, Roundup PowerMAX™, glyphosate, Raptor®, Flame®, Spinnaker®, Sniper®, Wipe Out® Plus, Sickle® 520, Precept®, Velocity®	Clean water (Spraymate®), Absolute Boomer®	Rinse thoroughly several times with clean water before use.
Hormone type, salt or amine formulations (2,4-D amine, MCPA amine, 2,4-DB, dicamba)	2 L household ammonia (Spraymate®), Ammonition®	Thoroughly agitate and flush a small amount of solution through the system and let stand in sprayer overnight. Flush and rinse with clean water several times before use.
Hormone type, ester formulations 2,4-D ester, MCPA ester, Paragon®, Midas®	500 g washing soda (chrystaline sodium carbonate) + 4 L kerosene + 125 g powdered detergent (Spraymate®), 2 L Ammonition®	Rinse the inside and outside of the tank and flush a small amount through the system for 15–20 min. Let stand for at least 2 h or overnight preferably. Flush and rinse before use.
Atrazine, simazine	125 g powdered detergent (Spraymate®), Absolute Boomer®	Rinse with clean water before and after using the solution.
Sulfonylurea herbicides Glean®, Logran®, Ally®, Logran® B-power, Hussar® OD, Tackle®, Lynx®, Lonestar®, Atlantis® OD	300 mL fresh household chlorine bleach containing 4% chlorine or 300 mL BC-45 Spray Equipment Cleaning Agent (Spraymate®) per 100 L water with agitation. Absolute Boomer® or CC49®	1.Drain and flush the tank, hoses and boom with clean water for 10 min. 2. Fill the tank with clean water and add the chlorine bleach. Flush the boom and allow to stand for 15 min then drain. 3. Repeat step 2. 4. Nozzles, screens and filters should be removed and cleaned separately.
Broadstrike™, Eclipse® 100 SC, Lontrel™, Grazon™ DS, Victory®, Fightback®, Conclude™, Crusader™, Torpedo™	500 mL liquid detergent DynamoMatic®, or 500 g of the powder equivalent such as Surf®, Omo®, 1 L Absolute Boomer®	Flush the system, then quarter-fill the tank with water and add the detergent. Start the pump and circulate for at least 15 min. Drain the whole system. Remove and clean the filters, screens and nozzles with clean water and allow to drain.
Herbicides for grass control in broadleaf crops and pastures such as Verdict™ (520 g/L)	500 mL liquid alkali liquid detergent such as Surf®, Omo®, DynamoMatic®, or 500 g of the powder equivalent.1 L Absolute Boomer®	If broadleaf herbicides, particularly sulfonylureas (such as Glean®, Logran®), have been used in the spray equipment at any time prior to grass herbicides such as Verdict™, particular care should be taken to follow the directions for cleaning and decontamination on the label of the relevant broadleaf herbicide. Before spraying cereals, maize, sorghum or other sensitive crops, wash the tank and rinse after use. Completely drain the tank and wash filters, screens and nozzles. Drain and repeat the procedure twice. To decontaminate, wash and rinse the system as above, quarter-fill the tank, add the detergent and circulate through the system for at least 15 min. Drain the whole system. Remove filters, screens and nozzles and clean separately. Finally, flush the system with clean water and allow to drain.
Affinity®	100 g of alkali detergent, e.g. Omo® or Spree® 1 L Absolute Boomer®	1. Drain sprayer tank and system and thoroughly rinse the inside of the sprayer tank with clean water. Remove and clean all filters and nozzle strainers. Flush through sprayer system. 2. Half-fill the tank with clean water and add alkali detergent. Fill the tank to capacity and operate the sprayer for a minimum of 15 min. 3. Drain the sprayer system and rinse the tank with clean water and flush through the system. Remove and check all filters and nozzle strainers and clean if necessary.

Spray-tank contamination of small quantities of sulfonylurea herbicides such as Glean® and Logran® can be extremely damaging to crops such as pulses, canola and other oilseed crops as well as legume pastures. Grass-control herbicides such as Verdict™, Fusilade® Forte, Correct®, Select®, Targa® and Sertin® can be extremely damaging to winter and summer cereals

Nufarm Spraymate® Tank and Equipment Cleaner can also be used to decontaminate spraying equipment.

NOTE: Rinse water should be discharged into a designated disposal area, or if this is unavailable, onto unused land away from plants and water sources.

6.7.3 Spray drift

When applying pesticides, the aim is to maximise the amount reaching the target and to minimise the amount reaching off-target areas. This results in:

- maximum pesticide effectiveness
- reduced damage and/or contamination of off-target crops and areas

In areas where various agricultural enterprises co-exist, conflicts can arise, particularly from the use of pesticides.

Pulse crops can be severely damaged by some hormone herbicide sprays, such as 2,4-D ester, drifting into the crop. This can happen when these sprays are applied nearby in very windy or still conditions, especially where there is an inversion layer of air on a cool morning.

When using these herbicides, spray when there is some wind to mix the spray with the crop. Do not use excessively high spray pressure, which will produce very fine droplets that are more likely to drift onto a neighbouring pulse crop.

All pesticides are capable of drift. There is a moral and legal responsibility to prevent pesticides from drifting and contaminating or damaging neighbours' crops and sensitive areas (Figure 21). [8]

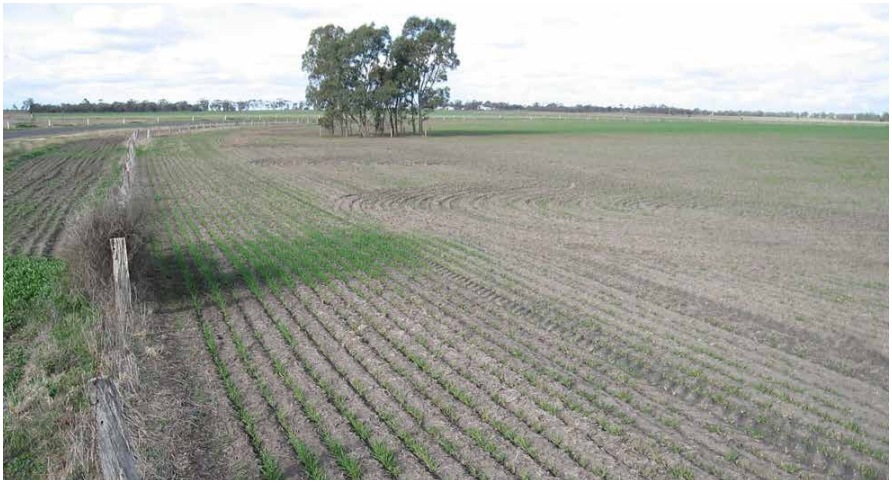


Figure 21: *Glyphosate spray drift from the road verge on the left. Note the barrier effect of the tall weeds on the fence line.*

Photo: G. Bardell, Nufarm

6.8 Legal considerations of pesticide use

Information on the registration status, rates of application and warnings related to withholding periods, occupation health and safety (OH&S), residues and off-target effects should be obtained before making decisions on which herbicide to use. This information is available from the State Department Chemical Standards Branches, chemical resellers, APVMA and the pesticide manufacturer.

Some of the legal issues surrounding herbicide usage are considered here, but it by no means exhaustive. Specific questions should be followed up with the relevant staff from your local State Department.

8 Southern/Western Faba & Broad Bean—Best Management Practices Training Course. Module 5—Weed Management. 2013. GRDC/ Pulse Australia.

Registration

Users should be aware that all herbicides go through a registration process, where they are normally authorised (registered) by the Australian Pesticide and Veterinary Medicine Authority (APVMA) for use:

- against specific weeds
- at specific rates of product
- in prescribed crops and situations
- where risk assessments have been evaluated that these uses are:
  - » effective (against the weed, at that rate, in that crop or situation)
  - » safe in terms of residues not exceeding the prescribed maximum residue level (MRL)
  - » not a trade risk

Labels

A major outcome of the registration process is the approved product label, a legal document, that prescribes the pest (weed) and crop situation where a product can be legally used, and how.

SDS

Material Safety Data Sheets are also essential reading. These document the hazards posed by the product, and the necessary and legally enforceable handling and storage safety protocols.

Permits

In some cases, a product may not be fully registered but is available under a Permit with conditions attached, which often require the generation of further data for eventual registration.

APVMA

The national body in charge of administering these processes is called the APVMA (the Australian Pesticides and Veterinary Medicines Authority) and is based in Canberra.

Details of product registrations and permits are available via the APVMA's website www.apvma.gov.au.

Always read the label

Apart from questions about the legality of such an action, the use of products for purposes or in manners not on the label involves potential risks. These risks include reduced efficacy, exceeded MRLs and litigation.

Be aware that herbicide-use guidelines on the label are there to protect product quality and Australian trade by keeping residues below specified MRLs. Residue limits in any crop are at risk of being exceeded or breached where herbicides:

- are applied at rates higher than the maximum specified;
- are applied more frequently than the maximum number of times specified per crop;
- are applied within the specified withholding period (i.e. within the shortest time before harvest that a product can be applied); or
- are not registered for the crop in question.

6.9 Getting best results from herbicides

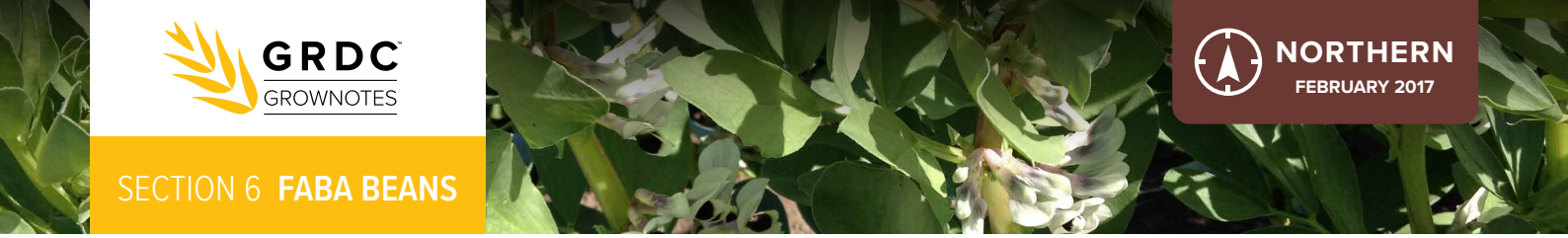
Successful results from herbicide application depend on numerous interacting factors. Many of the biological factors involved are not fully understood, and are out of your control, so give careful attention to the factors that you can control.

Annual weeds compete with cereals and broadleaf crops mainly when the crops are in their earlier stages of growth. Weeds should be removed no later than 6 weeks after sowing to minimise losses. Early post-emergence control nearly always results in higher yields than treatments applied after branching in broadleaf crops.

Points to remember for the successful use of herbicides:

- Plan the operation. Check paddock sizes, tank capacities, water availability and supply.
  - » Do not spray outside the recommended crop growth stages; damage may result.
- Carefully check crop and weed growth stages before deciding upon a specific post-emergent herbicide.
- Read the label. Check to make sure the chemical will do the job. Note any mixing instructions, especially when tank-mixing two chemicals.
- Follow the recommendations on the label.
- Conditions inhibiting plant cell growth, such as stress from drought, waterlogging, poor nutrition, high or low temperatures, low light intensity, disease or insect attack, or a previous herbicide application, are not conducive to maximum herbicide uptake and translocation.
- Use good quality water, preferably from a rainwater tank. Water quality is very important.
  - » Hard, dirty or muddy water can reduce the effectiveness of some herbicides.
- Use good equipment checked frequently for performance and output.
- Use sufficient water to ensure a thorough, uniform coverage regardless of the method of application.
- Check boom height with spray pattern operation for full coverage of the target.
- Check accuracy of boom width marking equipment.
- Check wind speed.
  - » A light breeze helps herbicide penetration into crops.
  - » Do not spray when wind is strong (>10–15 km/h).
- Do not spray if rain is imminent or when heavy dew or frost is present.
- Calculate the amount of herbicide required for each paddock and tank load. Add surfactant where recommended.
- Select the appropriate nozzle type for the application.
- Beware of compromising nozzle-types when tank-mixing herbicides with fungicides or insecticides.
- Be aware of spray conditions to avoid potential spray drift onto sensitive crops and pastures, roadways, dams, trees, watercourses or public places. Note: all chemicals can drift.
- After products such as Atlantis®, chlorsulfuron, Hussar®, metsulfuron or triasulfuron have been used in equipment, it is essential to clean the equipment thoroughly with chlorine before using other chemicals. After using Affinity®, Broadstrike® or Eclipse® decontaminate with liquid alkali detergent.
- Seek advice before spraying recently released pulse varieties, which may differ in their tolerance to herbicides. Information on herbicide tolerance is available on the variety management package for the variety.
- Keep appropriate spray records for each spray operation. [9]

9 Southern/Western Faba & Broad Bean—Best Management Practices Training Course. Module 5—Weed Management. 2013. GRDC/Pulse Australia.



6.10 Weed control requires a planned approach

Faba beans can mature too late in some extended seasons, so crop-topping (see section 6.13.2 Crop-topping) may have to be delayed or done before physiological maturity, risking yield and quality losses.

Faba beans can be relatively slow to emerge but with rapid early growth even during the colder winter months. Consequently, they are poor competitors with weeds early. Even moderate weed infestations can cause large yield losses and harvest problems.

Risk with crop-topping or inability to be able to crop-top to prevent weed seed-set is one reason producers give for not growing faba beans in southern Australia. Broadleaf weed control options post-emergence are very limited in faba beans, and this is another common reason producers cite for not growing them.

The weed-control strategy for growing a successful faba bean crop depends on substantially reducing the viable weed seedbank in the soil before the crop emerges, because post-emergence weed-control options are limited.

Selecting paddocks that are relatively free, or carry a low burden, of grass and broadleaf weeds is very important.

Broadleaf weeds need to be heavily targeted in the preceding crop and or fallow. Always assess the risk of broadleaf weeds prior to planting. This should be based on:

- grower experience
- the previous crop and herbicides used
- an assessment of winter weeds germinating in the fallow prior to planting

Paddocks with a severe broadleaf or grass weed problem should be avoided.

6.10.1 Weed competition in faba beans

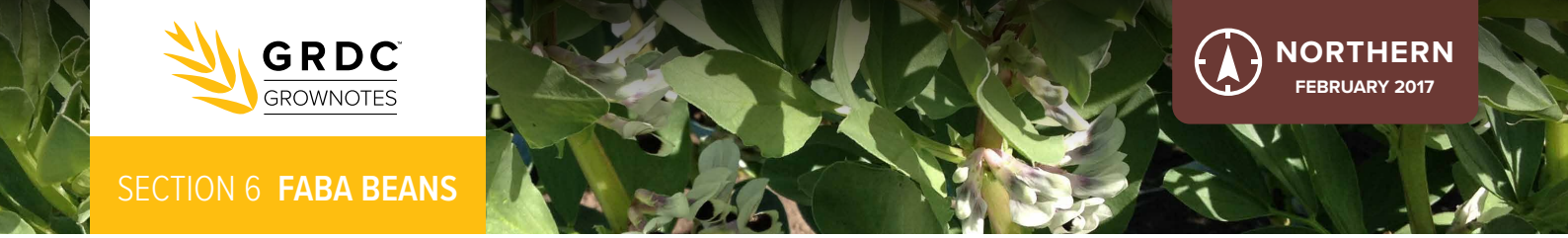
Preventing increases in herbicide-resistant ryegrass populations during the faba bean phase of rotations is essential for maximum crop yield and sustainable cropping systems in southern Australia. Preventing weed seed-set in beans is the aim for most faba bean growers. Faba beans are reasonable competitors against ryegrass and other weeds early, but are at a relatively low plant population; hence, weeds can grow without necessarily inhibiting early development of the beans. If weeds are present, then later in the season they can affect yield and become a nuisance by setting seed, often necessitating desiccation to enable harvest.

Yield loss in faba beans caused by weed presence has not been recorded in research trials. Impact of weed seed-set and carryover to subsequent years may be more significant than yield loss *per se*, especially where weeds such as ryegrass or late broad-leafed weeds are present and not controlled.

6.10.2 Knockdown herbicides

The most important part of the weed-control strategy is to control the majority of weeds before seeding, either by cultivation or with knockdown herbicides such as glyphosate or Spray.Seed®

A technique used with varying success by growers has been to sow faba bean and then use a knockdown herbicide tank-mixed with a pre-emergent herbicide to control germinating weeds before the crop has time to emerge. Faba bean crops may take up to 28 days to emerge under cool, drying soil conditions, but under favourable warm, moist soil conditions, faba bean may emerge after 7–10 days. Growers considering this option should sow deeper (10–15 cm) and carefully check their paddocks for the emergence of the faba bean immediately before spraying. Done well, this can be an effective weed-control option.



6.10.3 Pre-emergent herbicides

These herbicides are primarily absorbed through the roots, but there may also be some foliar absorption (e.g. Terbyne®). When applied to soil, best control is achieved when the soil is flat and relatively free of clods and trash. Although most pre-emergent herbicides are suitable for use in high stubble-load paddocks, modern labels will suggest adequate control with 50% ground cover. Sufficient rainfall (20–30 mm) to wet the soil through the weed root-zone is necessary within 2–3 weeks of application. Best weed control is often achieved from a post-sowing application, because rainfall gives the best incorporation. Mechanical incorporation is less uniform and so weed control may be less effective. If applied pre-sowing and sown with minimal disturbance, incorporation will essentially be by rainfall after application. Weed control in the sowing row may be less effective because a certain amount of herbicide will be removed from the crop row.

Weed control

The absence of cost-effective and safe post-emergent herbicides effectively limits broadleaf weed control options in faba beans to a small number of pre-emergent herbicides. The efficacy of most of these chemicals is very dependent on rainfall soon after application, and consequently, inconsistent or partial weed control can result under drier conditions.

The pre-emergent herbicides will not adequately control large weed populations by themselves, and so they need to be used in conjunction with paddock selection, crop rotation and pre-seeding weed control.

Which pre-emergent herbicide to use is a question that can only be answered after assessing such factors as weed spectrum, soil type, farming system and local experience.

Refer to the complete product label for directions for use, rates and weeds controlled and conditions for best results.

Crop safety

The safety to pulse crops is due in part to chemical tolerance of the crop, in part to ensuring the seed is below the treated soil, and to ensuring no wash of herbicide into the seeding furrow.

Pre-sowing application is possible with some products and is often safer than post-sowing application, because the sowing operation removes a certain amount of the herbicide from the crop row. Higher rates can often be used pre-sowing, but in both cases the rate must be adjusted to soil type, as recommended on the product label.

The pH of a soil can strongly influence the persistence of herbicides. Many labels have warnings about high pH (≥8.0) and reduced rates to avoid crop damage.

The movement of herbicides down the soil profile after rain can affect crop safety. Movement is greater on sandy soils (and those with less organic matter), and so the application rate must be lower than on heavier soils (loams, silt plus clay 40–60%).

Heavy, intense rainfall following application may cause crop damage. This will be worse if the crop has been sown shallow (<3–5 cm), where there is light soil and where the soil surface is ridged. The soil surface should not be ridged, as this can lead to herbicides being washed down and concentrated in the crop row.

6.10.4 Pre-sowing (IBS, incorporation by sowing) herbicides

The resistance status of the weeds present, particularly ryegrass, must be known in order to determine which products and mixtures are used pre-sowing. IBS is generally considered safer for the crop than post-sowing pre-emergence with most herbicides used in modern, no-till sowing systems. There is, however, little protection

within the sowing row, or else there is potential for crop damage if soil is thrown into the seeding furrow.

Outlook® (dimethenamid) has been registered to control herbicide-resistant ryegrass in some pulses. BUT it is NOT REGISTERED for use in faba beans because it is deemed too damaging.

Trifluralin (i.e. TriflurX®), pendimethalin (i.e. Stomp®), tri-allate (i.e. Avadex®), cyanazine (i.e. Bladex®), simazine, terbuthylazine (Terbyne®) and some diuron brands (e.g. Diurex®) are registered for use on faba bean. Most require mechanical incorporation by sowing, and are often used in mixtures.

Both trifluralin and pendimethalin are used on annual ryegrass and provide partial control of wild oats, barley grass and brome grass. They are also effective on a range of broadleaf weeds including red and white fumitory and wireweed. Incorporation should occur within 4–12 h of application. Stubble can also tie up these two products. Best results have been achieved when stubble is at ≤50% ground cover, preferably left standing, and when higher water volumes (>80 L/ha) and coarse droplets are used.

Triallate provides control of wild oats and assists in the control of resistant ryegrass when used in a mixture. It can be applied immediately prior to or up 3 weeks before sowing. In a mixture, it does help to control ryegrass that has some resistance to trifluralin.

Cyanazine may be applied from 14 days before sowing to the time of sowing and is often recommended in combination with trifluralin or pendimethalin.

Simazine is often mixed with trifluralin or other products to provide a broader spectrum of both broadleaf and grass weed control, including annual ryegrass and wild oats as well as capeweed, fumitory, mustards, turnips and geranium. Incorporation should be made within 4 h of application.

Some brands of diuron (e.g. Diurex®, some proprietary diurons) are currently registered for IBS or PSPE use in faba beans in all states. If IBS is used, diuron should be applied to bare soil prior to or at sowing and incorporated by the sowing operation. Note that diuron use is currently under review by APVMA.

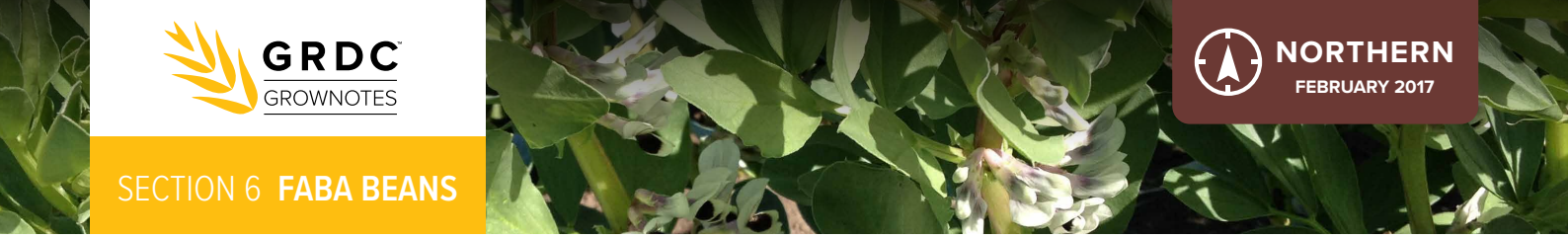
Most of these products work best if thoroughly mixed with soil either mechanically or by irrigation or rainfall. The aim of incorporation is to produce an even band of herbicide to intercept germinating weed seeds. There is some herbicide incorporation when sowing with knife-points, provided the sowing speed will throw soil into the inter-row only and not into the adjacent seed furrow. There may be insufficient soil throw with some low disturbance, disc seeding systems.

Typically, a follow-up, post-emergent grass-weed herbicide is still required to provide the level of grass-weed control desired by growers, particularly for the seed furrow. Faba beans are not a highly competitive crop, and early post-emergent grass control is often necessary.

With the continued development of populations of annual ryegrass and/or wild oats resistant to Group A, Group B and Group D herbicides, growers are again using older products as part of their resistance strategy for the opportunity they provide to rotate chemical groups.

If using trifluralin on faba bean, avoid shallow planting (below 2.5 cm). Similar comments apply to Stomp®. Very deep planting (below 5 cm) is usually safe. Be aware, though, that deep planting may also cause problems if the emerging shoots absorb greater quantities of the chemical. Affected shoots tend to swell and deform, and can result in a weak, patchy plant stand. [10]

10 Southern/Western Faba & Broad Bean—Best Management Practices Training Course. Module 5—Weed Management. 2013. GRDC/Pulse Australia.



6.10.5 Post-sowing pre-emergent (PSPE) herbicides

Simazine

Simazine is the most widely used herbicide for broadleaf weed control, and can provide relatively cheap control of cruciferous weeds. Efficacy is highly dependent on rainfall (20–30 mm) within 2–3 weeks of application, and consequently weed control efficacy varies under drier conditions.

Simazine has an adequate level of crop safety provided the following guidelines are adhered to.

- Simazine needs to be applied to moist soil as close to planting as possible. Moist soil helps to fix the chemical onto the clay particles and minimises simazine degradation.
- Weed control will be more reliable if the seedbed is level and free of clods. When clods break down after rainfall they expose untreated soil and disrupt the herbicide 'blanket'. Heavily ridged seedbeds often exhibit 'striping' and poor weed control on the 'hills'.
- Stubble does not present major problems, other than in heavy header trails or heavily 'bunched' from tillage operations.
- Avoid shallow planting if simazine is to be used, because crop tolerance is based on physical separation of the chemical from the faba bean roots. A planting depth of 7 cm is normally adequate on clay soils.
- Crop damage is often evident in compacted wheel tracks as a result of shallower planting depth and/or the concentration of chemically treated soil in the wheel-track depressions after rain.
- The planting furrow or trench needs to be closed and levelled at planting. This will minimise the risk of simazine-treated soil being washed in and concentrated near the seedling.
- Good subsoil moisture at planting will also help to minimise the risk of crop damage. Roots will develop down into moisture, rather than developing a shallow root system in the topsoil (where simazine activity is greatest).
- If grass weeds are present at application, consider tank-mixing glyphosate or Spray.Seed®.
- Avoid using simazine on coarse-textured, sandy loam soils; even low rates can leach down to the roots and cause significant crop damage.
- Avoid overlapping when applying simazine, and double spraying on headlands.

Terbyne® (terbuthylazine, 750 g/kg)

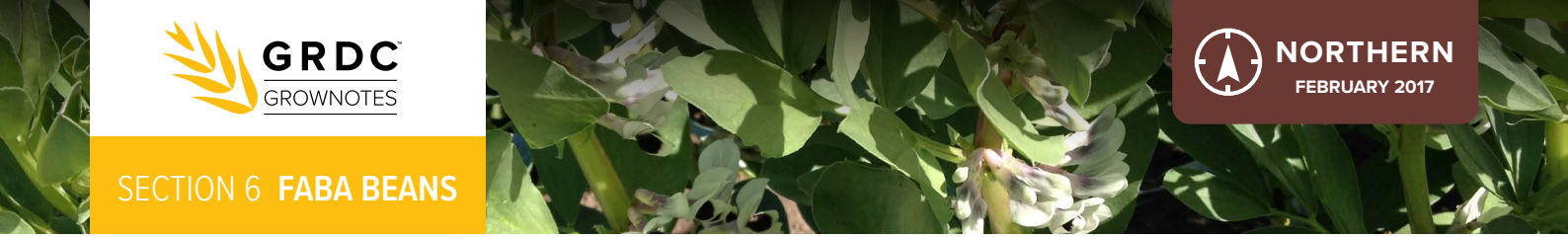
Terbuthylazine is the newest triazine herbicide to be introduced in Australia and is registered for pre-emergent weed control in faba beans, chickpeas, lupins, field peas, lentils and triazine-tolerant canola. Terbyne® is recommended for pre-emergent use (pre or post sowing).

Terbuthylazine controls a wide range of broadleaf weeds, with some suppression of grasses, particularly if there is good soil moisture. Sufficient rainfall (20–30 mm) to wet the soil through the weed root-zone is necessary within 2–3 weeks of application. Best weed control is achieved from post-sowing application because rainfall gives the best incorporation of Terbyne®. Mechanical incorporation pre-sowing is less uniform and so weed control may be less effective.

Although terbuthylazine is similar to the old triazine herbicides atrazine and simazine, it controls more weeds, lasts longer and is different in a number of ways that make it more effective and safer to crops.

Water solubility

The higher solubility of atrazine means greater movement through the soil, potentially causing crop damage and leaching into groundwater. The lower solubility of simazine



results in less movement down the soil profile but can also make it less effective than terbuthylazine, which is slightly more soluble.

Soil binding

Terbuthylazine has significantly higher soil binding than atrazine or simazine, meaning greater crop safety and better weed control.

In a field test using soil columns containing a sandy loam or sandy clay loam, 75–80% of the applied Terbyne® remained in the top 5 cm of soil after 2.5 days of watering (Mountacer *et al*. 1997).

Sencor® (metribuzin, 480 g/L)

Depending on soil type, heavy rain (>10–20 mm) after spraying can leach metribuzin into the root-zone, causing crop damage. Risk of leaching of metribuzin is greatest on sandy soils, followed by friable, well-structured soils. Very heavy rain (>80–100 mm) after spraying on these soils may cause crop damage and leach metribuzin beyond the root-zone, thus reducing residual effect.

Chemical application rate used must match the soil type (see label). Apply to crops that were sown at depths greater than 4 cm to minimise damage through root uptake.

Cautions:

- DO NOT apply until soil is well wetted by the first good soil-settling rain after sowing. Apply to moist soil for best efficacy.
- DO NOT spray plants under stress from drought, waterlogging, frost or disease.
- DO NOT allow spray mix to stand overnight.

With no-till planting systems that use knife-points and press-wheels, the risk of crop damage is increased, especially on light soil types and if heavy rain occurs after spraying. Herbicide can wash into the furrows. Use of cover-harrows after planting and before either pre- or post-emergent metribuzin application improves crop safety.

Spinnaker® (imazethapyr, 700 g/kg)

Imazethapyr is registered for the pre-emergence control of certain weeds in faba beans and may be mixed with simazine. It is a Group B herbicide. Black bindweed (*Fallopia convolvulus*) is the main weed that is controlled with this herbicide in the northern region. Other listed weeds are deadnettle (*Lamium amplexicaule*), Indian hedge mustard (*Sisymbrium orientale*), white ironweed (*Buglossoides arvensis*), wild radish (*Raphanus raphanistrum*), and wireweed (*Polygonum aviculare*).

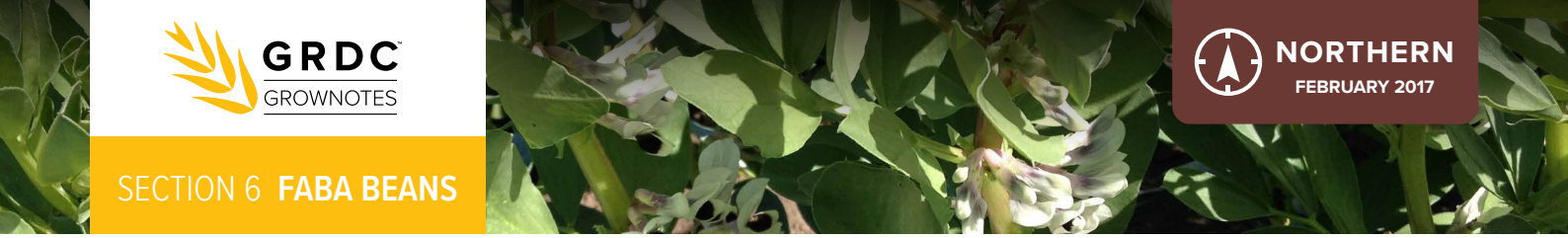
Cautions:

- DO NOT apply to very wet soils if rain is imminent, or to soils prone to waterlogging.
- DO NOT apply to soils of very high organic matter content.
- DO NOT apply to crops or weeds under stress caused by factors such as root or foliar diseases, nutrient deficiencies, or extremes of temperature or moisture.

Apply to moist, well-prepared, clod- and weed-free soil after planting and before crop emergence. Sufficient rainfall is required after application and prior to weed emergence to wet soil to a depth of 5 cm. Use the higher rate of simazine on heavier soils, or where higher weed pressure is expected, or where wireweed is a problem. Under adverse conditions, weeds may not be totally controlled but populations will be significantly reduced and surviving plants will generally be severely retarded. Good crop growth will aid weed control.

Transient yellowing or blackening of the crop may occur. The risk of crop injury may be increased under adverse growing conditions.

Do not use this mixture on soils or in areas ill-suited to growing faba beans, as crop injury will be increased.



MORE INFORMATION

NSW DPI 'Using pre-emergent herbicides in conservation farming systems': http://www.dpi.nsw.gov.au/agriculture/farm/conservation/information/pre-emergent-herbicides

Diuron

Not all diuron brands are registered for use in faba beans. As well, the APVMA is currently reviewing use of diuron with the intent of removing it from use. Some brands are currently registered for IBS or PSPE use in faba beans in all states. If applied by IBS, it should be applied to bare soil prior to or at sowing and incorporated by the sowing operation. For PSPE, apply as a post-plant application to moist soil before weed and crop emergence. Use the lower rate on light, sandy soils and do not apply to excessively ridged or waterlogged soils. Sow the crop at least 5 cm deep. Trifluralin or imazethapyr can be tank-mixed at the recommended rates.

Weeds controlled include capeweed, *Crassula*, doublegee, *Erodium*, wild radish, wild turnip, and toad rush.

6.10.6 Post-emergent herbicides

Only one broadleaf herbicide is currently registered under permit for post-emergence use, and it is used only to a very limited extent. Imazamox (e.g. Raptor® WG) can be used post-emergent for broadleaf weed control, but can cause transient yellowing, height reduction and delayed flowering, any of which can potentially reduce yield. It is effective on cruciferous weeds (turnip, etc.).

Imazamox can result in significant crop damage in our environment, particularly where dry conditions are experienced after applivcation. As stated on the product label, Raptor® usually causes some transient crop yellowing and can cause reddish discoloration and height suppression. Flowering may be delayed resulting in yield suppression.

It is used mainly in salvage situations (as a last resort), and even then, should be applied only under good growing conditions.

With the shift into row-crop faba beans, some growers are successfully using glyphosate and other products as a directed spray into the inter-row area. This keeps a large proportion of the herbicide off the faba bean foliage, and minimises problems associated with crop damage. [11]

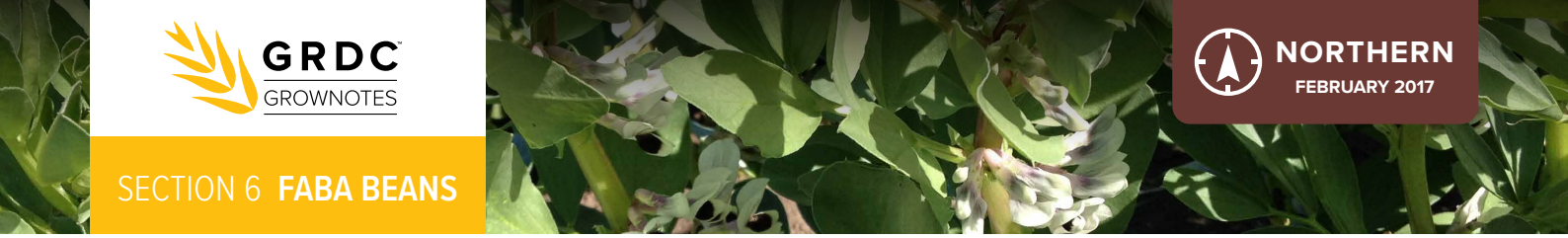
6.11 Post-emergent grass-weed control

Control of grass weeds post-emergence is often inconsistent, with variable levels of control depending on the rate used and the level of resistance to the fop or dim herbicide being used. This particularly applies where marginal rates of the Group A herbicides are being used because of cost constraints.

More reliable and cost-effective control is considered achievable through the adoption of a management package that addresses all of the following key issues:

- Correct weed identification.
  - » Match the product used to the weeds present.
- Weeds should be small, preferably at the 2–5 leaf stage.
  - » Larger weeds will require heavier rates of Group A herbicides.
- Spray when weeds are actively growing and free from temperature, water, and nutritional stress.
  - » Weeds enter into moisture stress quickly, especially if secondary roots have not established.
  - » The leaves can also become water-repellent under dry, dusty conditions.
  - » Seedling grasses stress very quickly, and there is usually only a narrow window of ideal conditions for applying Group A herbicides.
- Application techniques and boom-spray set-up are critical in achieving coverage of seedling grasses:

11 Southern/Western Faba & Broad Bean—Best Management Practices Training Course. Module 5—Weed Management. 2013. GRDC/Pulse Australia.



MORE INFORMATION

GRDC Update Paper: Herbicide resistance management, a local, in-field perspective

  - » nozzle selection to achieve a medium spray quality
  - » operating pressures >3 bar
  - » water volumes >60 L/ha.
- Use the preferred adjuvant listed on the product label.

6.11.1 Mode of action

All the grass herbicides are systemic and rely on absorption through the leaves and then translocation to the growing points (meristematic tissue) of the plant.

Treated grasses usually stop growing within 1–2 days of spraying.

Visible symptoms first occur 7–10 days after treatment, usually as a yellowing of the youngest leaves and a browning of the growing points at the base of the youngest leaves. Unfurled leaves are easily pulled out, revealing brown rotting buds at the leaf base.

The young leaves turn pale and chlorotic and then brown off. The older leaves eventually collapse, with complete plant death occurring 4–6 weeks after spraying. Some weed species may also exhibit reddening of lower leaves and leaf sheaths.

6.11.2 Avoidance of stress conditions

All grass herbicide labels emphasise the importance of spraying only when the weeds are actively growing under mild, favourable conditions. Any of the following stress conditions can significantly impair both uptake and translocation of the herbicide within the plant.

The following conditions may result in incomplete kill or suppression only of weeds:

- moisture stress (and drought)
- waterlogging
- high temperature–low humidity conditions
- extreme cold or frost periods
- nutrient deficiency, especially low nitrogen
- use of pre-emergent herbicides (e.g. simazine, trifluralin and Stomp®) that can effect growth and root development (ensure that grass weeds have fully recovered from previous herbicide applications before applying grass herbicides)
- excessively heavy dews resulting in poor spray retention on grass leaves

Research overseas has verified that translocation rates of fluazifop are 2–3 times higher in oats grown under high nitrogen status than in low-fertility situations (Table 5).

Table 5: *Impact of low nitrogen fertility on translocation of fluazifop.*

	Uptake (% applied dose)	Translocation (% applied dose)	Fluazifop translocated to youngest leaf (dpm/mg)
Low nitrogen status	69%	9%	8
High nitrogen status	63%	26%	24

Source: Dickson et al. 1990.

6.11.3 Grass-herbicide damage in faba beans

Group A herbicides can occasionally cause leaf spotting in faba beans. This is usually associated with either frost or high temperatures occurring soon after spray application. It is not the Group A but the oil mixed with it that causes the damage. It acts as a magnifying glass on the leaf and burns the leaf surface (Figure 22).

Figure 22: *Herbicide-mix injury from a Group A grass selective herbicide.*

Photo: R. Kimber, SARDI

6.11.4 Sulfonylurea residues in boom sprays

Traces of sulfonylurea herbicides in boom sprays can cause significant damage to faba bean crops and other crops (Figure 23).

The risk of residue damage is greater in the presence of grass-selective herbicides.

Decontaminate the boom if you have previously used a sulfonylurea herbicide. See product labels for specific product recommendations on decontamination.

As a guide, use fresh chlorine bleach (household grade containing 4% chlorine) at a rate of 300 mL/100 L water. Allow to stand for 15 min with agitation engaged, then drain. [12]

Figure 23: *Damage to field peas from failing to de-contaminate the spray tank after use of Eclipse®.*

Photos W. Hawthorne, Pulse Australia

MORE INFORMATION

GRDC Fact Sheet: Pre-harvest Herbicide Use

6.12 Other weed-control strategies

6.12.1 Directed sprays in-crop

With the shift to cropping faba beans on wide rows, there is greater scope for the use of 'directed sprays' of glyphosate and other chemicals, either alone or in tank-mixes with simazine. This largely avoids the problem of crop damage, and improves weed control through the ability to safely add wetters or mineral oils to the spray mix.

12 Southern/Western Faba & Broad Bean—Best Management Practices Training Course. Module 5—Weed Management. 2013. GRDC/ Pulse Australia.

Shielded sprayers

These are becoming increasingly more common in or around the cotton-growing areas, as they provide very cheap control of grass and broadleaf weeds with glyphosate.

Although faba beans do have a degree of tolerance to glyphosate during the vegetative stage, caution is still required, as the branches arising from the base and main stem contribute a large proportion of the total faba bean yield. Issues that need to be considered include:

- selection and operation of spray shields (speed, nozzle type, etc.)
- height of the crop (small faba bean plants are more susceptible)
- variety (upright types such as Amethyst or Jimbour are more suited to this technique than the more prostrate types)

6.12.2 Crop-topping

Growers should consider choosing paraquat rather than glyphosate for crop-topping pulse crops where possible to minimise resistance development. Both glyphosate and paraquat are registered for use in pulses, however only glyphosate is registered for crop-topping canola or wheat. A key tactic of integrated weed management (IWM) is to rotate modes of action as much as possible and glyphosate is a chemical that is really heavily relied on in grain growing. There is no alternative in wheat or canola, but when it comes to crop-topping in pulses, paraquat can be a sensible choice to avoid the overuse of glyphosate. Along with herbicide selection, the timing of crop-topping is key to its success. It can be difficult to align the growth stage of the weed to prevent seed-set with the maturity of the crop to prevent damage, particularly in a good season when the crop will stay green longer. This is where the second advantage of paraquat comes to the fore: it can be applied a little later.

Paraquat can be applied up until the soft dough stage of ryegrass, whereas effective control with glyphosate needs to be at the milky dough stage. This means growers using paraquat can wait a little longer to allow the crop to mature and minimise yield losses. Growers should decide in advance what yield loss they are willing to risk in order to control weed seed-set. While crop-topping might be more difficult in a good year, a wet spring also means an increase in weed seed-set so doing nothing is not an option.

Some growers will accept a loss of five to 10 per cent yield in their pulse crop in order to target the weeds at the ideal growth stage. This loss is generally recovered through improved performance in the following year's cereal crop. However, if that risk is too high, or if the crop matures too late, growers can still receive some benefits in reducing late weed seed-set by crop-topping even if some of the weeds have set seed.

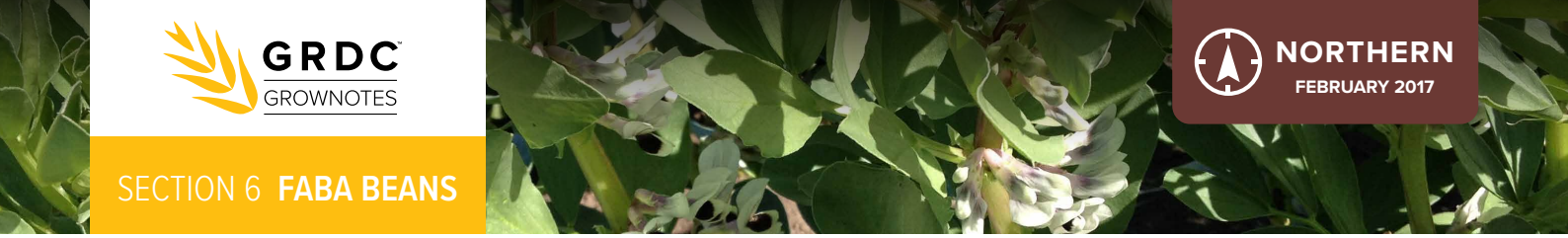
Where a late crop-top is performed with a significant weed problem, growers should consider a harvest weed-seed control option in addition to improve control of seed-set. [13]

Minimising glyphosate resistance

Glyphosate resistance has been found in about five per cent of annual ryegrass populations in random surveys in SA and Victoria. There have not yet been any cases of paraquat resistance in broadacre applications in Australia. This is in contrast to selective herbicides, to all of which, including clethodim, there is extensive resistance in annual ryegrass. It will take at least 10 years for any new mode of action to be available for growers even if it were discovered tomorrow. This means it is critical for growers to preserve the effectiveness of glyphosate through integrated weed management. [14]

13 GRDC (2016), Paraquat preferred for crop-topping pulses, Ground Cover Issue 124, https://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-124-SeptemberOctober-2016/Paraquat-preferred-for-croptopping-pulses

14 GRDC (2016), Paraquat preferred for crop-topping pulses, Ground Cover Issue 124, https://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-124-SeptemberOctober-2016/Paraquat-preferred-for-croptopping-pulses



MORE INFORMATION

Australian Pulse Bulletin: Desiccation and croptopping in pulses

6.12.3 Desiccation

With correct timing, desiccation can improve overall weed control as well as increase profitability in pulse crops.

The major differences between crop-topping and desiccation are:

- Herbicides used for crop-topping and desiccation are not always the same.
- Timing is not the same; desiccation occurs after crop maturity. Crop-topping is earlier, aimed to reduce seed-set of weeds before crop maturity.
- Herbicides are registered for desiccation as 'harvest aids', and rates used are higher than those used for crop-topping.
- Both desiccation and crop-topping will cause reduced grain quality and yield if applied at the wrong maturity stage of the crop.

6.13 References and further reading

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Weeds: the Ute Guide—Southern & Western edition (Version 2). GRDC Ground Cover Direct.

Weeds: the Ute Guide. Weeds app available for weed identification, www.grdc.com.au/apps

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