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Chemical weed control in canola

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1.0 Introduction

Canola is an important break and cash crop in Western Australia. To provide maximum benefit to the following crop, while maximising the yield potential of canola, growers should aim to control weeds as early as possible. There is a wide suite of chemicals available for use before sowing, before crop emergence, in-crop and near maturity, which along with cultural techniques provide opportunities for effective weed control in canola.

Managing summer weeds is important to avoid seeding delays, conserve nutrients and moisture for the canola crop to use during the growing season, and minimise potential green bridge and allelopathic impacts.

Strategies for controlling emerged weeds (before sowing canola) using knockdown herbicides are similar to those for most other crops. However, due to the common practice of sowing canola early (April) in many regions, there is often a limited emergence of winter weeds before sowing canola which places heavy reliance on in-crop or residual weed control options.

Ideally, canola should not be sown into paddocks with a high weed burden. Delayed sowing of early maturing canola varieties, particularly if conventional canola is being grown, is a better option for achieving effective knockdown weed control in very weedy paddocks. This may only be practical in high rainfall, long growing-season regions unless a very early maturing variety is available. If seasonal conditions permit, growers should use a double knock whereby two sequential but different weed management tactics are applied.

Herbicide information is regularly updated, therefore we advise reading herbicide labels for rates, tank-mixing compatibilities, crop and weed growth stages, requirements for adjuvants, plant and environmental conditions, rain-fastness and withholding periods.

The purpose of this bulletin is to provide a handy reference on herbicide options registered for different canola herbicide tolerance systems. Growers should engage their consultant to determine the herbicide tolerance system that meets their specific circumstances - taking into consideration the weeds present and their herbicide resistance status as well as the crop rotations and economic and weed management goals of the farming system.

2.0 Herbicide tolerance systems

There are many chemical options for the control of specific weeds in canola, so with careful management, the development of resistance in weeds to specific herbicide modes-of-action can be delayed.

Growers in Western Australia have access to the herbicide tolerance systems listed in Table 1.

Table 1: Canola herbicide tolerance systems

Herbicide tolerance systems	Abbreviations	Herbicide group
Conventional	CC (Conv.)	-
Triazine tolerant	TT	C
Clearfield® (Imidazolinone-tolerant)	CL or IMI	B
Triazine tolerant + Clearfield®	TT + CL	C + B
Glyphosate tolerant	GT	M
• Roundup Ready®	RR	M
• TruFlex®	-	M
• Optimum GLY®	-	M
• Glyphosate tolerant +Triazine tolerant	GT + TT	M + C
• Glyphosate tolerant + Clearfield®	GT + CL	M + B

Refer to the *Western Australian crop sowing guide*[1] (updated annually) and seed company websites to find the varieties available for each system.

The main features of each system are as follows:

2.1 Conventional canola

Conventional canola is a term used to define canola varieties that have no specific herbicide tolerance. Therefore, options to control broadleaf weeds in this canola are limited. Herbicides registered for weed control in conventional canola and all other canola types are listed in Table 2 and 3. Clopyralid (for example, Lontrel®) is registered for use in all types of canola and can provide useful control of capeweed, volunteer legume crops and pasture species. Clopyralid has limited efficacy on wild radish, therefore conventional canola is most widely used in paddocks with low wild radish populations. The reliance on clopyralid for broadleaf weed control is not only problematic with respect to its limited weed spectrum but also a long plant-back interval for legume crops. The plant-back period is nine months for rates up to 90g a.i./ha and up to 24 months for higher rates for field pea, faba bean, lupins, lentil, vetch, chickpea, lucerne, medic and clover. In situations of high weed burden, sowing of conventional canola varieties may have to be delayed to ensure adequate control with knockdown herbicides or cultivation, otherwise growers should consider using herbicide tolerant canola systems.

Group D herbicides including trifluralin, pendimethalin and propyzamide (not all products) can be used in all canola varieties for control of annual ryegrass, certain broadleaf weeds and other grasses. This is useful to reduce the overall ryegrass burden especially where there has been a limited knockdown opportunity.

A range of Group A herbicides are registered for use in all types of canola for post-emergent grass control. Resistance to Group A herbicides in grass weeds, especially ryegrass, is widespread in WA. To avoid haloxyfop (e.g. Verdict™ 520 , Asset™, Inquest®) residue in canola grain, DO NOT apply haloxyfop to canola after the 8-leaf growth stage of the crop or after the commencement of stem elongation. This means that if stem elongation commences before the 8-leaf stage, application must not occur. DO NOT apply haloxyfop under or between the windrows.

Note: Use of simazine, atrazine, terbuthylazine, imazapic + imazapyr (e.g. Sentry®), imazamox + imazapyr (e.g. Intervix® or Intercept®) or glyphosate (e.g. Roundup®) in conventional canola will kill the crop.

Table 2: Pre-sowing herbicides registered for the control of weeds in canola – all herbicide systems

Herbicide #	Rate of product*	Weeds controlled	Comments
Metazachlor 500g/L (For example, Butisan®)	1.5 to 1.8L/ha	Annual ryegrass	Incorporate by sowing using knife points and press wheels.
	1.8L/ha	Wild oats, wireweed	
Metolachlor 720g/L (For example, RYGEL Metolachlor 720 EC)	300 to 500mL/ha	Toad rush	Apply before canola and weeds emerge either incorporated by sowing (IBS) or post sowing pre-emergent (PSPE). To avoid crop injury use rates towards the lower end of the range on light sandy soils.
Pendimethalin 440g/L (For example, Stomp® 440)	1.35 to 2.25L/ha	Annual ryegrass, wireweed. Suppression of wild oats and silver grass	Incorporate within 24 hours. Minimum rate for suppression of silver grass is 1.5L/ha.
Propyzamide 500g/L (For example, Rustler®)	1L/ha	Annual ryegrass, winter grass, barley grass, silver grass, great brome, rat's tail fescue	Incorporate by sowing (IBS) when weeds are at the pre-emergent stage. The potential for canola seedling damage may occur on: • Light soils with low organic matter if heavy rainfall follows sowing. • Dry sown canola crops treated with Rustler® after heavy rain events.
S-metolachlor 960g/L (For example, Dual Gold®)	150 to 250mL/ha	Toad rush	Can be used either immediately before sowing (IBS) or post sowing pre-emergent (PSPE). Use IBS for furrow sowing.

Table 2: Continued...

Herbicide #	Rate of product*	Weeds controlled	Comments
Tri-allate 500g/L (For example, Avadex® Xtra)	1.6 or 3.2L/ha	Wild oats	Rates depend on seeding system. Incorporate within 48 hours or 24 hours when tank-mixed with trifluralin.
Tri-allate 550g/L + trifluralin 350g/L (For example, Jetti Duo®)	1.45 to 1.8L/ha	Annual ryegrass, trifluralin resistant annual ryegrass, wild oats, brome grass. Suppression of wireweed, barley grass, deadnettle	Incorporation by sowing (IBS) with knife or blade points and press wheels seeding system within 12 hours of its application.
Trifluralin 125g/L + oryzalin 125g/L (For example, Yield® 250 EC)	1.6 or 2.3L/ha	Annual ryegrass, wireweed. Partial suppression of wild oats, fumitory. Suppression of silver grass	Rates depend on seeding system. Lower rate for conventional cultivation and higher rate for direct seeding.
Trifluralin 480g/L (For example, TriflurX®)	1.5 to 3L/ha	Annual ryegrass, wireweed, fumitory, phalaris spp., winter grass, paradoxa grass, corn gromwell, rough poppy	Incorporate within 24 hours.
# Most common or initial product listed – similar available from other suppliers. * Check label for specific application rates.			

Table 3: Post-emergent herbicides registered for the control of weeds in canola – all herbicide systems

Crop stage / timing	Herbicide #	Rate of product*	Weeds controlled	Comments^
2-leaf to 8-leaf stage	Clopyralid 750g/kg (For example, Lontrel® 750)	60 to 120g/ha	Capeweed, saffron thistle, skeleton weed, clover, medic, chickpea, field pea, lentil. Suppression of lupin and faba bean	Extended plant back period.
> 4-leaf to visible flower buds	Butroxydim 250g/kg (For example, Factor® WG)	80g/ha	Annual ryegrass, barley grass, wild oats	For barley grass, brome grass, volunteer cereals and wild oats, add an effective rate of a 'fop' herbicide containing fluazifop, haloxyfop, propaquizafop or quizalofop. Always apply with Supercharge® Elite® at 1%.
Prior to visible flower buds	Clethodim 240g/L (For example, Select®/ Status®)	150 to 500mL/ha	Annual ryegrass	Always apply with D-C-Trate® at 2L/100L, Hasten® or Kwicken® at 1L/100L volume; Uptake® at 500mL/100L spray volume.
		175 to 500mL/ha	Barley grass, wild oats, brome grass, volunteer cereals	
< 6-leaf	Fluazifop-P 128g/L (For example, Fusilade® Forte)	410mL/ha	Wild oats, volunteer cereals, barley grass, ryegrass in diminishing order of susceptibility	Do not apply beyond 6-leaf stage of canola.
2-leaf to 8-leaf stage. DO NOT apply after the commencement of stem elongation or 8-leaf stage, whichever happens earlier.	Haloxyfop 520g/L (For example, Verdict™)	75 to 100mL/ha	Annual ryegrass	Use Uptake® at 0.5L/100L or if using other oils, 1.0L/100L and add a non-ionic wetter at 200mL/100L of spray solution.
		37.5 to 75mL/ha	Wild oats	
		50 to 100mL/ha	Brome grass, barley grass, volunteer cereals	

Table 3: Continued...

Crop stage / timing	Herbicide #	Rate of product*	Weeds controlled	Comments^
From 5-leaf stage	Quizalofop 99.5g/L (For example, Targa®)	300 or 375mL/ha	Annual ryegrass and brome grass	See label for herbicide rates for different weed growth stages, and surfactant/wetting agent details.
		125 or 250mL/ha	Wild oats	
		250mL/ha	Barley grass and volunteer cereals	
Pre-harvest application for harvest aid and weed control¥	Glyphosate 570g/L (For example, Roundup Ultra® Max)	1.2 to 3.4L/ha	Annual weeds	Spray when 20% of the seeds from main stem (at different heights) have turned dark brown/black in colour.
Pre-harvest application for harvest aid and weed control¥	Glyphosate 470g/L (For example, weedmaster® DST®)	1.4 to 4.1L/ha	Annual weeds	Spray when 20% of the seeds from main stem (at different heights) have turned dark brown/black in colour.
Pre-harvest application for harvest aid and weed control¥	Glyphosate 600g/L (For example, CRUCIAL®)	1.1 to 3.2L/ha	Annual weeds	Spray when 20% of the seeds from main stem (at different heights) have turned dark brown/black in colour.
Pre-harvest desiccation	Diquat 200g/L (For example, Reglone®)	1.5 to 3.0L/ha	Pre-harvest desiccation	Spray when 70% of the pods are yellow and the seeds are brown/bluish and pliable.

Most common or initial product listed – similar actives available from other suppliers.
* Check label for specific application rates.
^ Check label for adjuvant (wetters, oils) and for advice on mixes to extend weed kill.
¥ Pre-harvest application is not registered on canola hybrids using the Optimum GLY® herbicide tolerance trait.

2.2 Triazine tolerant (TT) canola

TT canola is the most widely grown canola system in WA. Triazine herbicides (Group C) such as atrazine or simazine or terbuthylazine (e.g. Terbyne® or Terbyne® Xtreme®), either alone or in combination, can be used to control/suppress wild radish, wild turnip, wild oats, annual ryegrass, barley grass, brome grass and silver grass. Simazine is registered on TT canola for pre-emergent use only (both incorporated by sowing –IBS and post sowing pre-emergent –PSPE). Atrazine and terbuthylazine can be used both pre- and post-emergent.

The first application of triazines should be applied immediately before sowing or post sowing pre-emergence of TT canola. Apply to wet soil or where sufficient rain is expected within the next two to three weeks to wet the soil through the weed root zone. In most situations, PSPE application will be slightly less effective than IBS, but will provide better weed control in crop rows. In dry soil, incorporate atrazine or simazine or terbuthylazine to increase effectiveness. Most of the atrazine that is sprayed onto stubble will be retained for some time. In the presence of heavy stubble, spraying (pre- or post-sowing) during rain will ensure that most chemical is washed into the soil.

After emergence, atrazine plus oil can be applied at or before the two-leaf stage of weeds. Atrazine plus oil is generally applied four to six weeks after sowing if a second flush of weeds emerges. Terbuthylazine plus Hasten® can be applied up to the 6-leaf stage of canola.

The paddock should remain free of weeds until the canola canopies close. Once closed, the canopy hinders further weed emergence and growth.

For paddocks that have a heavy stubble cover, delay the second application until sufficient weed growth appears above the stubble to allow good uptake by the leaves.

Check herbicide labels for maximum use rates (single or multiple applications), product compatibility, soil type and seeding systems. There are restrictions on the maximum use rate of triazines to avoid their carry over into sensitive crops (e.g. cereals) in rotation. For example, on acidic soils (pH less than 6.5), it is recommended to restrict the maximum use rate of atrazine or simazine or a combination of the two herbicides per crop during the growing season to 2kg a.i./ha and on alkaline soils (pH greater than 6.5) to 1kg a.i./ha. For post-emergent use of atrazine (one application per crop in a season), the maximum recommended rate during the crop season is 1kg a.i./ha or less on both acid and alkaline soils (Atradex® WG and Gesaprim® 900 WG labels). The maximum rate of terbuthylazine registered during a crop season is 1kg a.i./ha. If replacing simazine or atrazine with terbuthylazine, the total amount of these herbicides used should not exceed the amount specified above for different soil pH levels.

Herbicides in Table 2 and 3 along with triazines (Table 4) can be used on TT canola.

Table 4: Triazine herbicides registered for weed control specifically in TT canola

Timing	Herbicide #	Rate of product	Weeds controlled	Comments
Pre-sowing	Atrazine 900g/kg (For example, Atradex® WG)	1.1 to 2.2kg/ha	Capeweed, clover, doublegee, fumitories, geraniums, mustards, turnips, Paterson's curse, silver grass Suppression of annual ryegrass, barley grass, brome grass, wild oats, wild radish	For best results, apply to bare moist soil immediately before sowing.
	Simazine 900g/kg (For example, Simagranz®)	1.1 to 2.2kg/ha	Capeweed, clover, fumitories, geraniums, mustards, Paterson's curse, silver grass Suppression of annual ryegrass, barley grass, brome grass	For best results, apply to bare moist soil immediately before sowing.
	Terbuthylazine 750g/kg (For example, Terbyne®)	1.0 to 1.4kg/ha	Suppression of wild radish and doublegee	Could be applied up to a week before sowing.
Post sowing pre-emergent	Atrazine 900g/kg (For example, Atradex® WG)	1.1 to 2.2kg/ha	As per Pre-sowing	Apply to soil within seven days of sowing.
	Simazine 900g/kg (For example, Simagranz®)	1.1 to 2.2kg/ha	As per Pre-sowing	Apply to soil within seven days of sowing.
	Terbuthylazine 750g/kg (For example, Terbyne®)	1.0 to 1.4kg/ha	Burr medic, Indian hedge mustard, mint weed, prickly lettuce, sow thistle, turnip weed, wild turnip, wild radish, wireweed/ hogweed. Suppression of annual ryegrass, doublegee, wild oats and phalaris	Apply to soil within two days of sowing.
Post-emergent	Atrazine 900g/kg (For example, Atradex® WG)	0.55 to 1.1kg/ha	Annual ryegrass (1-2-leaf stage only), mustards, wild radish and turnips	The addition of 0.5-1% v/v of crop oil will enhance post emergence activity.
	Terbuthylazine 750g/kg (For example, Terbyne®)	0.7 to 1.4kg/ha	Wild radish and dead nettle. Suppression of annual ryegrass, doublegee, wild oats and phalaris	Up to 6-leaf stage of canola. Always add Hasten™ at 500mL/100L of water.

Most common or initial product listed – similar actives available from other suppliers.

2.3 Clearfield® canola (CL)

The Clearfield® system refers to canola varieties tolerant to imidazolinone (IMI) herbicides (Group B) which include imazapic + imazapyr (e.g. Sentry®) and imazamox + imazapyr (e.g. Intercept® and Intervix®) that are registered for use on canola. Imidazolinones can have long residual activity, particularly in low rainfall environments and acid soils. Follow plant-back periods as described on product labels.

Sentry® (imazapic + imazapyr) is registered pre-emergent in IMI tolerant canola at 40-50g/ha as IBS and can be applied mixed with TriflurX® (trifluralin) or Avadex® Xtra (tri-allate) for broadening the spectrum of weeds controlled. This can be a useful tool in heavy weed burden situations and be combined with a post-emergent application of Intercept® (follow the plant-back restrictions on label). Where pre-emergent Sentry® is followed by post-emergent Intercept® in a season, the succeeding crop in rotation must be an IMI tolerant variety. Sentry® is also registered post-emergent at 20, 40 or 55g/ha (depending on weed species present) with Supercharge® Elite® at 0.5% and can be applied tank-mixed with Archer® (clopyralid) and Havoc® (clethodim). Do not apply Sentry® more than once per season to any one crop. Check Sentry® labels for more details.

Apply Intercept® or Intervix® at the label rate at the two-to six-leaf stage of CL canola crops that are not affected by waterlogging, drought, frost, disease or nutrient disorders. Always add Hasten® or Kwickin® with Intervix® and Supercharge® Elite® or Banjo® with Intercept® at 0.5L/100L spray volume. Apply to actively growing weeds when grasses are in the three-leaf to two-tiller stage and broadleaf weeds are in the two-to six-leaf stage.

Use the higher herbicide label rates when weed numbers are high or at the later recommended growth stages and/or when the crop is at the five-to six-leaf stage and herbicide contact and coverage by weeds may be compromised.

Intercept® or Intervix® can be tank-mixed with some grass herbicides and some formulations of clopyralid (refer to the product label in Table 5). Alternatively, if weeds other than those listed on the product label need to be controlled or grass herbicides or formulations of clopyralid not listed on the label are used, then apply any alternative post-emergent herbicides at least two weeks after Intercept® or Intervix® when signs of regrowth or renewed vigour of weeds are evident.

Three-way tank-mixes (Intercept® + clopyralid + clethodim) can be used when legume, grass and other broadleaf weeds are present (Table 5). However, rates greater than 45g a.i./ha of clopyralid can reduce grass control. See label for more details. Do not apply if rain is expected within two hours of application.

Herbicides as per Table 2 and 3 along with IMI herbicides (Table 5) can be used on CL canola.

Table 5: Imazamox + imazapyr rates and mixes for weed control in Clearfield® canola as per Intercept® label. *If using comparable products such as Intervix®, check the specific product label. Active ingredient in Archer® 750 Dual Salt is clopyralid and in Havoc® is clethodim*

Weeds	Intercept® 300-500mL/ha	Intercept® 300-500mL/ha + Archer® 60-120mL/ha	Intercept® 300-500mL/ha + Havoc® 150-500mL/ha	Intercept® 300-500mL/ha + Archer® 60-120mL/ha + Havoc® 150-500mL/ha	Intercept® 600-750mL/ha	Intercept® 600-750mL/ha + Archer® 60-120mL/ha	Intercept® 600-750mL/ha + Havoc® 150-500mL/ha	Intercept® 600-750mL/ha + Archer® 60-120mL/ha + Havoc® 150-500mL/ha
Annual medics		c		c		c		c
Annual ryegrass			c	c	s	s	c	c
Barley ∞			c	c	c	c	c	c
Barley grass			c	c	c	c	c	c
Bedstraw spp.					s	s	s	s
Capeweed		c		c		c		c
Charlock					c	c	c	c
Chickpea		c q #		c q #		c q		c q
Dense flower fumitory					c	c	c	c
Doublegee					s	s	s	s
Faba bean		c q #		c q #		c q		c q
Field pea		c		c		c		c
Great brome			c	c	c	c	c	c
Indian hedge mustard	c	c	c	c	c	c	c	c
Lentil		c q		c q		c q		c q
Marshmallow					c	c	c	c
Muskweed	c	c	c	c	c	c	c	c
Narrow leaf lupin		c		c		c		c
Oat			c	c	c	c	c	c
Rigid brome			c	c	c	c	c	c
Sub clover		c		c	c	c	c	c
Silver grasses					s	s	s	s
Wheat ∞			c	c	c	c	c	c
Wild oat			c	c	c	c	c	c
Wild radish	c	c	c	c	c	c	c	c
Wild turnip	c	c	c	c	c	c	c	c

c = control
s = suppression
q = If targeting chickpea and lentil up to 6-leaf stage, use tank-mixes of Intercept® with 100mL/ha Archer® 750 Dual Salt; if targeting faba bean up to 4-leaf stage, use tank-mix of Intercept® with 100mL/ha Archer® 750 Dual Salt.
# = Minimum rate for Intercept® is 375mL/ha.
∞ = Non-imidazolinone herbicide tolerant barley and non-imidazolinone herbicide tolerant wheat.

2.4 TT + CL hybrid technology

Triazine tolerant and Clearfield® (TT + CL) hybrid technology which combines tolerance of both triazine (Group C) and IMI (Group B) herbicides (e.g. Hyola® 580CT) is now available for growers. In this system, both triazines and imazamox + imazapyr (e.g. Intercept®, Intervix®) or imazapic + imazapyr (e.g. Sentry®) can be used according to the label recommendations.

The combination of IMI and triazine herbicide tolerance can be used to target particular problem weeds like dock seedlings or fumitory in addition to ryegrass and wild radish for effective weed management.

This technology is also recommended for paddocks with low levels of IMI herbicide residues after previous IMI tolerant cultivars of winter crops like wheat or barley (particularly in low rainfall environments or on soils with low pH).

2.5 Glyphosate tolerant (GT) canola

Roundup Ready canola was the first glyphosate tolerant canola type. With the advent of TruFlex® and Optimum Gly® canola technologies, we use the general term glyphosate tolerant (GT) to refer to all canola types tolerant of glyphosate.

Heavy selection pressure can result in glyphosate resistance in weeds. To reduce or prevent glyphosate-resistant weeds developing, growers should adhere to resistance management principles as per the *Roundup Ready®* Canola Resistance Management Plan[17]:

1. Aim to enter the Roundup Ready canola phase of the rotation with a low weed burden.
2. Integrate as many different weed control options (chemical and cultural) as possible through all phases of the crop rotation.
3. Make every herbicide application count – use registered rates – and assess effectiveness.
4. Rotate herbicides with different modes of action throughout the crop rotation.
5. Regularly monitor the effectiveness of resistance management practices.
6. Test weed populations for their herbicide resistance status as part of ongoing integrated weed management.
7. If planting into a paddock with suspected glyphosate resistance, growers must have a plan to manage such weeds.

Before using GT canola, growers are required to sign a License and Stewardship agreement and attend an accreditation course — these are one-off requirements.

It is not recommended to rely on glyphosate alone for the management of weeds. Some suggestions include using trifluralin or similar products before seeding to aid in the control of annual ryegrass and wireweed; applying clopyralid in-crop; and diquat pre-harvest along with cultural methods of weed control.

2.5.1 Roundup Ready® (RR) canola

Roundup Ready® canola varieties are tolerant to glyphosate. It should be noted that not all glyphosate products are registered for use with RR canola. Registered products include Roundup Ready® Herbicide with PLANTSHIELD® (Table 6), Roundup Ready® PL Herbicide, weedmaster® DST® and CRUCIAL®. CRUCIAL® (glyphosate 600g/L, triple salt and surfactant) is a new product registered in March 2020 for all Roundup Ready®, TruFlex® and Optimum Gly® canola types. When using CRUCIAL® follow label recommendations.

Check labels of these herbicides for tank-mixing with other herbicides as only specific products are recommended. For example, KELPIE® A-ZINE 900 (atrazine) and Archer® (clopyralid) are on the label for use in tank-mixes with Roundup Ready® herbicide with PLANTSHIELD®.

Before using the registered glyphosate products on RR canola varieties, growers should consult the *Roundup Ready® Canola Resistance Management Plan*[17], which has been developed to minimise the evolution of herbicide resistance in weed populations.

General guidelines for Roundup Ready® registered products include:

- Applications can be made from crop emergence to the sixth true leaf stage (prior to bud formation). Application later than 6-leaf can have unpredictable effects, which may include delayed maturity and reduced yields.
- Maximum of two applications of Roundup Ready® herbicide per crop.
- Each application must be 621g a.i. glyphosate/ha (for example, 0.9kg/ha of Roundup Ready® herbicide with PLANTSHIELD®).
- Sequential application must be 14 days apart with two new leaves of crop growth. The goal of the first spray should be to minimise weed competition through early removal of weeds. The second spray should be done at the latest possible opportunity to reduce grain sample contamination and weed-seed set.
- All applications must be made according to label directions.
- Only use tank-mix partners that are on the Roundup Ready® or weedmaster® DST® or CRUCIAL® herbicide labels.
- Use a coarse spray pattern to reduce off-target drift.

Table 6: Roundup Ready® Herbicide with PLANTSHIELD® (glyphosate 690g/kg) label for **Roundup Ready® canola**. *For other registered glyphosate products such as CRUCIAL® (glyphosate 600g/L), Roundup Ready® PL Herbicide (glyphosate 540g/L) and weedmaster® DST® (glyphosate 470g/L), refer to labels for product rates*

Weeds controlled	Growth stage of crop	Growth stage of weed	Rate	Critical comments
Annual ryegrass, barley grass, brome grass, canary grass, capeweed, Paterson's curse, saffron thistle, scotch thistle, silver grass, spear thistle, variegated thistle, volunteer cereals, wild mustard, wild oats, wild radish, wild turnip, winter grass	Crop emergence to 6-leaf (prior to bud formation)	For grass weeds and volunteer cereals: 1-leaf to mid-tillering For volunteer plants and/ or broadleaf weeds: 1-true-leaf to 8-leaves	0.9kg/ha	Up to two applications only may be made in any one crop. Each application must be 0.9kg/ha of the product. Repeat applications may be required if a second flush of weeds germinates but do not apply after the 6-leaf stage of the crop. Sequential applications must be at least 14 days apart and the canola crop must have incremental growth of two-leaves between applications. The canola crop must not have advanced beyond the latest recommended growth stage (i.e. 6-leaf). Ensure broadleaf weeds have at least one-true-leaf, and grasses two-leaves before application. **Tank-mixes**: Roundup Ready® Herbicide with PLANTSHIELD® may be tank-mixed with KELPIE® A-ZINE 900 HERBICIDE for post-emergence application in Triazine Tolerant-Roundup Ready (TT-RR) canola up to the 6-leaf stage. For label rates of KELPIE® A-ZINE 900 HERBICIDE, refer to the KELPIE® A-ZINE 900 HERBICIDE label. Read and follow all label directions, restraints, plant-back and withholding periods, regional use restrictions and safety directions for the tank-mix products.

Table 6: continued...

Weeds controlled	Growth stage of crop	Growth stage of weed	Rate	Critical comments
Weeds as above plus annual medic, chickpeas, field peas, lentils, lupins and sub clover	Same as above. Two applications required.	For grass weeds and volunteer cereals: 1-leaf to mid-tillering For volunteer plants and/ or broadleaf weeds: 1-true-leaf to 8-leaves	0.9kg/ha	Two applications of Roundup Ready® Herbicide with PLANTSHIELD® provide higher levels of control than a single application. **Tank-mixes:** same as above.
Weeds as above plus, faba beans and vetch	2- to 6-leaf (prior to bud formation). One or two applications; however total rate of Archer® (clopyralid) should not exceed 300mL/ha in the one season.	For grass weeds and volunteer cereals: 1-leaf to mid-tillering For volunteer plants and/ or broadleaf weeds: 1-true-leaf to 8-leaves	0.9kg/ha +150 to 300mL/ha of a 300g/L clopyralid (e.g. Archer®) aqueous concentrate product	Use the higher rate of a 300g/L clopyralid aqueous concentrate product in situations of high weed population, large weed size and/or conditions of environmental stress (dry, frost etc.). Varying levels of control can be experienced between different varieties of these species. Total application of a 300g/L clopyralid aqueous concentrate product should not exceed 300mL/ha in the one season. Application of this tank-mix at the first spray timing is recommended.

2.5.2 TruFlex® canola technology

TruFlex® canola offers growers increased weed control flexibility through higher glyphosate rates than Roundup Ready® technology and a wider application window from crop emergence to appearance of first canola flower. Currently Roundup Ready® Herbicide with PLANTSHIELD® (RRHP), Roundup Ready® PL Herbicide (RRPLH) and CRUCIAL® are the only products registered for this canola. Either three applications of RRHP at 0.9kg/ha or RRPLH at 1.15L/ha or CRUCIAL® at 1.0L/ha or two applications of RRHP up to 1.3kg/ha or RRPLH up to 1.67L/ha or CRUCIAL® up to 1.5L/ha can be made from crop emergence up to the appearance of the first canola flower. The spectrum of weeds controlled and weed growth stages for application of these herbicide products are the same. For details, see Table 7 for Roundup Ready® Herbicide with PLANTSHIELD® label.

TruFlex® canola has been built on RR technology and contains the same CP4 EPSPS gene for glyphosate tolerance, but gene expression in TruFlex® varieties is enhanced by the addition of a new promoter sequence.

Table 7: Roundup Ready® Herbicide with PLANTSHIELD® (glyphosate 690g/kg) label for **TruFlex® canola**. *For other registered glyphosate products such as CRUCIAL® (glyphosate 600g/L) and Roundup Ready® PL Herbicide (glyphosate 540g/L), refer to labels for product rates*

Weeds controlled	Growth stage of crop	Growth stage of weed	Rate	Critical comments
Annual ryegrass, barley grass, brome grass, canary grass, capeweed, Paterson's curse, saffron thistle, scotch thistle, silver grass, spear thistle, variegated thistle, volunteer cereals, wild mustard, wild oats, wild radish, wild turnip, winter grass	Crop emergence to first flowering (at least 50% of plants have at least one flower)	For grass weeds and volunteer cereals: 1-leaf to mid-tillering For volunteer plants and/or broadleaf weeds: 1-true-leaf to 8-leaves	0.9 to 1.3kg/ha	Up to two applications with each application not exceeding 1.3kg/ha may be made in any one crop. Up to three applications with each application not exceeding 0.9kg/ha may be made in any one crop. Repeat applications may be required if a second flush of weeds germinates but do not apply after the first flowering stage of the crop. Sequential applications must be at least 14 days apart and the canola crop must have incremental growth of two-leaves between applications. The canola crop must not have advanced beyond the latest recommended growth stage (i.e. first flowering). Ensure broadleaf weeds have at least one-true-leaf, and grasses two-leaves before application. DO NOT apply after first flowering.

Table 7: Continued...

Weeds controlled	Growth stage of crop	Growth stage of weed	Rate	Critical comments
Weeds as above plus annual medic, chickpeas, field peas, lentils, lupins, sub clover	Same as above. Two applications required.	For grass weeds and volunteer cereals: 1-leaf to mid-tillering For volunteer plants and/or broadleaf weeds: 1-true-leaf to 8-leaves	0.9 to 1.3kg/ha	Two applications of Roundup Ready® Herbicide with PLANTSHIELD® provide higher levels of control than a single application. DO NOT apply after first flowering.
Weeds as above plus faba beans and vetch	Same as above. One or two applications; however total rate of Archer® (clopyralid) should not exceed 300mL/ ha in the one season	For grass weeds and volunteer cereals: 1-leaf to mid-tillering For volunteer plants and/or broadleaf weeds: 1-true-leaf to 8-leaves	0.9 to 1.3kg/ha + 150 to 300L/ha Archer® (clopyralid)	Use the higher rate of Archer® (clopyralid) in situations of high weed population, large weed size, and/or conditions of environmental stress (dry, frost etc.). Varying levels of control can be experienced between different varieties of these weed species. Total application of Archer® (clopyralid) should not exceed 300mL/ha in the one season. Application of this tank-mix at the first spray timing is recommended. DO NOT apply after first flowering.

2.5.3 Optimum GLY® canola technology

Optimum GLY® canola is similar to TruFlex® technology in terms of the glyphosate application window. Varieties with the Optimum GLY® trait may be released in the future.

This canola has been genetically modified to express the GAT4621 protein (glyphosate acetyltransferase) which gives tolerance to herbicides containing glyphosate by acetylating glyphosate and rendering it non-phytotoxic.

At the time of writing this bulletin, only CRUCIAL® (600g/L glyphosate) and weedmaster® DST® (470g/L glyphosate) are registered for use on Optimum GLY® canola varieties. A maximum of three applications of CRUCIAL® at 1.0 – 1.8L/ha or weedmaster® DST® at 1.3 – 2.3L/ha can be made from the cotyledon to early bloom stage (when 10% of flowers on main raceme open and the main raceme is elongating). The spectrum of weeds controlled is the same for both the herbicide products. Later application of these herbicide products as a harvest-aid on Optimum GLY® canola hybrids is not registered.

Before application of CRUCIAL® or weedmaster® DST® on Optimum GLY® canola hybrids/ varieties, users should consult the *Optimum Gly® technical manual*[11] which has been designed to minimise the development of glyphosate resistance in weed populations.

See CRUCIAL® label in Table 8 for details.

2.5.4 GT + TT canola technology

In this dual stacked gene technology, triazine tolerance (TT) has been combined with the Roundup Ready® (e.g. BASF 3000TR) or TruFlex® (e.g. Hyola® 530XT) trait for residual and more flexible weed control especially in weedy paddocks.

Glyphosate herbicides registered for Roundup Ready® or TruFlex® canola as appropriate and triazine herbicides registered for TT canola can be used in accordance with label directions on this technology.

A *DPIRD research trial*[6] under weed-free conditions on a sandy-loam soil showed no phytotoxicity on the GT + TT variety BASF 3000TR with a two-glyphosate spray strategy consisting of: application of glyphosate alone at 621g a.i./ha (e.g. Roundup Ready® Herbicide with PLANTSHIELD®) at the 1- to 2-leaf stage and a second application of glyphosate in a tank-mixture with atrazine at 990g a.i./ha (e.g. KELPIE® A-ZINE 900) at the 4- to 5-leaf stage.

A technical extension trial using TruFlex® + TT technology by *Pacific Seeds*[9] in conjunction with Bayer Crop Science demonstrated that using a tank-mixed, post-emergent application of glyphosate (e.g. Roundup Ready® Herbicide with PLANTSHIELD®) and atrazine (e.g. KELPIE® A-Zine 900) (at label rates and timings) improved ryegrass control by 4% compared to a two-glyphosate spray strategy and by 30% compared to a two-triazine spray strategy.

The combined post-emergent glyphosate and atrazine system also improved wild radish control by 3% compared to the two-glyphosate spray strategy and provided 10% better control than the two-triazine spray strategy.

2.5.5 TruFlex® + CL canola technology

In this stacked gene technology, the TruFlex® trait is combined with Clearfield® tolerance (IMI tolerance) in the variety Hyola® 540XC. The TruFlex® technology offers a wider spray window while the CL technology allows application of IMI herbicides in-crop or sowing into soils with IMI herbicide residues.

Glyphosate herbicides registered for TruFlex canola (Roundup Ready® Herbicide with PLANTSHIELD®, Roundup Ready® PL Herbicide and CRUCIAL®) and IMI herbicides registered for Clearfield® canola (imazamox + imazapyr and imazapic + imazapyr) can be used in accordance with label directions on this technology. At the time of writing this bulletin, tank-mixes of Truflex® and Clearfield® herbicides over the top of this canola technology were not registered. Growers are strongly encouraged to follow *Pacific Seeds Hyola XC stewardship guide*[13], which has been endorsed by BASF and Bayer Australia.

Table 8: CRUCIAL® (glyphosate 600g/L) label for **Optimum GLY® canola**. *For another registered glyphosate product weedmaster® DST® (glyphosate 470g/L), refer to label rates*

Weeds controlled	Growth stage of crop	Rate	With holding period	Critical comments
African turnip weed, Amsinckia, annual ryegrass, Australian bluebell, barley grass, brome grass, canary grass, capeweed, chickweed, climbing buckwheat (less than 12-leaves), cudweed, Deadnettle, dock (seedling), doublegee, erodium, flatweed, fumitory, hoary cress (late rosette to early flowering), Indian hedge mustard, lesser swinecress, medic (annual), Mexican poppy, milk thistle, mintweed, New Zealand spinach, paradoxa grass, Paterson's curse, prickly lettuce, saffron thistle, scotch thistle, silver grass, skeleton weed (fully emerged rosettes), spear thistle, spiny Emex, sub clover, volunteer cereals, volunteer pulses (chickpeas, field peas, lentils, lupins), variegated thistle, wild mustard, wild oats,wild lettuce, wild radish, wild turnip, winter grass, wireweed	Cotyledon (ØBBCH10 - cotyledons completely unfolded) to early bloom (ØBBCH 61 - 10% of flowers on main raceme open, main raceme elongating)	1.0 to 1.8L/ ha	**Harvest**: Not required when used as directed. **Grazing / cutting for stockfeed:** 7 days.	DO NOT apply after ØBBCH 61(10% flowering) crop stage. DO NOT apply more than three applications in any one crop. Each application must be a minimum of 1.0L/ha and a maximum of 1.8L/ ha. Applications may be made to canola hybrids with the Optimum GLY® herbicide tolerance trait from cotyledon to the 10% flowering stage. The addition of a surfactant is not required for use in canola hybrids with the Optimum GLY® herbicide tolerance trait. Apply treatments to weeds that have at least one-true-leaf (broadleaf weeds) or two-leaves (grasses) to provide an adequate surface area for herbicide uptake. Repeat applications may be required if a second flush of weeds germinate. Sequential applications must be at least 14 days apart. Annual weeds are only to be sprayed when they are actively growing. Use the lower rate on grass weeds up to early tillering and broadleaf weeds with up to 2-true-leaves. Increase to the higher rate on larger weeds and in situations of high density weed populations or tough environmental conditions. Perennial weeds should always be treated at the higher rate. Applications of CRUCIAL® will provide knockdown, seasonal suppression and reduction in treated plant numbers. The effects of this product may not be apparent for three to seven days (annual weeds) or two to three weeks (perennial weeds) or longer under cool, cloudy conditions. This product will control emerged weeds only, and provides no residual control.

Table 8: Continued...

Weeds controlled	Growth stage of crop	Rate	With holding period	Critical comments
Weeds as above plus: Soldier thistle (up to 10cm diameter, 4- to 8-leaf)*, volunteer faba beans, volunteer safflower (up to 6-leaf)*, volunteer vetch	2- to 8-leaf (ØBBCH12 to BBCH18). One or two applications; however total rate of Archer® 750 Dual Salt Liquid Herbicide (clopyralid) should not exceed 120mL/ha in the one season.	1.0L/ha + 60 to 120mL/ha Archer® 750 Dual Salt Liquid Herbicide (clopyralid)		Use the higher rate of Archer® 750 Dual Salt Liquid Herbicide (clopyralid) in situations of high weed population, large weed size, and/or conditions of environmental stress (dry, frost etc). *The higher rate of Archer® 750 Dual Salt Liquid Herbicide is required for control of soldier thistle and volunteer safflower. Varying levels of control can be experienced between different varieties of these species. Total application of Archer® 750 Dual Salt Liquid Herbicide should not exceed 120mL/ha in the one season. Application of this tank-mix at the first spray timing is recommended.
ØBBCH is a growth stage scale for canola (croppro.com.au/cb_pages/bbch_growth_stage_for_canola.php).				

3.0 Crop-topping

Crop-topping refers to the application of non-selective herbicides at or near maturity of canola to reduce the number of weed-seeds going into the soil seedbank. It can also be used to control 'escapees' from other weed management treatments, as a late post-emergent salvage treatment, as a harvest weed-seed management option or for managing herbicide resistance. Crop-topping may also speed up the maturity or the ripening process of the crop and desiccate green weeds.

The timing of crop-topping is critical and should always be based on the crop growth stage to minimise yield loss from herbicide application. However, the optimum growth stage timing for crop yield is often too late for effective weed-seed control. For optimum control of grass weed species (especially annual ryegrass), timing is aimed at the soft dough stage of the seed while in wild radish, target timing is at the pre-embryo stage of the seed. This period generally lasts for approximately one month from the time of first flower of wild radish.

Products registered for application prior to direct heading or under the windrow are weedmaster® DST®, Roundup Ultra® MAX and CRUCIAL® with a withholding period for grain harvest of five days, nil and five days, respectively. Diquat is also registered for use in canola with a withholding period for grain harvest of four days.

The registration of weedmaster® DST® as a harvest aid and weed control applies to triazine tolerant (TT), Clearfield® (CL), Roundup Ready® (RR) and conventional canola varieties. Label rates for applications of weedmaster® DST® to standing canola or under the cutter bar at windrowing are 1.4 – 4.1L/ha. However, *Nufarm trials*[12] showed best results were achieved at rates of 2.8 – 4.1L/ha with an adjuvant (Collide 700®) and a minimum of 80L/ha water volume to increase penetration into the crop canopy and manage spray drift. See Table 9 below for product details.

Table 9: Herbicides registered for crop-topping in canola

Product	Rate/ha	Weeds controlled	Critical comments
weedmaster® DST® (glyphosate 470g/L)	1.4 to 4.1L	Annual weeds	Timing Apply to mature standing crops when 20% of the seeds from main stem (at different heights) have turned dark brown/black in colour.
Roundup Ultra® MAX (glyphosate 570g/L)	1.2 to 3.4L		Application can also be done at the time of windrowing (windrow equipment fitted with spray booms). To avoid shatter losses from ground boom application, apply before complete senescence of the crop.
CRUCIAL® (glyphosate 600g/L)	1.1 to 3.2L		
Diquat 200g/L (For example, Reglone®)	1.5 to 3.0L	Pre-harvest desiccation	Timing Spray on mature standing crop when 70% of canola pods are yellow and the seeds are brown/ bluish and pliable. Canola ripens unevenly and is prone to pod shatter and seed loss.
Higher end label rates are recommended when crops or weeds are dense.			

Chris Preston[12] of the University Adelaide found that weedmaster® DST® used for crop-topping had no negative effect on seed yield if applied when 20% of canola seeds had turned brown.

Research by Glen Riethmuller[14] (DPIRD) in 2013 at Katanning showed that pre-harvest spray with weedmaster® DST® at 3 and 4L/ha applied at 20 and 50% canola seed colour change, reduced ryegrass seed viability by an average of 96%. However, desiccation with diquat 200g/L at 2.0L/ha applied at 80% canola seed colour change reduced viability of ryegrass seed by 85%. These treatments had no significant negative effect on canola grain yield or oil content.

When using glyphosate for crop-topping, consider the following points:

- Glyphosate must not be applied to crops intended for seed. Refer to the label prior to use and follow the instructions.
- Glyphosate must not be applied to standing crops and again at windrowing. Application of glyphosate to the standing crop is a better option than spraying it under the cutter-bar during windrowing.
- Windrows must not be over-sprayed with glyphosate.
- It is important to check the glyphosate resistance status of the weeds in a paddock before applying glyphosate for crop-topping. Research by University of Adelaide's Dr Peter Boutsalis[8] and others has shown that application of glyphosate on glyphosate-resistant annual ryegrass provides no control and 80% of its seed remains viable after crop-topping.
- To reduce selection pressure on glyphosate and drive down ryegrass numbers, canola could be a good candidate for combining crop-topping with crop competition and harvest weed-seed control.

4.0 Withholding period of herbicides

As part of the herbicide registration process, withholding periods for grazing and harvest are set for each registered use pattern. To ensure market access, canola growers and industry must abide by the withholding periods.

A withholding period refers to the minimum allowable period of time that must elapse between the last application of the crop protection chemical and the commencement of grazing or grain harvest.

A maximum residue limit (MRL) is established when a use pattern is registered for a chemical in a crop. A MRL is the maximum concentration of a residue, resulting from the registered use, of an agricultural chemical which is legally permitted or recognized as acceptable to be present in or on a food, agricultural commodity or animal feed.

The table below summarises the withholding periods for different herbicides registered for use on canola.

Table 10: Withholding period (WHP) of different herbicides for grain harvest and grazing

Herbicide*	Herbicide group	WHP for grain harvest	WHP for grazing	Trade name	Active ingredient concentration
Atrazine	C	NR	Pre-em: 15 weeks Post-em: 6 weeks	Various	500g/L or 900g/kg
Butroxydim	A	NR	2 weeks	Factor® WG	250g/kg
Clethodim	A	NR	21 days	Various	240g/L
Clopyralid	I	12 weeks	7 days	Various	300g/L or 750g/L
Diquat	L	4 day	1 day	Various	200g/L
Fluazifop-P	A	17 weeks	3 weeks	Fusilade®	212g/L
				Fusilade Forte®	128g/L
Glyphosate (application on glyphosate tolerant varieties from crop emergence to pre-bud formation or early flowering)	M	NR	RR varieties: 7 days TruFlex® varieties: 14 days	Roundup Ready® herbicide with PLANTSHIELD®	690g/kg
		NR	RR varieties: 7 days TruFlex® varieties: 14 days	Roundup Ready® PL Herbicide	540g/L
		NR	7 days	CRUCIAL®	600g/L
		NR	7 days	weedmaster® DST®	470g/L

Table 10: Continued...

Herbicide*	Herbicide group	WHP for grain harvest	WHP for grazing	Trade name	Active ingredient concentration
Glyphosate (pre-harvest/ cutting application as a harvest aid)	M	NR	NR	Roundup Ultra® MAX	570g/L
		5 days	7 days	CRUCIAL®	600g/L
		5 days	7 days	weedmaster® DST®	470g/L
Haloxyfop	A	NR	4 weeks	Various	520g/L
Imazamox + imazapyr	B	NR	5 weeks	Intercept® Intervix®	33g/L + 15g/L
Imazapic + imazapyr	B	NR	6 weeks	Sentry®	525g/kg + 175g/kg
Metolachlor	K	NR	10 weeks	Various	720g/L
Pendimethalin	D	NR	NR	Various	330g/L
Quizalofop	A	11 weeks	4 weeks	Various	99.5-200g/L
Simazine	C	NR	15 weeks	Various	500-900g/L
Simazine	C	NR	Pre-em: 15 weeks PSPE: 10 weeks	Sipcam Simazine 900 WDG	900g/L
S-metolachlor	K	NR	10 weeks	Various	960g/L
Terbuthylazine	C	NR	6 weeks	Terbyne®	750g/kg
				Terbyne® Xtreme®	875g/kg
Tri-allate	J	NR	12-13 weeks	Various	500-750g/L
Trifluralin	D	NR	NR	Various	260-500g/L
Trifluralin + oryzalin	D + D	NR	NR	Duet®, Thor® and Yield®	125g/L + 125g/L

*Listed in alphabetical order, NR = Not Required when used as directed, Pre-em. = Pre-emergent, Post-em. = Post-emergent, PSPE = Post sowing pre-emergent.

5.0 Herbicide resistance management

Weed populations can develop resistance to herbicides. In WA, annual ryegrass and wild radish are the two major weeds that have developed widespread resistance to a range of herbicide modes of action (Groups). Herbicides belonging to Group A and B are considered at “high risk” of herbicide resistance development in weeds (*CropLife Australia*[5]).

Weeds that are resistant to one Group of herbicides may also develop cross-resistance to other Groups. For example, Group A-(Fop)- and Group B-(SU)-resistant annual ryegrass has developed cross-resistance to imidazolinone (IMI) herbicides including Sentry® or Intercept® or Intervix®. Similarly, some SU-resistant wild radish populations have evolved cross-resistance to IMI herbicides within WA. Therefore, if you have wild radish with resistance to Group B-(SU) herbicides, such as chlorsulfuron or triasulfuron, it is worth doing a resistance test to determine whether the population can be managed with Intercept®, Intervix® or Sentry®.

Resistance frequencies of annual ryegrass and wild radish to triazines (atrazine, simazine and terbuthylazine) and glyphosate are still low but are known to be present in the WA wheatbelt.

Table 11: Herbicide resistance of weed species to different herbicide modes of action (herbicide groups) in Western Australia (Adapted from Heap[7], 2019)

Common name	Botanical name	Herbicide Group	Comments
Annual ryegrass	*Lolium rigidum*	A, B, C, D, M and Q	Resistance to individual groups
Annual ryegrass	*Lolium rigidum*	A, B and D	Multiple resistance
Annual ryegrass	*Lolium rigidum*	M and L	Multiple resistance
Wild radish	*Raphanus raphanistrum*	B,C, F and I	Resistance to individual groups
Wild radish	*Raphanus raphanistrum*	B, F, M and I	Multiple resistance
African Mustard	*Brassica tournefortii*	B	
Coat Buttons	*Tridax procumbens*	M	
Junglerice	*Echinochloa colona*	M	
Long flowered veldtgrass	*Ehrharta longiflora*	A	
Oriental mustard	*Sisymbrium orientale*	B	
Paterson's curse	*Echium plantagineum*	B	
Red brome	*Bromus rubens*	M	
Rigid brome	*Bromus diandrus ssp. rigidus* (= *B. rigidus*)	A and B	Resistance to individual groups
Silver grass/Squirrel tailed fescue	*Vulpia bromoides*	C	
Wild oat	*Avena fatua*	A	
Willow-leaved lettuce	*Lactuca saligna*	M	

Use of knockdown herbicides before sowing canola cultivars (other than glyphosate-tolerant) is especially important in paddocks with a heavy burden of herbicide-resistant ryegrass. It is better to reduce ryegrass numbers as much as possible using other weed management strategies before sowing herbicide-tolerant canola.

To avoid or delay and/or manage herbicide resistance in weeds, the different herbicide canola systems should be rotated as one part of a whole integrated weed management (IWM) strategy. This should also include non-chemical tactics such as increasing crop competition by using a higher canola plant population density, competitive cultivars, autumn tickles, double knocks, delayed sowing (where possible), and harvest weed-seed control (e.g. chaff lining, weed-seed impact mills).

6.0 Triazine, imidazolinone and clopyralid residue issues in succeeding crops

6.1 Triazine and imidazolinone residues

Residues from both the triazine and imidazolinone (IMI) herbicides have the potential to carryover in the soil during dry seasons, or years of patchy rain, to the following season. These residues can affect the emergence, growth and performance of susceptible crops sown into the paddock after TT or CL canola.

The main factors contributing to residue carryover are poor uptake of herbicides by crop plants and limited microbial or chemical degradation of herbicides in dry soil conditions.

As a general rule, IMI herbicides will be more persistent on acid soils and triazines are slightly more persistent on alkaline soils. Herbicide labels contain detailed information on the recommended plant-back periods for different crops.

If you suspect high levels of triazine carryover, cereal crops are a risky choice. Of the cereals, barley has the greatest tolerance to triazine residues. Delay sowing barley for as long as possible to enable increased opportunity for residue breakdown.

A safer option may be to sow lupins.

Imidazolinone herbicides are likely to be more persistent than triazines. Their persistence is dependent upon rainfall received between application and sowing of the next crop, and growers need to consult the label. Do not apply IMI herbicides such as Intercept® or Intervix® or Sentry® to canola later than the end of July if cereals such as oats, triticale, or non-Clearfield® wheat or barley are to be sown after CL canola. Similarly, do not use Intercept® or Intervix® and Sentry® rates above 20g/ha if rainfall between spraying and sowing susceptible crops is expected to be less than 150mm.

Regardless of the amount of rainfall received during the canola season, growers need to carefully choose the crop to be grown after CL canola to avoid damage from Intervix® or Intercept® or Sentry® residues. Crops that can be safely grown after using IMI herbicides in canola include CL wheat, CL barley, XT lentils and IMI tolerant faba bean (e.g. PBA Bendoc).

6.2 Clopyralid residues

Clopyralid (e.g. Lontrel™ Advanced) can be used on all canola types but could pose a risk of carryover both in soil and plant residues/stubbles for subsequent susceptible crops in rotation. Legumes are all sensitive to clopyralid residues in soil, whereas cereals are tolerant. The clopyralid molecule is degraded mainly by microbial activity, whereas other pathways of degradation like photolysis, hydrolysis and volatilisation are less important. Seasonal conditions along with the timing (early/late) and rate (45g vs 90g a.i./ha) of clopyralid applications will determine how long the chemical persists in the soil and crop stubble.

Warm, moist soil conditions in the autumn, spring and summer will result in significant degradation of clopyralid. According to the Lontrel™ Advanced label, a minimum 25mm rain after canola harvest (in summer to autumn period) that keeps soil moist for at least two weeks to a depth of 10cm is enough to result in significant residue degradation. However, low rainfall (less than 30% of average annual rainfall), applying clopyralid during the cold months, and grazing heavily with sheep and cattle can seal the soil surface and reduce the microbial breakdown of the chemical - leading to prolonged persistence. To avoid prolonged persistence of clopyralid it is important to avoid late-season applications to canola. It is also important to avoid dry-sowing susceptible crops the following season where canola stubble has been concentrated into harvest rows. Where possible, remove canola stubble through burning or baling before planting sensitive crops the following season. If clopyralid residues are suspected, it is best to grow a tolerant crop (e.g. cereals).

7.0 Volunteer canola control in succeeding crops

Volunteer canola is a weed of other rotational crops and, as such, can reduce grain/seed yield and quality. Canola volunteers also provide a host for blackleg, sclerotinia and other diseases and reduce the effectiveness of using crop rotation to manage these diseases.

There are a range of herbicide options available for managing canola volunteers in rotational crops:

7.1 Pre-seeding control of volunteer canola in cereals and grain legumes

Non-GT canola volunteers can be readily controlled prior to planting cereals, pulses and lupins using a wide range of knockdown herbicides like glyphosate, paraquat + diquat, amitrole + paraquat, glufosinate, saflufenacil and 2,4-D at the label rates. However, to manage GT canola volunteers, even in paddocks nominated for conventional canola, all knock-down herbicides except glyphosate can be used.

7.2 Volunteer canola control in cereals

In cereals, all types of canola volunteers can be controlled with a range of herbicides that are registered for control of brassica weeds. The herbicides listed below contain at least one active ingredient that differs in herbicide grouping from the currently available canola herbicide tolerance groups:

- Bicyclopyrone + bromoxynil (e.g. Talinor®) - Group H and C
- Carfentrazone (e.g. Affinity® Force) – Group G
- MCPA + bromoxynil + dicamba (e.g. Broadside®) – Group I and C
- Mixes of diflufenican, bromoxynil and/or MCPA (e.g. Jaguar®, Tigrex®, Triathlon®) – Group F, C and I
- Picolinafen + bromoxynil + MCPA (e.g. Flight®) – Group F, C and I
- Pyraflufen – ethyl (e.g. Ecopar®) – Group G
- Pyrasulfotole + bromoxynil (e.g. Velocity®) – Group H and C
- Pyrasulfotole + MCPA (e.g. Precept®) – Group H and I
- 2,4-D amine or LVE (e.g. Amicide® 625 and Estercide® 680) – Group I

Please note: the herbicides above may not be registered for use on all cereal crops (wheat, barley, oats, triticale and cereal rye), so check herbicide labels before use. Herbicides should be used at the correct label rate and timing.

7.3 Volunteer canola control in pulses

Limited herbicide options are available for control of volunteer canola in pulses. The registered herbicide options are as follows:

- All type of canola volunteers: flumioxazin 500g a.i./kg (e.g. Terrain®) – Group G, for control of pre-emergent volunteer canola in chickpea, faba bean and field pea at 90g a.i./ha.
- Non-IMI volunteer canola: flumetsulam 800g a.i./kg (e.g. Broadstrike®) – Group B, for control of volunteer canola up to 8-leaf stage or 10cm diameter in size in chickpea, field pea, lentils and vetch at 20g a.i./ha.
- Non-TT volunteer canola: a range of simazine (Group C) and trifluralin (Group D) products as a mixture are registered for pre-emergent volunteer canola control in chickpea and faba bean, at various rates depending on soil types.

8.0 Further reading

1. **2020 Western Australian crop sowing guide.**
   https://www.agric.wa.gov.au/barley/2020-western-australian-crop-sowing-guide

2. **Are 'pre-ems and crop competition' the 'wine and cheese' of weed control in canola?**
   https://ahri.uwa.edu.au/are-pre-ems-and-crop-competition-the-wine-and-cheese-of-weed-control-in-canola/

3. **Canola spray compliance an industry-wide effort.**
   https://grdc.com.au/news-and-media/news-and-media-releases/national/2019/5/canola-spray-compliance-an-industry-wide-effort

4. **Canola volunteer control 2019.**
   http://www.australianoilseeds.com/__data/assets/pdf_file/0018/9261/Canola_Volunteer_Control_Guide_October_2019_Version_2.pdf

5. **Herbicide mode of action table – CropLife Australia.**
   https://www.croplife.org.au/resources/programs/resistance-management/herbicide-moa-table-4-draft-2/

6. **Herbicide tolerance of canola - in Canola Agronomy Research in Western Australia.PP 55-57.**
   https://www.agric.wa.gov.au/canola/canola-agronomy-research-western-australia-bulletin

7. **Herbicide resistant weeds in Australia - in International survey of herbicide resistant weeds.**
   http://www.weedscience.org/Summary/Country.aspx?CountryID=1

8. **How can I get the most bang from crop-topping canola?**
   https://weedsmart.org.au/how-can-i-get-the-most-bang-from-crop-topping-canola/

9. **Hyola 530XT - Technote 2019.**
   https://www.pacificseeds.com.au/product/canola/hyola-530xt-2

10. **Optimising Group A herbicides in canola. GRDC herbicide behaviour fact sheet.**
    https://grdc.com.au/resources-and-publications/all-publications/factsheets/2019/optimising-group-a-herbicides-in-canola

11. **Optimum Gly® technical manual.**
    https://das.my.salesforce.com/sfc/p/#30000001J5oK/a/4S0000008OUk/WRM3jNkzaWpyTIvNg2VcHi91IcEliNCloejC38pPy9c

12. **Options for crop-topping canola.**
    https://weedsmart.org.au/crop-topping-canola/

13. **Pacific Seeds - Hyola XC stewardship guide.**
    https://www.pacificseeds.com.au/wp-content/uploads/2020/02/XC-stewardship-guide.pdf

14. **Protecting WA crops: pre-harvest protection.**
https://www.agric.wa.gov.au/newsletters/pwac/protecting-wa-crops-issue-6-october-2017

15. **Rotational constraints for pulse crops following the use of aminopyralid, clopyralid and picloram herbicides. GRDC herbicide behaviour fact sheet.**
https://www.grdc.com.au/__data/assets/pdf_file/0030/381837/10445-GRDC-Fact-sheet-Pyridine-herbicides.pdf

16. **Rotational crop constraints for herbicides used in Australian farming systems.**
https://www.grdc.com.au/resources-and-publications/all-publications/publications/2019/rotational-crop-constraints-for-herbicides-used-in-australian-farming-systems

17. **Roundup Ready® canola Crop Management Plan (CMP) and Resistance Management Plan (RMP).**
https://www.croplife.org.au/wp-content/uploads/2013/05/Roundup-Ready-canola-Crop-Management-Plan.pdf

18. **Roundup Ready canola weed management guide.**
http://www.roundupreadycanola.com.au/prod/media/1312/roundup-ready-canola-weed-management-guide.pdf

19. **Safe use of Lontrel® Advanced in Southeast Australian crop rotations.**
https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2019/02/safe-use-of-lontrel-advanced-in-southeast-australian-crop-rotations

20. **TruFlex® canola with Roundup Ready® technology.**
http://www.roundupreadycanola.com.au/products/truflex-canola/

21. **Weed management - in Canola encyclopedia by canola council of Canada.**
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