NORTHERN
SEPTEMBER 2018

GRDC
GROWNOTES™

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

CANOLA

SECTION 6

WEED CONTROL

GENERAL WEED MANAGEMENT | CLETHODIM DAMAGE | CLETHODIM RESISTANCE IN ANNUAL RYEGRASS

Weed control

MORE INFORMATION

Weed control in winter crops 2016

Integrated weed management manual

Soil behaviour of pre-emergent herbicides in Australian farming systems

What is Roundup Ready® canola? Clearfield Stewardship Best Management Practice 2014

Herbicide tolerant canola in farming systems: a guide for growers

Ground Cover Radio 118: Torch test on tramline weeds

FAQ

6.1 General weed management

Weed management is strongly influenced by crop rotation sequence. Careful planning of a five year rotation will enable targeted weed control through both cultural and chemical methods as well as the ability to plan herbicide rotations. The widespread occurrence of herbicide resistance in Australian weeds puts further emphasis on the need for careful planning and resistance management strategies such as monitoring, herbicide MOA rotation and cultural management techniques.

The area sown to herbicide tolerant varieties of canola has increased dramatically in recent years, however widespread use of these varieties without integrated weed management techniques is likely to accelerate the development of resistance to the herbicides.

The resistance to several of these herbicides that already occurs in Australian weeds shows that these varieties are not a panacea for herbicide resistance management, but they will add significantly to the options available to farmers in respect to resistance management.

Key points

- Choose paddocks relatively free of broadleaf weeds, especially charlock, wild turnip, wild radish and other weeds of the Brassica family, because in-crop herbicide options are limited. Grass weeds can be controlled in canola by using trifluralin or post-emergent herbicides however Group A resistant grasses are still of concern.
- Herbicide-resistant varieital syystems such as Triazine Tolerant (TT), Clearfields (CF) and Roundup Ready (RR) can be of use in managing weeds in canola, particularly broad leaf weeds however careful management is needed to avoid the buildup of reistant weed populations.
- When choosing paddocks for canola be careful with those treated with residual herbicides, especially Group B and triazine herbicides (for conventional varieties); their residues can affect canola. Check labels for re-cropping intervals, some of which are up to 36 months.
- Ensure that all spray equipment is thoroughly decontaminated before using to spray canola. Apply chlorine if the spraying equipment has previously been used to spray sulfonylureas, ammonia for hormone herbicides (salt and amine formulations) such as 2,4-D amine and MCPA, and liquid alkali detergent for Broadstrike® (flumetsulam) and Eclipse® (metosulam) decontamination. Where possible, use separate spraying equipment for residual herbicides such as the sulfonylureas.
- Imidazolinone-tolerant varieties are marketed as Clearfield® canola. These varieties allow the use of the Group B herbicide Intervix® (imazamox and imazapyr). Clearfield® varieties do not suffer from the yield and oil penalty that the TT varieties exhibit. The use of Clearfield® varieties allows the rotation of herbicide groups and broadens the spectrum of weeds controlled. [1]

1 L Serafin, J Holland, R Bambach, D McCaffery (2005) Canola: northern NSW planting guide. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0016/148300/canola-northern-NSW-planting-guide.pdf

6.1.1 Weed spectrum and herbicide resistance

While there are inevitably large numbers of weed species that affect canola production, those that feature consistently in Australia are listed in Table 1. Prior to the introduction of herbicide-resistant varieties, control of key broadleaf weeds was the most important constraint to production of canola throughout Australia.

Table 1: *Common weeds of Australian canola crops.*

Weed (common name)	Scientific name
Wild radish* (Figure 1)	*Raphanus raphanistrum*
Indian hedge mustard*	*Sisymbrium orientale*
Annual ryegrass	*Lolium rigidum*
Shepherds purse*	*Capsella bursa-pastoris*
Wild turnip	*Brassica tournefortii*
Charlock*	*Sinapsis arvensis*
Patterson's curse*	*Echium plantagineum*
Vulpia*	*Vulpia spp.*
Wireweed	*Polygonum aviculare*
Toad rush	*Juncus bufonius*
Wild oat	*Avena spp.*
Spiny emex	*Emex australis*
Turnip weed*	*Rapistrum rugosum*
Fumitory	*Fumaria spp.*
Buchan weed	*Hirschfeldia incana*
Capeweed	*Arctotheca calendula*
Volunteer cereals	

* Weeds species that have been particularly important in restricting canola production prior to the introduction of TT varieties.

The degree to which such weeds have restricted the canola area is reflected in the rapid adoption of the triazine tolerant (TT) varieties across Australia. [2]

2 S. Sutherland, Canola Weed Management. http://www.australianoilseeds.com/__data/assets/pdf_file/0012/2712/Chapter_12_-_Canola_Weed_Management.pdf

Figure 1: *Wild radish is a common weed in canola crops.*

6.1.2 Herbicide resistance in Australian weeds

Australian farmers have moved away from aggressive tillage practices because of the extreme risk of soil erosion. Few farmers use inversion tillage as is practiced in Europe, while the majority use reduced tillage methods. Significant proportions of the crops are seeded using no-till. Therefore, crop sequences and seeding techniques are highly dependent on herbicides.

Repetitious use of herbicides has selected for herbicide-resistant weed biotypes. Herbicide resistance now affects many species of Australian weeds, foremost among them being annual ryegrass. Where canola production was restricted by weeds like wild radish prior to the introduction of TT varieties, it is likely that herbicide-resistant weeds will also reimpose restrictions if not carefully managed.

This could be the case with multiple and or cross-resistance in single species as well as mixed populations of resistant weed species.

Canola growers in Australia use a range of herbicides on canola crops from many herbicide groups and the number of groups will increase with the commercial production of additional herbicide-resistant varieties in the next few years (Table 2).

MORE INFORMATION

Peter Newman from Australian Herbicide Resistance Initiative discusses ryegrass integrated management. Driving Agronomy podcast: Ryegrass control with RIM

Steve Jones from Aglign Consulting Pty Ltd discusses haloxyfop residue. GRDC Radio (Northern Update) 086: Haloxyfop residue concern

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

Table 2: *Common herbicides in use in canola crops in Australia.*

Herbicide Groups	Herbicides
A	Fluazifop, Haloxyfop, Diclofop-methyl, Sethoxydim, Quizalofop, Clethodim
B	Intervix* (Clearfield varieties)
C	Simazine, Atrazine, (TT varieties)
D	Trifluralin
I	Clopyralid
K	Metolachlor
M	Glyphosate (RR varieties)

www.apvma.gov.au

Many populations of annual ryegrass would now be classified as resistant to diclofop methyl and on some farms the ryegrass is cross-resistant to both Group A and Group B herbicides. There have been confirmed cases where annual ryegrass biotypes are resistant to all selective herbicides that are currently available. For each paddock monitoring and resistance testing is imperative to understand the control options open to the grower.

While the major herbicide resistance problems in Australian weeds are with Groups A and B herbicides, resistance to Groups C, D, F, L and M herbicides have also been discovered.

Wild radish has now developed resistance to Group B, Group C and Group F herbicides. Combined with the resistance in ryegrass, this has serious implications for farmers in general but particularly to those wishing to use the IT and TT varieties.

Farmers across Australia are being encouraged to adopt IWM in order to address the resistance problem. There are two essential components to IWM, namely the rotation of herbicide groups to avoid repetitious use of the same or similar herbicides, and the avoidance of treating large numbers of weeds with a single herbicide. Weed seed contamination of the canola seed in excess of limits will lead to reduced prices. This is especially the case with weeds from the family Brassicaceae, which lead to increased erucic acid and glucosinolates and consequent reduction in canola quality. Weed seed and other debris in the canola seed leads to direct penalties, based on the percentage present. Weed competition can affect nutrient uptake by the canola plants and thus affect yield.[3]

6.1.3 Weed management in differing scenarios

Canola in a continuous cropping sequence

Weed control in these preceding crops consists of manipulating sowing time, exploiting crop competitive effects and relying heavily on selective herbicides.

Selection pressure for herbicide resistance is often high, especially to the Group A and Group B herbicides, because of the need to use these herbicides in the preceding crops.

Weed numbers tend to be higher as farmers do not have the range of non-selective treatments available in the pasture. This increases the risk of resistant biotypes being present in the crops when the herbicides are applied. Due to herbicide resistance, continuous crop programs may include a forage / fodder or green manure crop so that non selective weed control can be achieved.

MORE INFORMATION

AHRI Insight: Canola's a better crop plant than a weed

3 S. Sutherland, Canola Weed Management. http://www.australianoilseeds.com/__data/assets/pdf_file/0012/2712/Chapter_12_-_Canola_Weed_Management.pdf

In both the ley system and the continuous cropping system, a significant component of weed management may be achieved through crop competition, although the effectiveness will vary between environments. [4]

Triazine Tolerant (TT) canola

In 1999, TT canola accounted for almost 50% of the Australian crop, even though the varieties have a yield penalty relative to non-TT varieties. In the majority of cases, TT canola is chosen because the weeds present cannot be controlled in the conventional varieties. In some situations, TT canola may be chosen as part of a strategy to control annual ryegrass resistant to Group A and Group B herbicides, in order to avoid repetitious use of trifluralin. In addition, the TT varieties were initially grown without an associated best management package, although this has now been rectified. All future herbicide-resistant crops will be introduced with a best management guide.

Some areas have a long history of triazine herbicide use, particularly in lupins. The widespread production of TT canola and use of triazines will certainly lead to an escalation in resistant populations of weeds, particularly annual ryegrass. There is already evidence of triazine resistance in wild radish. [5]

Imidazolinone Tolerant (IT) canola

IT canola varieties offer some significant benefits but there are important limitations. These varieties are marketed along with an imidazolinone herbicide mix originally called 'On Duty' but this has been replaced with a mix called 'Intervix'. This has a wide spectrum of activity and does not suffer from extended plant-back periods on acid soils. Unlike the TT varieties, the IT varieties carry no yield or oil penalties. The introduction of IT varieties has reduced the area of TT canola, which will have herbicide resistance management and environmental benefits.

Of the disadvantages, Group B herbicides are 'high risk' in terms of the development of herbicide resistance. Group B herbicides (e.g. chlorsulfuron and triasulfuron) are already used frequently in cropping sequences. Therefore, producers will have to plan carefully on how to fit the IT varieties without increasing the frequency of Group B herbicide use. The company is developing best management packages that will help greatly in this regard. The Group B resistance problem is so severe already in some areas (particularly in Western Australia) that the IT varieties may have limited, if any, scope for use. [6]

Liberty Link® canola

Liberty Link® varieties are currently being developed for the Australian market. At this time, there are problems with efficacy of glufosinate ammonium during the cool growing season, particularly on wild radish and annual ryegrass. This may limit the widespread application of Liberty Link® canola in some areas of southern Australia.

However, when Liberty Link® is combined into hybrids the additional seedling vigour may enhance competition with weeds. [7]

Roundup Ready® canola

Roundup Ready® canola (Figure 2) is now available to Australian producers.

Roundup has a wide spectrum of activity on weeds, has no soil residual problems (in the great majority of situations) and belongs to a low risk group in terms of herbicide resistance. Given these factors, Roundup Ready® canola will offer producers a significant alternative to other varieties, herbicide-resistant or otherwise. The

4 S. Sutherland, Canola Weed Management. http://www.australianoilseeds.com/__data/assets/pdf_file/0012/2712/Chapter_12_-_Canola_Weed_Management.pdf

5 S. Sutherland, Canola Weed Management. http://www.australianoilseeds.com/__data/assets/pdf_file/0012/2712/Chapter_12_-_Canola_Weed_Management.pdf

6 S. Sutherland, Canola Weed Management. http://www.australianoilseeds.com/__data/assets/pdf_file/0012/2712/Chapter_12_-_Canola_Weed_Management.pdf

7 S. Sutherland, Canola Weed Management. http://www.australianoilseeds.com/__data/assets/pdf_file/0012/2712/Chapter_12_-_Canola_Weed_Management.pdf

introduction of Roundup Ready® canola will lead to further reductions in the area of TT canola, which will be good for management of triazine resistant weeds and the environment.

A problem industry has to deal with is glyphosate resistance in annual ryegrass, for which there are an increasing number of documented cases. If glyphosate is the only herbicide used in Roundup Ready® canola, these biotypes will survive unless some other intervention is used, such as alternative knockdown herbicides prior to sowing, cultivation at or prior to planting, and/or in-crop herbicides. Therefore, best management packages will need to include recommendations for minimising the risk of increased selection for the glyphosate resistant biotypes. [8]

Figure 2: *Herbicide tolerant canola, including Roundup Ready varieties, growing at the NVT site at Forbes, NSW.*

Source: GRDC

6.1.4 Future directions

Canola is set to remain a popular crop in Australia providing grain prices remain satisfactory and blackleg is controlled with varietal tolerance. However, herbicide resistance in weeds may force producers into less intensive rotations in order to manage seed banks of resistant weeds.

Weed resistance is likely to restrict the useful life of the IT and TT varieties. This is particularly the case with the IT varieties because the associated herbicides are 'high risk' for resistance development, but also because widespread resistance to these herbicides already exists. [9]

Microwave technology for weed management

University of Melbourne research has demonstrated that microwave heating, using a suitable device to project the microwave energy onto plants and the soil, can kill weed plants and their seeds. Microwave treatment is not affected by incumbent weather conditions such as wind or rain.

The following species have been tested with good success: ryegrasses – annual and perennial; barnyard grass; barley grass; bellyache bush; brome grass; clover; feathertop Rhodes grass; fleabane; hemlock; mimosa pigra; parthinium; rubber vine; wild oats; and wild radish. The microwave energy density required to kill plants varies according to the species.

Microwave treatment significantly reduces bacterial numbers in the top layer of the soil; however their numbers rebound to a significantly higher population after one month. Microwave treatment has no measurable effect on fungi or protozoa in the soil. Microwave soil treatment also significantly increases the yield and maturation rate of subsequent crops grown in the treated soil. [10]

8 S. Sutherland, Canola Weed Management. http://www.australianoilseeds.com/__data/assets/pdf_file/0012/2712/Chapter_12_-_Canola_Weed_Management.pdf

9 S. Sutherland, Canola Weed Management. http://www.australianoilseeds.com/__data/assets/pdf_file/0012/2712/Chapter_12_-_Canola_Weed_Management.pdf

10 G Brodie (2016) Microwave technology for weed management. GRDC Update Papers 1 March 2016, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/03/Microwave-technology-for-weed-management

MORE INFORMATION

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

6.2 Clethodim damage

Clethodim damage in canola is particularly relevant in the northern region. The application of clethodim at rates of product of 500 mL/ha (for Select (240 g/L) this is the maximum label rate in canola, but for Select Xtra (360 g/L) the maximum label rate in canola is 330 mL/ha) have been reported to cause the following symptoms on canola:

- delayed flowering
- distorted flower buds
- possible yield suppression. [11]

Recent research by the Grain Orana Alliance (GOA) examined the impact of clethodim on canola at different rates and crop stages as growers had become increasingly reliant on clethodim herbicide to manage resistance issues, but in turn were seeing more cases of clethodim damage in their crops following application.

After three years of research and more than a dozen trials GOA found Clethodim was safe to use in canola as long as it was applied according to label rates and timing. If growers get their timing right they can use full label rate (500 ml/hectare) without any significant damage to yield.

But it is absolutely critical growers understand the crop's growth stages and apply the chemical before the canola is at bud visible stage. This means before the plant is at 8-leaf stage, which is when canola is likely to be budding. Ideally growers should be targeting clethodim application (at the maximum label rate) when the plant is at 2–4 leaf stage.

If canola is at 6-leaf stage growers should exercise caution and check if the bud is visible. [12]

Clearly growers need to be aware of the main factor driving such drop damage. There may also be varietal differences, about which little is known, however, farmers can control the timing and rate of herbicide and should be able to avoid such issues. As for controlling the conditions of canola at the time of application, spraying earlier may avoid moisture stress issues particularly in seasons when rainfall is light. Spraying early means late emerging grass weeds will not be controlled with in-crop sprays but these plants are likely to be suppressed by a rapidly closing canola canopy. Seed production from these weed could still be managed with non-chemical options such a windrow burning. [13]

6.3 Clethodim resistance in annual ryegrass

Clethodim resistance in annual ryegrass is increasing. In the past clethodim resistance was managed by increasing the rate of clethodim. Unfortunately it is no longer possible to do that. There are now populations of annual ryegrass that are resistant to 500 mL ha^{-1} clethodim and some will survive when treated with 2 L ha^{-1} of clethodim.

As there are no new post-emergent grass herbicides for canola in the pipeline, pre-emergent herbicides will have to take a greater role in managing ryegrass post-emergent. Researchers examined the ability of some currently registered and potential products for controlling annual ryegrass in canola in 2012 (Table 3). None of the pre-emergent herbicides were particularly efficacious against clethodim resistant annual ryegrass and none were better than using clethodim. Currently, the mix of

11 T Cook, G Brooke, M Widderick, M Street (2014) Herbicides and weeds regional issues trials and developments https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/Herbicides-and-weeds-regional-issues-trials-and-developments

12 T Somes (2016) Crop stage critical when using Clethodim in canola. GRDC E-newsletter 6 June 2016, https://grdc.com.au/Media-Centre/GRDC-E-Newsletters/Paddock-Practices/Crop-stage-critical-when-using-Clethodim-in-canola

13 T Cook, G Brooke, M Widderick, M Street (2014) Herbicides and weeds regional issues trials and developments https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/Herbicides-and-weeds-regional-issues-trials-and-developments

clethodim plus butroxydim (Factor®) applied after a pre-emergent herbicide offers the best control; despite continuing to select for clethodim resistance. [14]

Table 3: *Control of clethodim-resistant annual ryegrass in canola at Roseworthy in 2012. POST herbicides were applied 8 weeks after sowing.*

Herbicide program	Annual ryegrass 8 weeks after sowing (plants/m²)	Annual ryegrass spikes at harvest (per m²)	Crop yield (t/ha)
1.5 kg/ha Atrazine IBS + 500 mL/ha Select® POST	387ab	149cd	1.34a
1.5 kg/ha Atrazine IBS + 250 mL/ha Select® POST	262b	306c	1.13a
1.5 kg/ha Atrazine IBS + 500 mL/ha Select® + 80 g/ha Factor® POST	333b	92d	1.37a
Group K IBS	498a	1105a	0.46d
Group K + 2.0 L/ha Avadex® Xtra IBS	298b	775b	0.76c
Group K + 2.0 L/ha Avadex® Xtra IBS	235b	260cd	0.88bc
Group K + 250 mL/ha Dual Gold® IBS	350ab	802b	0.50cd
Group D IBS	108c	149cd	1.11ab

Abbreviations: IBS, incorporated by sowing; POST, post-emergence; CT, crop-topped

6.3.1 Hybrid canola and pre-emergent herbicides for grass weed control in wheat

Clethodim resistance in annual ryegrass has become a major concern for canola production. During 2013 and 2014 University of Adelaide researched conducted trials to examine potential new herbicides for the control of clethodim-resistant annual ryegrass in TT and Clearfield® canola at Roseworthy (SA). These trials were sown on 17 May 2013 and 23 May 2014. The varieties used were ATR Stingray (TT) and Pioneer® 45Y84 hybrid (Clearfield) and were sown to achieve plant stands of 50 plants/m² for the TT canola and 35 plants/m² for the Clearfield canola. Several pre-emergent herbicide options used alone were compared with current usual practice of a pre-emergent herbicide followed by post-emergent herbicides. The population was tested as resistant to clethodim, but was also clearly resistant to Group B and Group D herbicides. [15]

The results of these trials were that pre-emergent herbicides alone would be ineffective at managing annual ryegrass in canola. However, it became clear that the surviving annual ryegrass plants set a lot more seed in TT canola than it did in hybrid Clearfield canola (Table 4). Typically, there was more than twice as much ryegrass seed produced in the open-pollinated TT canola than in the hybrid Clearfield canola. This was a result of the slower-growing open-pollinated TT canola achieving canopy closure much later than the hybrid Clearfield canola. The result was that each surviving ryegrass plant had more opportunity to set seed.

MORE INFORMATION

Maintaining the best options with herbicides

Options for using more residual herbicides in northern no-till systems

Herbicides and weeds regional issues trials and developments

Revisiting canola management can lift returns

For more information on weed management in winter crops, see the Wheat GrowNotes.

14 C Preston, P Boutsalis, S Kleeman, R Saini, G Gill (2013) Maintaining the best options with herbicides http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/08/Maintaining-the-best-options-with-herbicides

15 C Preston, S Kleemann, G Gill (2016) Coupling pre emergent herbicides and crop competition for big reductions in weed escapes. GRDC Update Papers 22 February 2016, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/02/Coupling-pre-emergent-herbicides-and-crop-competition-for-big-reductions-in-weed-escapes

Table 4: *Annual ryegrass plants in crop, annual ryegrass seed production and canola yield at Roseworthy in 2013 and 2014. Different letters in each column for each year indicate significant differences in means (there was no significant difference for yield of Clearfield canola in 2014).*

Pre-emergent herbicide**	Ryegrass plants (per m²)		Ryegrass seeds (x1000 per m²)		Yield (t/ha)	
	ATR Stingray	45Y82 (CL)	ATR Stingray	45Y82 (CL)	ATR Stingray	45Y82 (CL)
	2013					
Usual practice*	171 a	47 a	1.82 a	1.40 a	2.15 a	1.73 a
Rustler (1 L/ha)	96 a	63 a	15.83 b	4.58 b	1.68 b	1.62 ab
Experimental A	269 b	186 c	21.70 b	5.80 bc	1.62 b	1.48 b
Experimental B	381 c	198 c	34.82 c	8.86 d	1.30 c	1.60 ab
Experimental C	133 a	101 b	22.31 b	7.37 c	1.65 b	1.60 ab
	2014					
Usual practice*	522 ab	632 a	6.79 a	5.40 a	1.69 a	1.71
Rustler (1 L/ha)	354 a	553 a	32.78 b	17.27 ab	1.49 ab	1.65
Experimental A	864 b	1697 b	51.47 c		1.15 b	1.41
Experimental B	869 b	1643 b	51.19 c	27.11 b	1.26 b	1.36
Experimental C	767 b	1088 b	54.53 c	26.45 b	1.31 b	1.62

A Usual practice was Atrazine (1.5 kg/ha) pre followed by 240 gai/L Clethodim (500 mL/ha) post for TT canola (ATR Stingray) and Trifluralin (2 L/ha) + Avadex Xtra (2 L/ha) pre followed by Intervix (750 mL/ha) + 240 gai/L Clethodim (500 mL/ha) post for Clearfield canola (45Y82).

B Rates listed in this table are for trial purposes. If using these products commercially ensure you follow the rates listed on the registered labels.

In 2015 a further trial was conducted at Roseworthy (SA) that included three TT canola cultivars: ATR Stingray (open-pollinated), Hyola 559TT (a hybrid) and Hyola 750TT (a high biomass hybrid). The trial was sown on 15 May 2015 with a target population of 35 plants/m². There were three herbicide management strategies employed: Herbicide Treatment 1 – no herbicides; Herbicide Treatment 2 – Atrazine (1.5 kg/ha) pre followed by Clethodim (500 mL/ha) post; and Herbicide Treatment 3 – Rustler (1 L/ha) pre followed by Clethodim (500 mL/ha) + Factor (80 g/ha) + Atrazine (1.1 kg/ha) post.

In this trial there was a significant effect of both cultivar ($P < 0.0001$) and herbicide treatment ($P < 0.0001$) on the number of annual ryegrass spikes present at maturity. The annual ryegrass population at the site was resistant to clethodim, so post-emergent treatments were not very effective. The high biomass canola (Hyola 750TT) significantly reduced the number of annual ryegrass spikes at harvest compared to the other two cultivars in the absence of herbicides (Herbicide Treatment 1), demonstrating the impact of extra competition provided by this cultivar (Figure 3). Where Herbicide Treatments 2 and 3 were employed (Figure 3) there was about twice the number of annual ryegrass spikes at maturity in the ATR Stingray plots compared with the two hybrid cultivars. Simply changing from an open-pollinated cultivar to a hybrid canola has the potential to reduce annual ryegrass seed set by half.

South Australia experienced a hot and dry spring during 2015 and so canola yields in this trial were low. The early finish to the season did not suit the longer season cultivars and in addition yield of Hyola 750TT was affected by frost. There were significant effects of cultivar ($P = 0.042$) and herbicide treatment ($P < 0.001$) on canola yield; however, the highest yield was only 1.17 T/ha for Hyola 559TT with Herbicide Treatment 3. [16]

16 C Preston, S Kleemann, G Gill (2016) Coupling pre emergent herbicides and crop competition for big reductions in weed escapes. GRDC Update Papers 22 February 2016, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/02/Coupling-pre-emergent-herbicides-and-crop-competition-for-big-reductions-in-weed-escapes

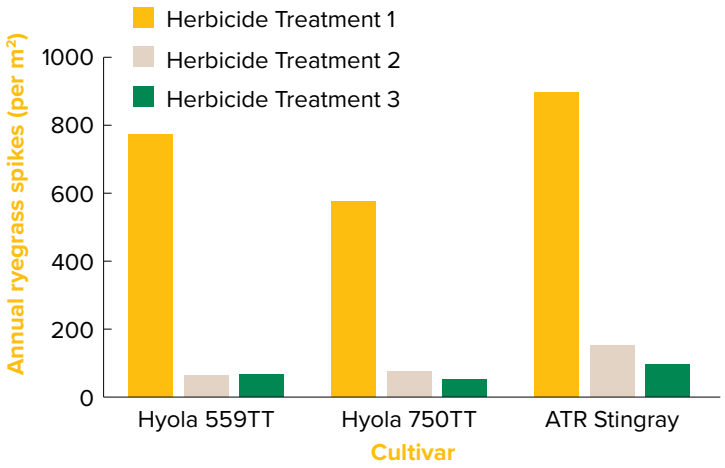

Figure 3: *Effect of canola cultivar and herbicide treatment on annual ryegrass spike numbers at maturity at Roseworthy in 2015.*

Herbicide Treatment 1: no herbicides; Herbicide Treatment 2: Atrazine (1.5 kg/ha) pre followed by 240 gai/L Clethodim (500 mL/ha) post; and Herbicide Treatment 3: Rustler (1 L/ha) pre followed by 240 gai/L Clethodim (500 mL/ha) + Factor (80 g/ha) + Atrazine (1.1 kg/ha) post.