The tolerance of canola to herbicides

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Summary Dose response curves for 20 herbicides and various mixtures or sequential applications were developed for canola over six seasons in the Mediterranean environment of Western Australia in a GRDC and WA Department of Agriculture funded project. Carbetamide and metolachlor have good potential for controlling herbicide resistant ryegrass. Dicamba was well tolerated by canola as both a pre- and post-emergent treatment. Tralkoxydim provided good control of annual poa. Diflufenican, 2,2-DPA and simazine had marginal crop tolerance. Oxyfluorfen was tolerated at up to 500 g a.i. ha^{-1} pre-planting but caused severe scorching as a post-emergence application. A table of the rates of various herbicides tolerated by canola is presented. There are a number of weeds that can not be adequately controlled in normal lines of canola and herbicide tolerant varieties will continue to be an important part of the canola industry.

Keywords 2,2-DPA, 2,4-D amine, 2,4-D ester, *Acetocella vulgaris*, Achieve™, Ally™, annual poa, annual ryegrass, atrazine, aziprotryne, Basagran™, bentazone, Bladex™, Brasoran™, *Brassica napus*, Brodal™, canola, Carbetamex™, carbetamide, clopyralid, control, cyanazine, dicamba, diflufenican, diuron, dock, doublegee, *Emex australis*, Dual™, Eclipse™, ethametsulfuron, *Fumaria muralis*, glufosinate, Goal™, herbicide, Kerb™, Lexone™, Liberty™, *Lolium rigidum*, Lontrel™, metolachlor, metosulam, metribuzin, metsulfuron, Muster™, oxyfluorfen, *Poa annua*, Propon™, propyzamide, rat-tailed fescue, *Rumex pulcher*, Sencor™, silver grass, simazine, Sorrel, squirrel-tailed fescue, tralkoxydim, Treflan™, trifluralin, *Vulpia bromoides*, *Vulpia myuros*, wall fumitory, weed.

INTRODUCTION

There are few herbicides registered for use in canola and this is encouraging farmers to plant the lower yielding triazine tolerant varieties. This project investigated the tolerance and efficacy of various herbicides potentially useful for weed control in canola.

MATERIALS AND METHODS

Twenty six field trials were planted across the WA wheatbelt from 1995 to 2000 to determine the efficacy on weeds and crop tolerance of canola to various herbicides and combinations. Most were sprayed with a logarithmic boom sprayer to collect dose response data. Varieties planted were those recommended for the site by the Department of Agriculture.

Tolerance quoted is the dose of herbicide that caused no significant decrease in grain yield or caused a 5% reduction in grain yield based on the dose response curve.

RESULTS AND DISCUSSION

The tolerance of canola to the herbicides and combinations tested is in Table 1.

A number of herbicides were identified as having sufficient selectivity and a spectrum of weeds not currently covered by present registrations. These include dicamba for dock (*Rumex pulcher* L.), doublegee (*Emex australis* Steinh.) and sorrel (*Acetocella vulgaris* Fourr.) control, tralkoxydim for annual poa or winter grass (*Poa annua* L.) control, oxyfluorfen for wall fumitory (*Fumaria muralis* Sond. ex Koch) control and simazine for rat-tailed fescue (*Vulpia bromoides* (L.) C.Gmelin) and squirrel-tailed fescue (*Vulpia myuros* (L.) Gray) or silver grass control.

Control of annual ryegrass (*Lolium rigidum* Gaudin) that is resistant to group A, B and C herbicides was possible in canola with propyzamide, carbetamide (group K), 2,2-DPA (group J), trifluralin or metolachlor (group D) and suppression was achieved with oxyfluorfen (group G).

Commonly used additives for pre-planting knockdown herbicides such as 2,4-D amine and metsulfuron were poorly tolerated by canola. Dicamba, oxyfluorfen, diuron and 2,4-D ester should be substituted and labels adjusted to reflect these findings.

Post emergence diflufenican following pre-planting applications of diuron (or cyanazine) provided reasonable control of wild radish but the crop tolerance was marginal.

Generally the tolerance of canola to the various herbicides varied by a factor of three over the range of sites and seasons (see Table 1). Where limited data is available, a three times tolerance should be adopted to reduce the risk of crop damage.

Dicamba (as various products) was well tolerated pre-planting and had adequate tolerance for early post-emergence use.

Tralkoxydim (as Achieve™) is one of the few products to control annual poa (winter grass) and is tolerated at high rates by canola.

Table 1. The tolerance of canola to various herbicides.

Herbicide	Time of application	Canola tolerance (g a.i. ha^{-1})	No. of trials
2,4-D amine (500 g L^{-1} dimethylamine)	pre-planting	<250	1
2,4-D ester (800 g L^{-1} ethyl ester)	1 wk pre-plant	480–1800	2
2,2-DPA (as Propon™ 740 g kg^{-1})	pre-planting	2000–7500	3
2,2-DPA (as Propon™ 740 g kg^{-1})	3–5 leaf stage	1500–7000	5
Aziprotryne (as Brasoran™ 50 g kg^{-1})	4-leaf stage	>5000	1
Bentazone (as Basagran™ 480 g L^{-1})	4-leaf stage	<240	1
Carbetamide (as Carbetamex™ 700 g kg^{-1})	post-plantSA	>7000	1
Carbetamide (as Carbetamex™ 700 g kg^{-1})	4-leaf stage	1400	1
Clopyralid (as Lontrel™ 300 g L^{-1})	pre-planting	>300	1
Clopyralid (as Lontrel™ 300 g L^{-1})	4-leaf stage	>600	1
Cyanazine (as Bladex™ 500 g L^{-1})	pre-planting	700–2000	7
Cyanazine (as Bladex™ 500 g L^{-1})	1–5 leaf stage	300–1750	8
Cyanazine + diflufenican	cot to 3-leaf	200+22	1
Dicamba (200 g L^{-1})	pre-planting	400–750	4
Dicamba (200 g L^{-1})	2–5 leaf stage	150–500	5
Diflufenican (as Brodal™ 500 g L^{-1})	cot to 1-leaf	<25	1
Diflufenican (as Brodal™ 500 g L^{-1})	cot to 3-leaf	40	1
Diflufenican (as Brodal™ 500 g L^{-1})	4–5 leaf stage	100–220	7
Diflufenican (as Brodal™ 500 g L^{-1})	bolting stage	220	1
Diflufenican + dicamba	cot to 3-leaf	50+500	1
Diflufenican + oxyfluorfen	cot to 3-leaf	<10+12	1
Diuron (900 g kg^{-1})	pre-planting	1000–2000	12
Diuron (900 g kg^{-1})	4-leaf stage	500	1
Diuron + metolachlor	pre-planting	1500+1080–2000+1440	4
Diuron + oxyfluorfen	post-plantSA	1125+600	1
Diuron + trifluralin	pre-planting	1350+1200	1
Ethametsulfuron (as Muster™ 750 g kg^{-1})	bolting stage	>75	1
Metolachlor (as Dual™ 720 g L^{-1})	pre-planting	>3000	5
Metosulam (as Eclipse™ 710 g kg^{-1})	1 wk pre-plant	4–8.5	3
Metribuzin (as Lexone™ 750 or Sencor™ 480)	pre-planting	<94	1
Metribuzin (as Sencor™ 480)	4-leaf stage	<100	1
Metsulfuron (as Ally™ 600 g kg^{-1})	1 wk pre-plant	2.4–7	2
Oxyfluorfen (as Goal™ 240 g L^{-1})	pre-planting	500	10
Oxyfluorfen (as Goal™ 240 g L^{-1})	post-plantSA	500	1
Oxyfluorfen (as Goal™ 240 g L^{-1})	2–5 leaf	110–250	5
Propyzamide (as Kerb™ 500 g kg^{-1})	pre-planting	>1000	2
Propyzamide (as Kerb™ 500 g kg^{-1})	1–5 leaf stage	>2500	2
Simazine (500 g L^{-1})	1 wk pre-plant	1250–2500	3
Simazine (500 g L^{-1})	3–5 leaf stage	250–700	4
Tralkoxydim (as Achieve™ 400g kg^{-1})	4-leaf stage	>800	1
Trifluralin (as Treflan™ 400 g L^{-1})	pre-plant incorp.	>5000	1
Cyanazine then cyanazine	pre-plant then 4-leaf stage	200 then 300–1000 then 1500	4

Table 1. continued overleaf/…

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Herbicide	Time of application	Canola tolerance (g a.i. ha^{-1})	No. of trials
Cyanazine then diflufenican	pre-plant then 2–4 leaf stage	1000 then 100–2000 then 200	1
Cyanazine then diflufenican	pre-plant then 1–4 leaf stage	500 then 25–2000 then 100	4
Diuron then diflufenican(3:1)	pre-plant then 4-leaf stage	300 then 55–900 then 165	6
Diuron then diflufenican (10:1)	pre-plant then 2–4 leaf stage	600 then 33–1800 then 100	5
Diflufenican then ethametsulfuron	2–4 leaf then bolting stage	50+22	1
Simazine then diflufenican	1 wk pre-plant then 2–4 leaf	<250 then 25	1
Trifluralin then oxyfluorfen	pre-plant incorp. then post-plantSA	2000 then 600	1
Atrazine (500 g L^{-1})	pre-plant the 4-leaf stage	>2000 then 2000	5 TT Canola
Glufosinate (as Liberty™ 200 g L^{-1})	4-leaf stage	>2000	1 IT Canola
Diflufenican (as Brodal™ 500 g L^{-1})	4-leaf stage	150	1 IT Canola
Glufosinate + diflufenican	4-leaf stage	120+30	1 IT Canola
Glufosinate then diflufenican	4-leaf then 10 leaf	500+50	1 IT Canola
Metosulam then diflufenican	1 wk pre-plant then cot to 3-leaf	4 then 17	1
Oxyfluorfen then diflufenican	1 wk pre-plant then 2–4 leaf	<96 then 12	1

pre-plant = pre-planting = herbicide applied 4–24 hours before planting.
post-plantSA = post-planting surface applied.
pre-plant incorp. = pre-planting and double incorporate with harrows.
wk = weeks.
All other refer to crop stage at time of spraying.

Aziprotryne (as Brasoran™) is not readily available but controls a spectrum of weeds that is not covered by other products.

Ethametsulfuron (as Muster™) was a useful product for wireweed control but requires negotiation with the company for release.

Carbetamide (as Carbetamex™) had good canola tolerance and potential for control of annual ryegrass that is resistant to group A, B and C herbicides.

Cyanazine (as Bladex™ 500 g L^{-1}) was tolerated by canola at 750 g a.i. ha^{-1} at the 4-leaf stage and 1500 g a.i. ha^{-1} pre-planting. At half of these rates, to allow for crop safety, wild radish control was around 90% for pre-plant and 75% for post emergent applications. Splitting the application, with two fifths applied pre-plant and three fifths at the 4-leaf stage, provided poorer control of wild radish and crop tolerance was midway between a single application at either stage. Cyanazine could provide high levels of suppression but had insufficient selectivity to provide adequate control of wild radish in canola The rates of Bladex™ tolerated by canola provided good control of rat and squirrel-tailed fescue (silver grass). Cyanazine also offered a more reliable option for control of emerged wild radish in TT Canola.

Diflufenican (as Brodal™ 500 g L^{-1}) was tolerated by canola at rates up to 25 g a.i. ha^{-1} at the cotyledonary to 1-leaf stage, 133–220 g a.i. ha^{-1} at the 4–5 leaf stage and 220 g a.i. ha^{-1} at bolting. These rates only provided 50–90% control of wild radish. Low rates of 25–50 g a.i. ha^{-1} diflufenican, applied at the 4-leaf stage of canola, provided about 60% control of wild radish. Rates up to 133 g a.i. ha^{-1} did not provide significantly better control but resulted in a grain yield loss of around 10%.

Simazine was tolerated by canola at the 3–5 leaf stage at rates just sufficient to control rat-tailed and squirrel-tailed fescue (silver grasses). When applied pre-planting, canola tolerated over 1000 g a.i. ha^{-1} which is twice the rate required for silver grass control.

Diuron was tolerated by canola at rates up to 1000 g a.i. ha^{-1} applied pre-planting. At these and lower rates there was generally an unexplained increase in yield.

Metolachlor (as Dual™ 720 g L^{-1}) is now registered and was generally well tolerated by canola. Further work is required for use under wet conditions.

Oxyfluorfen (as Goal™ 240 g L^{-1}) was tolerated at rates up to 500 g a.i. ha^{-1} pre-planting. Oxyfluorfen provided extended control of both toad rush and crassula killing late germinations and reducing seed carry over to the following season. In areas afflicted by these weeds (and mallows) and in zero tillage situations it is expected that this will become a standard treatment but will be used at higher rates than currently recommended.

Post-emergence applications of oxyfluorfen caused severe scorching of the crop, but there are few alternatives for wall fumitory control.

Wild radish in canola Control of wild radish in normal canola is possible, but variable, and requires considerable skill to achieve it without damaging the crop. For example; 150–200 mL ha^{-1} Brodal™ or 350–400 mL ha^{-1} Goal™ at the 4-leaf stage of the crop, or 200–300 g ha^{-1} Diuron900 pre-planting followed by 70–100 mL ha^{-1} Brodal™ at the 4-leaf stage provided good control of wild radish with little effect on the canola at Katanning in 2000. At Mt. Barker 300–450 g ha^{-1} Diuron 900 pre-planting followed by 100–150 mL ha^{-1} Brodal™ at the 4-leaf stage was required for adequate control of wild radish. Over all sites the most reliable technique was 300 g ha^{-1} Diuron 900 applied pre-planting followed by 100 mL ha^{-1} Brodal™ at the 4-leaf stage of the crop.

Up to 1000 g a.i. ha^{-1} diuron, applied pre-planting, was tolerated by canola but seldom provided more than 50% control of wild radish. Rates down to 200 g a.i. ha^{-1} provided 30% control of wild radish. Higher levels of control were not achieved without significant crop damage. Using diflufenican as a follow up treatment at the 4-leaf stage had little effect on the canola and improved wild radish control. However, it did not have enough selectivity to be useful in areas with heavy wild radish infestations.

Herbicide tolerant canola varieties will continue to be useful where *Brassica* weeds are present. Herbicides currently available can provide useful control in salvage situations or in paddocks where the infestations are patchy but they are generally not selective enough for widespread recommendation.

CONCLUSIONS

Companies should be encouraged to continue with registration of dicamba, tralkoxydim, aziprotryne, ethametsulfuron and carbetamide for use post-emergence use in canola.

The labels for products containing dicamba, oxyfluorfen, clopyralid, diuron and 2,4-D ester should contain clauses that state the maximum rate of these herbicides that can be added to knockdown herbicides prior to sowing a canola crop. 2,4-D amine labels should contain a clause stating the minimum plant back period for canola.

A permit system is required for salvage herbicides to deal with quality assurance issues and herbicide residue issues in crop products. This would include uses such as diflufenican for wild radish and simazine for rat and squirrel-tailed fescue control.

A registry of farmer experiences with herbicides is required to identify conditions where products fail in the field because it is too costly to cover all situations by experiment. This registry should be on the internet for public access.

The reasons for canola yield increases caused by pre-plant diuron and the effects of pre-planting group C herbicides (diuron, linuron, simazine, atrazine and cyanazine) as synergists for post emergence diflufenican requires further research.

Mixes of diuron plus metolachlor ± plus oxyfluorfen in combination with glyphosate as a single pass operation for minimum tillage requires more extensive testing.

ACKNOWLEDGMENTS

This project was funded by the Grains Research and Development Corporation and the Department of Agriculture of Western Australia. The herbicide companies provided valuable technical advice and samples for testing. Paul Matson and Research Station staff provided the majority of the technical assistance.