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Crop Updates 2011 - Weeds

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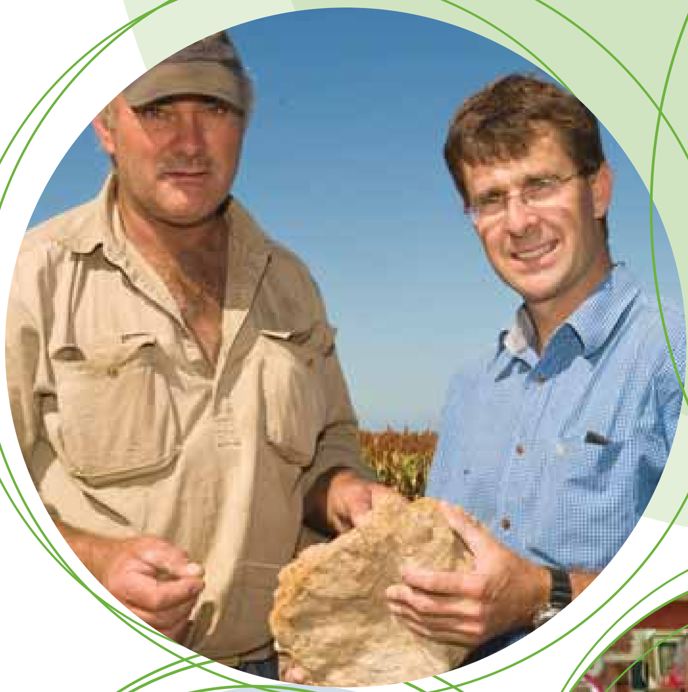
Weeds and Herbicides



CROP
updates

Herbicides for selective spot spraying application on winter weeds in chemical fallow

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Key Messages

- Weed sensing and selective spot spraying with machinery such as the Weedseeker and Weed-it selective spot sprayers has enabled cost-effective broadacre spot spraying of weeds.
- Selective spot spraying of hard-to kill summer weeds is one application where this technology has a potential to save growers significant funds usually allocated to herbicides.
- Elevated rates of non-traditional or previously cost-prohibitive herbicides of a different resistance group can now be used to achieve much more reliable and faster control of herbicide-resistant weeds.
- Robust rates of glyphosate provided the most acceptable levels of control across the three winter weeds species tested — brome grass (*Bromus* spp.), annual ryegrass (*Lolium rigidum*) and wild radish (*Raphanus raphanistrum*).
- Gramoxone® and Spray.Seed® at rates of 2 L and 4 L effectively controlled of brome grass, but both annual ryegrass and wild radish grew back and, at the final ratings, showed unacceptable levels of control.
- In a region where glyphosate-tolerant annual ryegrass populations have been identified, the lack of alternative modes of action to reliably control annual ryegrass and wild radish in fallow is of real concern.

Aims

- To assess herbicide treatments on mixed winter weeds in an early and long spray fallow.
- To identify alternative herbicides to control weeds that have, or are developing, resistance to traditional herbicides used in winter weed control.
- To identify possible alternative herbicide mixtures that could be effective in a low area selective spot spraying scenario with Weedseeker technology.
- To identify other modes of action for control of resistant weeds other than glyphosate.

Method

Herbicide application

- Trials sprayed with hand booms — 2 m wide, with Agrotop airmix 110 01 nozzles at 2 bar, 4 km/h at 98 L/ha (similar application rates and droplet composition as the Weedseeker).
- Herbicides applied from 1 pm–5 pm during mild, dry winter spraying conditions — 15–17^{o}C), 50% relative humidity (RH), Delta T 5, wind 8–10 km/h south-westerly, (typical of grower application window during winter, late post-emergent spraying.
- Herbicide mixtures prepared the evening before and stored in two-litre plastic containers.

Weeds

- Brome grass (*Bromus* spp.) — late tillering 150–200 mm diameter.
- Annual ryegrass (*Lolium rigidum*) — late tillering 150-200 mm diameter.
- Volunteer barley late tillering — 15-25 mm diameter.
- Wild radish (*Raphanus raphanistrum*) 200–500 mm diameter, rosette to early flowering (suspected multiple group resistance).

Herbicides used

- Glyphosate 450 g/L, Gramoxone® 250g/L, Basta®, Alliance®, Ally®, Grazon®, Hammer®, Estericide 680, Hotshot®, Striker®, Spray.Seed®, Atrazine 600g/L, Glean®, BS1000 wetting agent.

Results

Table 1. Ratings of herbicide efficacy at nine and 35 days after application (DAA)

(Control ratings 1=poor, 10=excellent)

							Brome		Annual ryegrass		Wild radish	
Treat-ment	Rate	Product	Rate	Product	Rate	Product	(1-10)		(1-10)		(1-10)	
	ml/ha		ml, g		ml, g		9	35	9D	35	9	35
1	2000	GLYPHOSATE CT					5.67	9.67	5.33	9.67	4.67	3.33
2	4000	GLYPHOSATE CT					5.00	10.00	5.33	9.67	5.33	8.33
3	2000	GRAMOXONE					9.00	10.00	8.00	4.67	5.67	1.33
4	4000	GRAMOXONE					9.00	9.67	8.67	7.33	6.67	1.33
5	2000	SPRAYSEED					9.00	9.33	7.00	6.00	5.33	2.67
6	4000	SPRAYSEED					9.00	10.00	8.67	9.00	7.33	1.67
7	2000	GRAMOXONE	800	ESTER 680			9.00	10.00	9.00	9.00	7.67	3.67
8	2000	GLYPHOSATE CT	800	ESTER 680			5.00	9.33	5.33	10.00	4.67	8.67
9	2000	SPRAYSEED	800	ESTER 680			9.00	9.33	7.67	4.33	6.00	2.67
10	0	NIL					0.00	0.00	0.00	0.00	0.00	0.00
11	2000	GLYPHOSATE CT	2000	Atrazine			3.67	6.00	4.00	9.00	5.33	7.33
12	2000	SPRAYSEED	2000	Atrazine			8.67	10.00	8.00	5.00	7.33	1.00
13	2000	SPRAYSEED	2000	Atrazine	800	ESTER 680	8.67	9.67	8.00	7.33	8.33	6.00
14	2000	GLYPHOSATE CT	2000	Atrazine	800	ESTER 680	3.00	6.67	3.00	6.33	3.00	3.67
15	2000	GLYPHOSATE CT	800	Ester 680	10g	Ally	5.00	9.00	5.33	9.33	4.33	8.33
16	2000	GLYPHOSATECTI	800	Ester 680	50	HAMMER	4.67	9.00	5.33	10.00	3.33	8.67
17	4000	BASTA					5.67	3.33	6.00	2.33	2.67	2.33
18	8000	BASTA					6.33	6.33	6.00	6.00	6.33	2.00
19	2000	GLYPHOSATE CT	3000	HOTSHOT			5.67	8.67	5.00	7.67	2.33	3.67
20	20g	ALLY					0.33	0.00	0.33	0.00	0.67	1.00
21	4000	GLYPHOSATE CT	20g	ALLY			5.00	9.67	5.33	9.67	4.33	5.67
22	2000	GLYPHOSATE CT	800	Ester 680	30g	GLEAN	5.00	8.67	4.33	10.00	3.33	6.33
23	2000	SPRAYSEED	800	Ester 680	10g	Ally	8.67	9.67	8.67	6.67	7.67	2.67
24	4000	GLYPHOSATE CT	50	HAMMER			5.00	9.33	4.67	9.00	3.67	4.67
25	4000	ALLIANCE					9.00	9.33	9.00	7.00	7.00	1.33
26	4000	ALLIANCE	800	Ester 680			9.00	10.00	9.00	8.67	7.00	3.33
27	4000	GLYPHOSATE CT	100	STRIKER			5.33	9.33	5.67	9.67	4.67	4.67
28	4000	GRAMOXONE	250	STRIKER			9.00	10.00	9.00	9.67	6.67	1.33
29	4000	GRAMOXONE	3000	HOTSHOT			9.00	10.00	9.00	9.00	7.00	1.67
30	2000	GLYPHOSATE CT	300	Grazon			5.33	8.00	5.67	6.33	2.67	4.33
31	4000	GLYPHOSATE CT	500	Starane			5.00	9.33	5.67	10.00	3.00	2.33
32	2000	GRAMOXONE	500	Starane			9.00	10.00	9.00	8.33	6.33	2.67
33	2000	GRAMOXONE	500	Starane	1000	Atrazine	8.67	10.00	8.00	6.00	6.33	2.33
34	2000	STRIKER					0.67	0.00	0.67	0.00	1.67	0.00
						LSD 0.01	3.44	6.86	3.44	6.25	3.63	4.54
						LSD 0.05	2.58	5.16	2.59	4.70	2.72	3.41
						CV	44.30	68.80	46.49	73.80	58.50	91.67

All treatments applied with 0.1% BS1000

Brome grass

Glyphosate at 2 L and 4 L/ha, Gramoxone and Spray.Seed at 2 L and 4 L/ha and Alliance at 4 L/ha provided acceptable control of tillering brome grass in the spray fallow situation. Addition of 2 L atrazine (600gai) to 2 L of glyphosate (no Amsul added) caused a large reduction in brome control. Addition of Ester 680 to this mix (trt 14) also provided less control due to the apparent biological antagonism. Addition of 2 L atrazine to 2 L Spray.Seed improved final brome control from 93% to 100%. Basta does not appear to have a fit in this situation at either 4 L or 8 L/ha. Use of much higher rates through a spot-spraying system may be effective and could provide resistance management options. Addition of 100 ml Striker (oxyflurofen) to 4 L glyphosate did not appear to improve brome control.

Annual ryegrass

Applications of 2 L and 4 L of glyphosate provided the best levels of control on annual ryegrass. Rates of 2 L and 4 L of Gramoxone or Spray.Seed and 4 L Alliance provided impressive initial burndown of ryegrass, but significant regrowth occurred after this and control was ultimately unacceptable. Addition of 250 ml of Striker to the 4 L of Gramoxone treatment did not improve ryegrass control. Striker alone at 2 L/ha was ineffective on annual ryegrass.

Wild radish

Control of wild radish in this population proved quite difficult with herbicides in the winter spray fallow scenario. Very poor control with 20 g Ally shows that this population is tolerant to the common group B herbicide metsulfuron-methyl. Unacceptable radish control was achieved with 2 L glyphosate (450gai). The 4 L/ha of glyphosate (450gai) treatment achieved the second-highest level of control, which is supported by in-field observations from other agronomists and growers that high rates of glyphosate are needed to control multiple-resistant radish plants.

Addition of 800 ml of 24-D Ester 680 to 2 L of glyphosate improved control of wild radish from 33% to 87%, showing that there was still some reasonable additive control from this tankmix. However, on a totally-susceptible population, this herbicide mix would be considered an effective lethal rate.

Addition of 50 ml Hammer (carfentrazone) to the 4 L of glyphosate treatment reduced radish control from 83% to 47%. Clearly the use of rapid burndown herbicides such as Hammer did not allow for sufficient translocation of glyphosate in these bright, sunny conditions and regrowth of the radish occurred. The addition of 50 ml Hammer to the 2 L glyphosate and 800ml Ester 680 mix did not cause any reduction in efficacy on radish, suggesting the presence of 2-4D is required in the mix if Hammer needs to be added for weed control of other species. Addition of 100 ml of Striker to the 4 L of glyphosate mix reduced radish control from 83% to 47%, suggesting that the burndown effect of Striker reduced glyphosate translocation and efficacy.

Treatments containing the bipyridils (Paraquat or Diquat) provided impressive initial burndown of wild radish, but ultimately only served to remove the bulk of other weeds in the sward and allowed the radish to regrow relatively uncontested with access to more soil resources. Final radish control was no different when comparing Gramoxone and Sprayseed at the 2 L and 4 L rates. However, initial burndown at nine days after application (DAA) was slightly better when Spray.Seed was used. Interestingly, the addition of 20 g of Ally to the 4 L/ha of glyphosate treatment reduced radish control from 83% to 57%. Considering that the 20 g of Ally treatment alone gave very poor control (7%) of radish, the reduction in control (not significant at $p<0.05$) suggests some level of biological antagonism between the high rate of Ally and the efficacy of the glyphosate on this population.

Further work is needed on the relative efficacy of glyphosate on wild radish when multiple or stacked genetics for herbicide resistance is present. In-field observations from other agronomists (Bostock pers.comm, 2010) suggest that wild radish resistant to several herbicide groups is more difficult to kill with glyphosate than a totally-susceptible individual.

Discussion

Careful consideration of herbicide mode of action (MOA) and herbicide resistance status is required for resistant weed populations. Using high rates of herbicides in mixtures may increase the level of biological antagonism between the herbicides acting on different pathways in the plant.

Caution is required when using dessicant or non-systemic herbicides in winter fallow situations, as removal of some weeds and subsequent additional stored soil moisture allows for rapid regrowth of weed survivors. Use of rapid burndown contact herbicides in a mix with systemic herbicides must be carefully considered, as reduced translocation may occur when burndown activity is fast in bright sunny conditions.

Key Words

Weedseeker, selective spot spraying, wild radish, annual ryegrass, winter fallow

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Peter Newman, Department of Agriculture and Food, Western Australia (DAFWA), Tim and Daniel Critch, Wyalong Pastoral Co and Peter Bostock, Landmark.

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Paper reviewed by: Peter Newman

Management of emerging weeds within the Western Australian wheatbelt

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Key Messages

- A lupin–wheat rotation provided effective suppression of barley grass (compared to a wheat–wheat or wheat–lupin rotation). The herbicides used in the lupin crop provided excellent suppression of barley grass. Herbicides used in the wheat crop during 2010 (Sakura 850 WG/ Monza®) also suppressed barley grass where density was low. These herbicides provided poor control where barley grass population was dense, probably due to dry seasonal conditions.
- Sakura 850 WG, Boxer Gold® and Triflur Xcel® provided equivalent suppression of brome grass plants in a wheat crop at five weeks after emergence. However, Sakura 850 WG suppressed weeds seed head production to the greatest extent, followed by Boxer Gold and then Triflur Xcel.
- When using a disc system where stubble is present at seeding, Sakura 850 WG and Triflur Xcel appeared safer for the crop than Boxer Gold. However, all pre-seeding herbicides caused injury to the crop, as rainfall occurred after seeding and the trial used a short coleoptile variety of wheat (i.e. a variety highly susceptible to herbicide damage). When using a knife-point system none of the herbicides caused crop damage.
- Boxer Gold was significantly more effective in suppressing silver grass than Triflur Xcel, and Boxer Gold increased wheat yield by 7–17% compared with Triflur Xcel.
- Brome grass, silver grass and wild oat seed collected from populations growing within cropped fields showed greater dormancy than seed collected from populations growing on the adjoining roadside.

Aims

The aim of this study was to understand seed dormancy behaviour and develop effective management strategies for emerging weed species, such as barley grass, brome grass and silver grass.

Method

Weed seed dormancy

Brome grass (*Bromus diandrus*), silver grass (*Vulpia myuros*) and wild oat (*Avena fatua*) seed was collected during December 2009 from the centre or edge (roadside/fence line) of a cropping paddock (in Beverley and Cunderdin, Western Australia). Seed dormancy was investigated by placing seeds on moist filter paper within petri dishes (100 seeds per dish, three replications) maintained at a 12-hour temperature cycle of 25/15°C, and monitoring germination for a 60 day period. This experiment was repeated on a monthly basis from December 2009 to July 2010.

Barley grass trials

A two-year trial (2009–2010) was established at Beverley, WA (plot size of 2 m by 4 m, four replications), in a paddock containing a naturally-occurring infestation of barley grass (*H. leporinum*). Crop rotations during the two year period included wheat–lupin, lupin–wheat and wheat–wheat (wheat cv Eagle Rock during 2009 and Magenta during 2010, lupin cv Mandelup during both years). Crops were sown on May 25, 2009 and May 18, 2010. Herbicides are indicated in Table 1. Note that Sakura® is a registered product of Bayer. Sakura 850 WG is not currently registered in Australia but an application has been made for registration. The untreated control plots in 2009 remained as the untreated control plots in 2010. In both years, soil moisture was adequate at seeding. However, during 2010 the soil surface was relatively dry in the weeks following seeding. The site was not grazed or burnt during the two-year period and there were no summer or autumn cultivation events, before crop seeding. In both years, barley grass plant density was counted at five weeks after crop emergence (WAE) and barely grass suppression was visually assessed at flowering. Barley grass head number was counted during 2010. At harvest, grain yields of wheat and lupin ere recorded in both years.

Brome grass trial

A two-year trial (2009–2010) was established at Northam, WA (plot size of 2 m by 4 m, four replications), in a paddock containing a naturally-occurring infestation of brome grass. During 2009, herbicide treatments were applied and incorporated by seeding wheat cv Wyalkatchem on June 11, 2009 under three methods (single disc, knife point or minimum tillage) in the presence or absence of wheat stubble. Monza® at 25 g/ha was applied post-emergence (PO) across one half of all plots to suppress grass weeds. During 2010, all plots were treated with Sakura 850 WG (except for the herbicide-free control plots) (see Table 2). Sakura 850 WG was incorporated by seeding wheat cv Magenta (using a disc system) in all plots on June 3, 2010. Measurements in both years included brome grass plant number (at five WAE), brome grass head numbers (at the heading stage), crop phytotoxicity and crop grain yield.

Silver grass trials

Two separate trials (during 2008 and 2009) were carried out in a Beverley paddock (plot size of 2 m by 4 m, four replications) with a high infestation of silver grass. Wheat cv Calingiri was sown on May 30, 2008 and on June 5, 2009. Pre-seeding herbicide treatments were applied during each year (see Table 3). Untreated control plots were included in both trials. In each trial, silver grass head number was counted at flowering and grain yield was recorded at harvest. Weed density, crop vigour and crop damage were also recorded but results are not presented.

Results

Weed seed dormancy

For all three species, 85% to 100% of the seed was dormant at the time of collection (see Figure 1, 0 days after collection or DAC). Maximum germination occurred during June (180 DAC) for brome grass (85–90% germination), during July (210 DAC) for silver grass (45% germination of the crop field seed, 87% of the roadside seed) and July (210 DAC) or April (120 DAC) for the wild oat crop field seed (25% germination) or roadside seed (75% germination). In all three species, seed from the crop fields had greater dormancy than seed from the roadside. For brome grass seed, the difference in germinability was most evident from 60 to 150 DAC. For wild oat roadside seed, greater germinability was apparent from 0 DAC. For brome grass, seed from the crop field did not start to germinate until March (90 DAC), while the roadside population showed 49% germination during January (30 DAC).

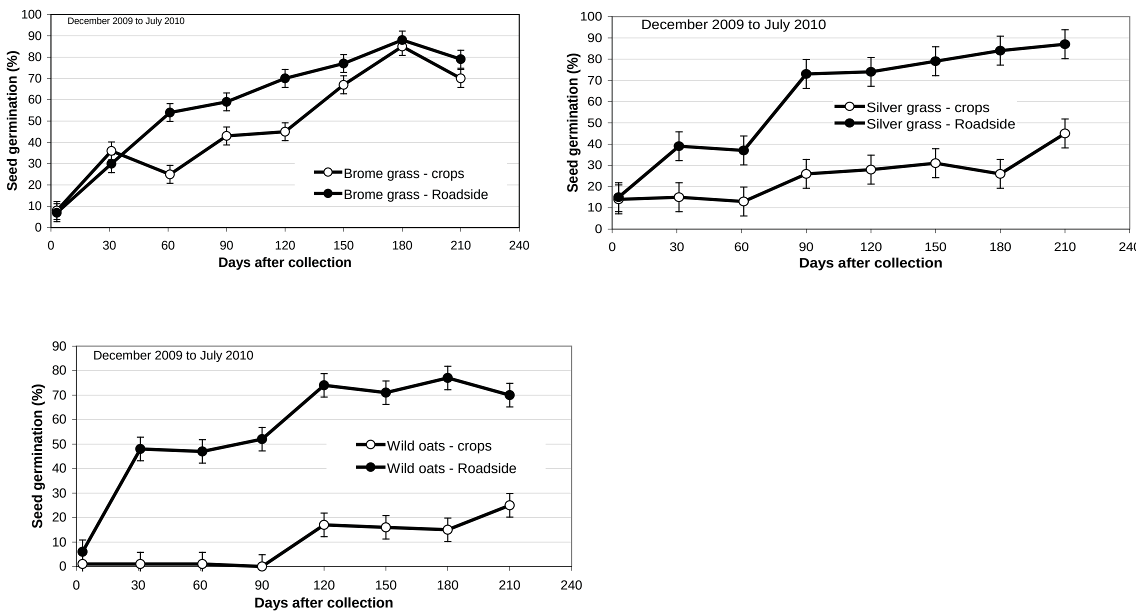

Figure 1. Germination of brome grass, silver grass and wild oat seed, from 0 to 210 days after collection from a population within a crop or growing on the adjoining roadside.

Barley grass suppression

Barley grass suppression in the lupin–wheat rotation was significantly greater than that of the wheat–lupin or wheat–wheat rotation. As a result, yield of both crops in the lupin–wheat rotation was greater than yield in the other rotations (see Table 1). The herbicides used in the lupin crop (metribuzin® or Simazine®, followed by Select®) provided excellent suppression of barley grass (87–92% in the lupin–wheat rotation during 2009, 92% in the wheat–lupin rotation during 2010). In the lupin–wheat rotation, the initial lupin rotation during 2009 reduced the density of the barley grass population to the extent that the herbicides used in wheat during 2010 could also provide effective control (83–88% suppression during 2010). Where herbicides in wheat crops were used against a dense population of barley grass (in the wheat–lupin or wheat–wheat rotation), weed suppression was poor. Sakura 850 WG is highly effective against barley grass in normal seasonal conditions and it is likely that Sakura 850 WG performance during 2010 was negatively affected by the dry conditions, making this herbicide (and the post-emergent Monza application) less effective against dense populations of barley grass.

Table 1. Effects of herbicides (Metribuzin® 750 150g/ha, Monza® 25 g/ha, Select® 250 mL/ha during 2009 and 500 mL/ha during 2010, Sakura 850 WG 118 g/ha, Simazine® 900 WG 1.1 kg/ha, Triflur Xcel® 2 L/ha) in three crop rotations on initial barley grass suppression, barley grass head number and crop yield at Beverley during 2009 and 2010

Crops and herbicides (where the first herbicide was applied pre-seeding and the second herbicide applied post-emergence)		Weed suppression (%)		Barley grass (heads/m²)	Wheat/lupin yield (kg/ha)	
2009	2010	2009	2010	2010	2009	2010
1. Wheat (Metribuzin/Monza)	Lupin (Simazine/Select)	51	92	44	1376	448
2. Wheat (Triflur Xcel/Monza)	Lupin (Simazine/ Select)	40	92	40	1246	486
3. Untreated	Untreated	0	0	1212	468	81
LSD (5%)		7.9	7.9	23.7	348.7	170.1
1. Lupin (Metribuzin/Select)	Wheat (Sakura 850 WG/ Monza)	87	88	118	1619	2226
2. Lupin (Simazine/Select)	Wheat (Sakura 850 WG/ Monza)	92	83	90	1298	2084
3. Untreated	Untreated	0	0	859	481	370
LSD (5%)		20.6	17.6	377.4	219.5	206.8
1. Wheat (Metribuzin/Monza)	Wheat (Sakura 850 WG/Monza)	51	50	802	1376	1353
2. Wheat (Triflur Xcel/Monza)	Wheat (Sakura 850 WG/Monza)	39	53	663	1246	1258
3. Untreated	Untreated	0	0	1352	468	196
LSD (5%)		7.7	9.4	525.2	246.1	236.8

Brome grass suppression

During 2009 early crop phytotoxicity was apparent for all pre-seeding herbicide treatments in the retained stubble plots sown using a disc system, with the greatest damage resulting from the Boxer Gold treatments (48%), compared with the Sakura 850 WG (14%) or Triflur Xcel treatments (18%, $P < 0.005$, LSD: 7.7). The knife-point system did not cause a significant level of crop phytotoxicity (5% or less for all herbicides). Wyalkatchem wheat (grown during 2009) is a short coleoptile variety, and so is prone to pre-seeding herbicide damage, in years like 2009 where rainfall causes movement of the herbicide into the seeding furrow. This result highlights the need to maintain positional selectivity of the herbicide in the soil profile. Phytotoxicity was not observed during 2010.

Brome grass density and head number in the untreated plots was 156–125 plants/m^2 and 298–226 heads/m^2, in 2009–2010. During 2009, all herbicides provided an equivalent reduction in brome grass numbers at five WAE, but seed head production was the lowest in Sakura 850 WG plots, and lower in Boxer Gold plots compared with Triflur Xcel. During 2010 (when Boxer Gold was not included in the trial), Sakura 850 WG again

provided effective suppression of brome grass. Weed suppression by Sakura 850 WG during 2010 was slightly less effective where weed density was high, due to poor suppression by Triflur Xcel during 2009. Herbicide effectiveness during 2010 was probably reduced due to the dry seasonal conditions. Herbicides increased wheat grain yield by 10–16% during 2009 and 23–31% during 2010, compared to the untreated control (see Table 2). Yield of wheat following application of Boxer Gold during 2009 was slightly reduced compared with Sakura 850 WG, possibly due to the initial crop phytotoxicity observed in the disc seeding system. Despite the early crop phytoxicity observed in this seeding system, final grain yield for Boxer Gold was not significantly different to Triflur Xcel.

Table 2. Effect of pre-seeding herbicides on brome grass density, seed head production and wheat yield in a wheat–wheat rotation during 2009 and 2010

Herbicide treatments		Brome grass (plants/m^2)		Brome grass (heads/m^2)		Wheat yield (kg/ha)	
2009	2010	2009	2010	2009	2010	2009	2010
Boxer Gold 2.5 L/ha	Sakura 850 WG 118 g/ha	81	31	111	64	2531	1848
Sakura 850 WG 118 g/ha	Sakura 850 WG 118 g/ha	85	29	48	63	2781	1920
Triflur Xcel 2 L/ha	Sakura 850 WG 118 g/ha	101	83	169	104	2590	1723
Untreated	Untreated	156	125	298	226	2332	1318
LSD (5%)		27.8	18.1	56.2	36.4	195.8	200.1

Silver grass suppression

Silver grass head numbers in the untreated control was 304/m2 during 2008 and 651/m2 during 2009. Boxer Gold suppressed 83% and 82% of silver grass heads during 2008 and 2009, and Triflur Xcel suppressed 76% and 72% of silver grass heads (see Table 3). The mixture of Triflur Xcel plus Avadex Xtra did not improve silver grass head control compared with Triflur Xcel alone in either year. Weed control by Boxer Gold significantly increased wheat yield over the untreated control both during 2008 and 2009 (18%–27%). Triflur Xcel or a mixture of Boxer Gold + Triflur Xcel increased wheat yield over the untreated control during 2009 only. The grain yield of wheat in the mixture of Boxer Gold + Triflur Xcel was significantly lower than the yield from Boxer Gold alone, even though this mixture provided better suppression of silver grass than Boxer Gold alone during 2008. Therefore, this mixture may have caused some crop injury, even though crop emergence and crop vigour appeared to be unaffected by herbicides in either year. Sakura 850 WG was not included in the trial, but an application has been made for registration on silver grass.

Table 3. Effect of herbicides on suppression of silver grass and crop yield at Beverley during 2008 and 2009

Herbicide treatments	Silver grass head suppression (%)		Wheat yield (kg/ha)	
	2008	2009	2008	2009
Boxer Gold 2.5 L/ha	83	82	3822	3502
Triflur Xcel 1.45 L/ha	76	72	3550	2891
Boxer Gold 2.5 L/ha + Triflur Xcel 1.45 L/ha	92	85	3125	3029
Triflur Xcel 1.45 L/ha + Avadex Xtra 1.6 L/ha	79	67	3543	2658
Untreated	0	0	3140	2569
LSD (5%)	4.9	9.2	561	296

Discussion

Barley grass was most effectively suppressed in a lupin–wheat rotation. The superior weed suppression in this rotation maximised the yield of the lupin and wheat crops, compared with other rotations. Barley grass suppression was significantly lower in the wheat–wheat or wheat–lupin rotation (with wheat yields in the wheat–wheat rotation 54%–76% lower than those of the lupin–wheat rotation).

Initial suppression of brome grass by Boxer Gold, Sakura 850 WG and Triflur Xcel was equivalent in a wheat–wheat rotation. However, seed head production was the lowest in Sakura 850 WG plots. Where stubble was present, crop injury occurred if pre-seeding herbicides were applied using a single-disc seeding system (due to heavy rainfall after seeding and use of a short coleoptile variety) rather than a knife-point seeding system.

Boxer Gold controlled significantly more silver grass heads than Triflur Xcel and increased wheat yield by 7%–17% compared with Triflur Xcel. A mixture of Boxer Gold and Triflur Xcel improved silver grass suppression but resulted in lower grain yield, presumably due to some degree of crop injury.

Brome grass, silver grass and wild oat populations growing in a crop paddock produce seed with greater dormancy than those populations growing along the roadside. Different levels of dormancy may cause roadside and field populations to germinate at different times. Therefore, weed control strategies will need to be timed to target different populations, to remove weeds within the field and on the roadside.

Key Words

Seed dormancy, Boxer Gold, Sakura 850 WG, barley grass, brome grass, silver grass, wild oat, rotation, weed suppression

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Integrated weed management (IWM) — it's all about early sowing of a big crop

Peter Newman

Department of Agriculture and Food, WA

Key Messages

Computer simulation and grower case studies show that integrated weed management (IWM) can be used to manage ryegrass effectively within early sown crops even without a pre-seeding knockdown herbicide.

Aims

To determine whether under a continuous cropping situation in Western Australia, grain growers can realise the yield benefits of early seeding (without a knockdown herbicide) by using enough integrated weed management (IWM) to maintain a low ryegrass seed bank.

Method

Computer simulation — ryegrass integrated management (RIM)

Using the latest version of the ryegrass integrated management (RIM) model we investigated the effectiveness of IWM to manage the ryegrass seed bank in a medium- to high-rainfall environment within a lupin:wheat:canola:wheat rotation over 10 years. RIM assumes that year 0 is a wheat crop. The starting weed seed bank was 100 ryegrass seeds/m^2 in the soil during March. All lupin crops assumed Simazine pre-seeding and Select (clethodim) post-emergent at full label rates. All canola crops received Atrazine pre-seeding and Select (clethodim) post-emergent at full label rates.

The initial run was a herbicide-dominant scenario where trifluralin was applied every year and all crops received a knockdown herbicide (double knockdown for wheat crops). Trifluralin application for scenario two was reduced to being applied every second year in wheat crops only. From here on, additional IWM techniques were added one at a time to a point where the ryegrass seed bank was being eroded (scenarios 3 to 5). At this point, knockdown herbicides were removed from the full IWM package to determine the impact on the ryegrass seed bank and profitability (scenarios 6 and 7). The final scenario was carried out to represent a realistic, herbicide-dominant, farming system where lupins and canola are dry sown, trifluralin is applied every year, wheat crops receive a knockdown, which results in some wheat crops having delayed seeding (due to waiting for a pre-seeding knockdown).

Table 1. Assumptions used for all runs of RIM model

Wheat yield (wheat-on-wheat yield) t/ha and price	2 t/ha; $250/t
Lupin yield and price	1.8 t/ha; $200/t
Canola yield and price	1.3 t/ha; $400/t
Trifluralin ryegrass control — average of trials at 1.5 L/ha	75%
Simazine ryegrass control — estimated	50%
Atrazine ryegrass control — estimated	60%
Select (clethodim) ryegrass control — assumes some resistance	90%
Crop-topped lupin — ryegrass seed set control (assumes 20% crop phyto-toxicity)	75%
Spray/swath canola (glyphosate) ryegrass seed set control	70%
Chaff cart ryegrass seed removal of total ryegrass seeds in paddock	60%
Knockdown herbicide — % control of total seed bank	35%

Grower survey

127 growers were surveyed during 2010 using KeePad technology at seven grower meetings throughout Western Australia (Mingenew, Pingelly, Corrigin (x2), Hyden, Wubin and Kojonup) to assess attitudes and adoption of weed-seed management during harvest.

Results

Table 2. Results of RIM (computer simulation of ryegrass seed bank) runs showing ryegrass seed bank (annual ryegrass seeds/m² in soil during March) and average annual profit ($/ha) for a range of weed management scenarios

	Scenario	1	2	3	4	5	6	7	8
	IWM level	Nil IWM	Nil IWM	Increasing IWM	Increasing IWM	Full IWM	Full IWM	Full IWM	Nil IWM
	Trifluralin	Every year	Wheat only	Wheat only	Wheat only	Wheat only	Wheat only	Wheat only	Every year
	Knockdown	Every year	Every year	Every year	Every year	Every year	Wheat only	Nil	Wheat only
Year	**Crop**	**Nil IWM trifluralin every year**	**Nil IWM trifluralin every 2nd year**	**Plus Crop-topped lupin**	**Plus spray/swath canola (glyphosate)**	**Plus chaff cart every year**	**Minus knockdown lupin and canola**	**Nil knockdown (all crops)**	**Realistic comparison — delay seeding two wheat crops**
	Ryegrass seed bank (seeds in soil during March /m²)								
0	Wheat	100	100	100	100	100	100	100	100
1	Lupin	57	177	52	52	28	32	32	95
2	Wheat	177	537	161	161	38	44	62	215
3	Canola	82	710	219	77	10	13	19	176
4	Wheat	254	1961	659	239	14	18	38	532
5	Lupin	145	2933	328	123	4	6	12	495
6	Wheat	442	5961	967	376	5	8	24	1066
7	Canola	205	5715	1239	178	1	3	7	841
8	Wheat	617	8792	3151	539	2	3	15	2274
9	Lupin	349	8512	1317	271	1	1	5	1959
10	Wheat	1025	10594	3311	807	1	2	9	4498
Average annual profit ($/ha)		**230**	**150**	**186**	**208**	**212**	**216**	**225**	**156**

Table 2 summarises eight separate runs of the RIM computer model. Scenarios 1 and 2 describe a farming system with nil IWM that relies on herbicides only for ryegrass control. This leads to ryegrass blow-outs of 1025/m^2 (trifluralin every year) and 10,594 seeds/m^2 (trifluralin every second year) at the end of the 10-year crop rotation. The addition of three IWM tools (full IWM), crop topping lupin, spray/swath canola (glyphosate) and chaff cart, reduced the ryegrass seed bank to one seed/m^2 at the end of the 10-year crop rotation (see scenario 5).

Scenarios 1 to 5 all assumed that each crop received a knockdown herbicide pre-seeding. When this pre-seeding knockdown was removed from the full IWM package, the ryegrass seed bank at the end of 10-year crop rotation was nine seeds/m^2 (see scenario 7). Scenario 8 was included as a realistic comparison to the full IWM package with nil knockdown (scenario 7). The RIM computer model gives no time of seeding benefit to crops sown without a knockdown herbicide. Scenario 8 relies on herbicides only for weed control, assumes that lupin and canola are sown without a pre-seeding knockdown herbicide, and assumes that two wheat crops were delayed seeding by 10 days to account for waiting for a germination for a knockdown herbicide. The 10-day delayed seeding incurred a 10% yield reduction of those wheat crops. The seed bank of scenario 8 at the end of the 10-year crop rotation was 4498 seeds/m^2 with an annual profit of $156/ha compared with nine seeds/m^2 and annual profit of $225/ha for scenario 7.

Case study

Lance Turner – East Pingelly

Lance Turner presented this case study to growers on a three-day 'road-show' during 2010 (Wubin, Corrigin and Kojonup) promoting the benefits of weed seed management at harvest.

Continuous 100% crop since 1990. Lupins: wheat: wheat: canola: barley: barley rotation

Lance has been continuous cropping since 1990. During 1992 resistant ryegrass was discovered on his property. As resistance built up over the years, so did his ryegrass numbers. He was advised that the only way to manage his weeds was to start dropping paddocks out. After attending a RIM workshop, he realised the only way to make his system work was to tow a chaff cart.

Lance seeds by the calendar – starts seeding around April 20 each year. This is necessary due to his farm being made up of three blocks spread across 65 km. He applies trifluralin by spray line mounted to the front of the seeder, so no need for a boom spray during dry seeding. This also means the boom spray does not have to be in the same place as the seeder on the day of seeding. All lupin crops are crop topped (paraquat) and canola is swathed.

Lance has towed a chaff cart for seven harvests now (two chaff carts during 2010). His chaff carts use a conveyor belt system to deliver chaff into the chaff cart as opposed to the conventional system that involves a cross-auger/air-driven system. The main benefit, Lance says, is that with the conveyor belt system a small amount of straw ends up in the chaff heaps. This means that heaps burn out in eight to 12 hours rather than two to three days for conventional chaff dumps. This small amount of straw also makes it possible to bale the chaff heaps to generate extra revenue during dry seasons, when there is a market for roughage. The other benefit is there are very few modifications to the header making it easy to connect the chaff cart to a new header.

Seven years on and Lance has low ryegrass numbers and he is still continuous cropping. He believes that seeding by the calendar is only made possible by the fact that he has integrated a chaff cart with other weed management techniques to achieve a low weed seed bank.

Grower survey

Of 127 growers surveyed about harvest weed seed management, 10 are currently towing a chaff cart. A total of 28 of the growers surveyed indicated they are considering investing in a chaff cart in the near future. Seventy-three of the growers surveyed are currently practicing windrow burning of header trails to destroy weed seeds. In total, 65% of the growers surveyed are currently practicing some form of weed seed management at harvest. Thirty-three of the growers surveyed indicated they planned to buy a Harrington Seed Destructor when it comes to market. Seventy-one growers supported the Eagles while only 25 supported the Dockers. There was no correlation between farm size and football team. Sadly there were no Carlton supporters.

Discussion

It has taken me 10 years to work out what IWM is all about. During 2010 it became clearly apparent, that growers with low weed-seed banks could seed early without the need to wait for a germination of weeds. These growers have very few, if any, livestock and are consequently seeding the entire farm to crop. This is where money can be made by investing in IWM. WA grain growers should now be convinced herbicides alone are not capable of doing the job.

Computer simulation of ryegrass seed bank using the RIM model suggests it is possible for growers to realise the benefits of early seeding without a ryegrass blow-out if they use enough IWM.

Scenario 1 represents a situation where no IWM is used and trifluralin is applied to every crop every year (see Table 2). This scenario is profitable but results in increasing ryegrass numbers and is likely to be a fast track to trifluralin resistance. This scenario is also not very realistic because it assumes every crop receives a knockdown herbicide every year. Scenario 2 shows that reducing the frequency of trifluralin use leads to a ryegrass blow-out of more than 10,000 seeds/m^2.

Scenarios 3 to 5 demonstrate that through the addition of IWM tools that focus on stopping seed set or removing weed seeds, the ryegrass seed bank can be managed to a point where it starts to decline. As each IWM tool is added, the ryegrass management improves. But it is the final addition of the chaff cart that makes the system really work (see Table 2). The use of the caff cart in this paper is as an example only. A similar result could be achieved using alternative technology, such as windrow burning of all crops (for lower rainfall environments), baling direct from the header or towing the Harrington Seed Destructor when it comes to market.

Scenarios 6 and 7 then show that a knockdown herbicide is not essential where a robust IWM system is in place. In scenario 7 none of the crops receive a knockdown and the ryegrass seed bank is in decline (see Table 2). What is really happening here is that the seed bank is so low that a knockdown would only be applied to a low number of weeds. The weeds that do persist in crop are targeted either pre-harvest (crop topping/spray swathing) or at harvest (chaff cart). In other words, the knockdown is applied at the end of the season rather than the start.

Scenario 7 appears profitable compared with the other scenarios. However, scenario 1 where trifluralin is abused, appears to be similarly profitable. The RIM model does not take into account the time of seeding benefit of scenario 7 (nil knockdown) compared with scenario 1 where seeding must be delayed to achieve a knockdown every year. Scenario 8 was included as a realistic comparison to the full IWM package. Scenario 8 is a nil IWM package that assumes that trifluralin is applied every year, lupin and canola are early sown (without a pre-seeding knockdown) and all wheat crops receive a pre-seeding knockdown. To achieve this knockdown, some of the wheat crops must be delayed seeding. So when the full IWM package is compared with a realistic farming system package (nil IWM), the full IWM package is much more profitable ($225/ha compared with $156/ha) and has much better weed management (nine ryegrass seeds/m^2 compared to 4498 ryegrass seed / m^2 at the end of the 10-year rotation).

Clearly this is computer simulation, it is not real life, so consider the results with caution. However, the case study of Lance Turner shown here, and many more like it (see Peter Newman, *Focus paddock* Crop Updates paper, 2009), are demonstrating that growers who take an aggressive approach to IWM are not only winning the battle against resistant weeds, they are improving their profitability through their ability to early seed a large area of crop every year.

Chaff carts are making a resurgence in WA and the addition of the conveyor belt technology is likely to add to their compatibility with our farming system (see survey results). Many growers are currently practicing windrow burning, crop topping lupins and spray swathing canola and new technology such as the Harrington Seed Destructor is just around the corner. We have the tools, all we need to do now is convince growers they are worthwhile!

Key Words

RIM, ryegrass, computer simulation, early sowing, integrated weed management (IWM)

Acknowledgments

Many thanks to Lance Turner for allowing me to report his case study and to Rob Grima for his input. Many thanks to the Grains Research and Development Corporation (GRDC) for their ongoing support of this research.

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Increased water rates improve the performance of trifluralin in minimum tillage systems

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Key Messages

- Trifluralin is less effective in minimum tillage systems due to increased stubble retention, but this problem can be alleviated by increasing water rates when applying trifluralin.
- Spray coverage increased from 4.8% to 22.6% at Cunderdin, Western Australia and 6.0% to 41.8% at Merredin, WA as water rates for application of Triflur Xcel® (at 2.5 L/ha) were increased from 30 L/ha to 150 L/ha.
- Annual ryegrass control increased from 7% to 71% at Cunderdin and 71% to 92% at Merredin, as water rates for application of Triflur Xcel were increased from 30 L/ha to 150 L/ha.
- The effect of increased water rate on annual ryegrass control was greater at Cunderdin than at Merredin, due to greater stubble height and biomass at Cunderdin.

Background and Aims

Trifluralin is heavily relied on for pre-emergent annual ryegrass control, particularly in no-till cropping systems. However, the increased stubble density in a minimum tillage system reduces the efficacy of pre-seeding herbicides. A proportion of the herbicide binds to the stubble, rather than reaching the soil surface where it can successfully kill emerging weeds.

The current label for Triflur Xcel® recommends water rates of 70–450 L/ha (broadcast basis), dependent on soil type and stubble coverage level, and further states that stubble coverage above 40% to 50% can reduce weed control below acceptable levels.

Minimum tillage systems commonly have stubble cover of more than 40% or 50%. This project investigated ways to improve trifluralin efficacy in minimum tillage systems by altering the method of herbicide application (switching from medium to extremely coarse spray quality nozzles or increasing the water rate) to improve product penetration through the stubble.

Method

Two trials were established in Cunderdin and Merredin, Western Australia (in a randomised block design, three replications, plot size of 2 m by 20 m), to examine the interaction of nozzle type and water rates on efficacy of trifluralin (see Table 1). Both sites contained evenly distributed wheat stubble from the previous crop. Stubble biomass at each trial site was assessed by collecting stubble from 10 randomly distributed quadrats (500 mm by 500 mm). Stubble height in each quadrat was also assessed. Stubble samples were dried at 40°C for three days. Stubble biomass was greater at Cunderdin (2267 kg/ha) compared with Merredin (1573 kg/ha) and the Cunderdin stubble was taller than the Merredin stubble. At both sites, about 35% of the stubble was standing, the remainder was lying flat on the ground (see Table 1).

The trial sites were sprayed with a knockdown herbicide. Treatments included Triflur Xcel (2.5 L/ha) sprayed at varying water rates, using medium or extremely coarse nozzles (see Table 1). Water rates were varied by altering the speed of spraying. Before applying Triflur Xcel, water-sensitive paper strips (Syngenta) were placed in each plot (seven per plot at Cunderdin and four per plot at Merredin). After spraying, paper strips were collected and dried. The Assess 2.0 program was used to determine percentage cover of herbicide on each spray paper strip (Assess 2.0 Image analysis software for disease quantification was developed by The American Phytopathological Society, Minnesota, 2008).

The crop was sown directly after spraying Triflur Xcel, using knife points and press wheels (see Table 1). The number of wheat plants was assessed across a 1 m length, three times per plot in Cunderdin and twice per plot in Merredin, approximately five weeks after seeding.

Annual ryegrass was assessed from three quadrats of 320 mm by 320 mm/plot in Cunderdin and five quadrats of 500 mm by 500 mm/plot in Merredin. Both sites experienced drier than average growing seasons during

2010. However, rainfall at the start of the season (May and June) was average and soil moisture was adequate for optimal performance of Triflur Xcel at the time of seeding. Therefore, while subsequent crop growth was affected by low rainfall, initial weed emergence and pre-seeding herbicide performance were not influenced by the dry season.

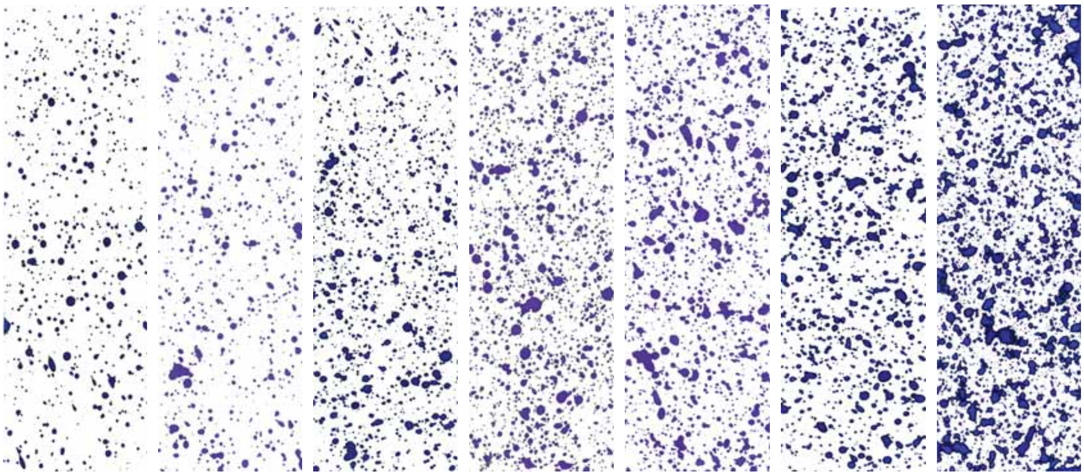
Table 1. The location of the two trials, soil type, knockdown herbicide application (herbicide type, rate and application date), stubble characteristics (height and dry biomass), Triflur Xcel application (date, herbicide rate, nozzle type, water rates and speed of application), and crop seeding operation (crop type, seeding rate, seeding depth, row spacing and fertiliser application)

Site	Cunderdin	Merredin
Location	Property of Chris Syme	DAFWA research station
Soil type	Grey sandy loam	Grey brown sandy loam
Knockdown herbicide and application date	Spray.Seed® (2 L/ha) on May 5, 2010, Roundup Power MAX® (1.5 L/ha) on June 2, 2010	Roundup Power MAX (1.5 L/ha) + Hammer® (40 m L/ha) on May 27, 2010
Stubble characteristics		
Stubble height	410 mm	225 mm
Biomass of standing stubble	785 kg/ha	578 kg/ha
Biomass of stubble lying flat on the soil	1482 kg/ha	995 kg/ha
Total stubble biomass	2267 kg/ha	1573 kg/ha
Application of Triflur Xcel (2.5 L/ha)		
Date	June 2, 2010	May 28, 2010
Nozzle type	Medium Teejet TT110015 at 0.59 L/min Extremely coarse Teejet TTI110015 (air-inducted) at 0.59 L/min Nozzles spaced at 500 mm on boom, sprayed at 3 bar (recommended pressure for these nozzle types ranges from 1 to 7 bar)	
Water rates (and speed of application)	0 L/ha (control treatment), 30 L/ha (24 km/h), 50 L/ha (14 km/h), 70 L/ha (10 km/h), 90 L/ha (7.8 km/h), 110 L/ha (6.4 km/h), 130 L/ha (5.4 km/h), 150 L/ha (4.7 km/h)	
Crop seeding details		
Crop	Wyalkatchem wheat at 70 kg/ha, 2–3 cm depth, 24 cm row spacing	Wyalkatchem wheat at 80 kg/ha, 2–3 cm depth, 23 cm row spacing
Fertiliser	Agras (100 kg/ha)	Agras (100 kg/ha)

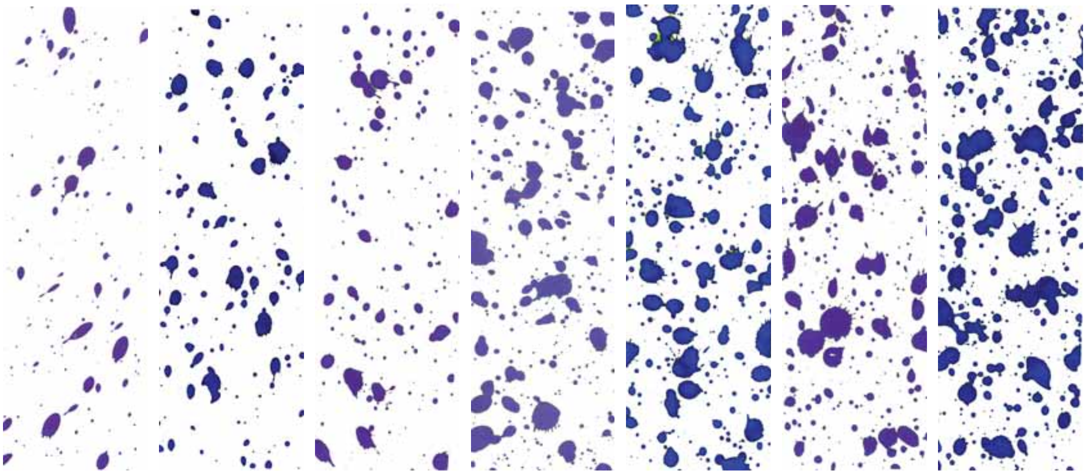
Results

Spray characteristics

The Triflur Xcel sprayed with medium and extremely coarse nozzles had varying droplet size (spray quality), as measured on the water sensitive strips (see Figure 1).



30 L/ha 50 L/ha 70 L/ha 90 L/ha 110 L/ha 130 L/ha 150 L/ha



30 L/ha 50 L/ha 70 L/ha 90 L/ha 110 L/ha 130 L/ha 150 L/ha

Figure 1. Spray droplet pattern from medium Teejet TT110015 nozzles (top) or extremely coarse Teejet TTI110015 nozzles (bottom), applying Triflur Xcel® at 2.5 L/ha, using 30 L/ha to 150 L/ha of water, at Merredin.

At Cunderdin, average percentage spray cover on each paper strip by the medium nozzle (15.9%) was significantly greater than by the extremely coarse nozzle (13.1%, $P < 0.001$, LSD: 0.9) (see Figure 2). There was also a significant interaction between nozzle type and water volume, with percentage spray cover ranging from 5.0% to 25.4% for the medium nozzle and 4.6% to 19.7% for the extremely coarse nozzle, as water rate increased from 30 L/ha to 150 L/ha ($P < 0.001$, LSD: 2.3).

At Merredin, average percentage spray cover by both nozzles was greater than that at Cunderdin, with an average of 25.4% and 20.6% spray cover by the medium and extremely coarse nozzles ($P < 0.001$, LSD: 1.7). Again, there was an interaction between nozzle type and water volume, with spray cover ranging from 6.9% to 50.4% for the medium nozzle and 5.0% to 33.2% for the extremely coarse nozzle, as water rate increased from 30 L/ha to 150 L/ha ($P < 0.001$, LSD: 4.6).

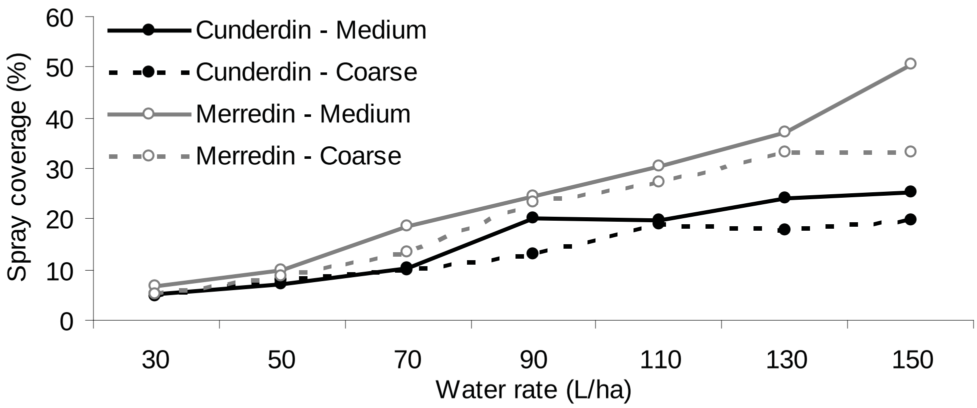


Figure 2. The percentage of each paper strip covered by Triflur Xcel, when sprayed with 30 L/ha to 150 L/ha of water, using medium Teejet TT110015 nozzles or extremely coarse Teejet TTI110015 nozzles, at Cunderdin and Merredin.

Plant density

At Cunderdin, annual ryegrass density averaged 100 plants/m^2 in the control plots. Annual ryegrass control significantly increased from 7% to 71%, as water rates increased from 30 L/ha to 150 L/ha (P: 0.002, LSD: 35). At Merredin, annual ryegrass density averaged 75 plants/m^2 in the control plots. Annual ryegrass control was greater than at Cunderdin, increasing from 71% to 92% (P: 0.007, LSD: 12) (see Figure 3). At both sites, control of annual ryegrass was not significantly different between nozzle types and there was no interaction between nozzle type and water rate.

Average crop density was 86 plants/m^2 at Cunderdin and 116 plants/m^2 at Merredin. At both sites, crop density was not affected by the herbicide treatments and there was no evidence of crop damage.

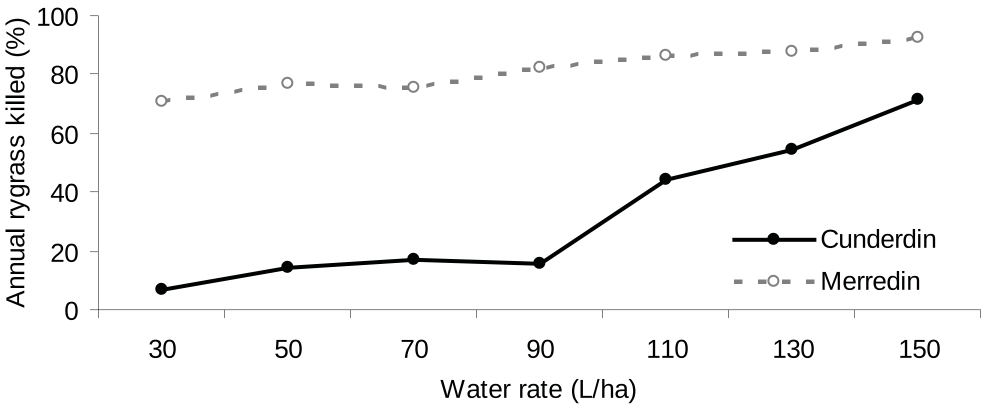


Figure 3. The percentage of annual ryegrass killed by Triflur Xcel at 30 L/ha to 150 L/ha of water, at Cunderdin and Merredin.

Discussion

Control of annual ryegrass improved as spray coverage of Triflur Xcel increased, due to increased water rates.

Spray coverage by the medium nozzles was slightly greater than by the extremely coarse nozzles, but this difference had no impact on weed control. Since extremely coarse nozzles will reduce spray drift, it is preferable to spray Triflur Xcel using extremely coarse nozzles. However, if Triflur Xcel is mixed with a knockdown herbicide, extremely coarse nozzles may be inappropriate.

At Merredin, there was a lower biomass of standing stubble and the stubble was shorter, compared to Cunderdin. Weed control was reasonably effective at all water rates (although still significantly improved

at high water rates). At Cunderdin, where the stubble height and biomass were greater, there was a larger impact of increasing water rates on annual ryegrass control.

This research confirms that the efficacy of Triflur Xcel is reduced by high stubble biomass, but this effect can be alleviated by increasing water rates. High water rates may not be appropriate if Triflur Xcel is mixed with knockdown herbicides. However, in areas with high annual ryegrass density, applying pre-seeding herbicides and knockdown herbicides separately, for optimal weed control, may be desirable.

It should be noted that adjusting the speed of spraying was the best way to investigate the impact of water rates in these trials, but in field conditions speed of spraying would be faster than speeds used here. Increased speed of spraying may cause droplets to travel at an angle, increasing the number of droplets that hit the standing stubble. Under these conditions, increased water rate will have an even greater impact on weed control by Triflur Xcel.

Key Words

Annual ryegrass, trifluralin, spray cover, water sensitive paper strips, droplet size, spray quality

Acknowledgments

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Paper reviewed by: Peter Newman and John Moore

Herbicide tolerance of new albus lupin WALAB2014 similar to or better than Andromeda

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Key Messages

- WALAB2014 tolerated a range of herbicides and herbicide mixtures at the recommended rates similar to or better than Andromeda.
- WALAB2014 registered low crop safety margin for simazine applied before crop seeding.
- WALAB2014 and Andromeda recorded low crop safety margin for Brodal® 100 mL mixture with Lexone® 150 g or Simazine 0.5L/ha applied at four-leaf stage.

Terbyne® (*Terbuthylazine*) — a new pre-emergent herbicide was tolerated well with good crop safety margin by both the varieties.

Aims

The aim of the trial was to identify herbicide sensitivities of the potential new albus lupin variety WALAB2014 to enable growers to reduce potential yield losses to herbicide damage.

Method

Location and year	Mingenew Irwin Group Heavyland site, 2010
Soil type, pH ($CaCl_2$) and OC (%)	Red sandy loam, 4.5 and 0.87
Trial design	Criss-cross, every 5th plot as untreated control
Varieties	Andromeda and WALAB2014
Plot size (net) and replications	10 m x 1.1 m (5 rows at 22 cm row spacing) and 3
Sowing date and seeding rate	June 2, 2010 and 100 Kg/ha
Seeding machinery and seeding depth	Cone seeder with knife points and press wheels, and 4–5 cm deep
Fertiliser	Super 100 kg/ha, applied with seed
Soil moisture at seeding 0–10 cm (Gravimetric method) 10–20 cm Rainfall with four weeks of seeding	6.3 % 6.4 % 103.4 mm
Herbicides application date: Before seeding, 2, 4 and 8 leaves Herbicide application machinery:	June 1, 2010, June 24, 2010, July 1, 2010 and July 23, 2010. Spray rig with shields on boom at a width of 1.5 m. Air-induction nozzles and 75 L/ha water volume used.
Visual observations scale: Visual observation dates:	0 to 100 %, where 0 = no visible injury and 100 = complete plant death June 21, 2010, July 6, 2010 July 19, 2010, August 4, 2010 and September 21, 2010
Blanket sprays:	Select® (Clethodim) 500 mL/ha on July 16, 2010 and Scud® (Cypermethrin) 400 mL/ha on September 3, 2010
Harvesting date:	November 11, 2010
Rainfall (mm): May – November	May June July Aug Sept Oct Nov Total 65.8 17 86.4 68.2 7 2.8 0.2 247.4

Note: In this trial a range of herbicides/mixtures were evaluated at maximum and higher than label rates. **Only results of label rates are presented here.** Low crop safety margin for a particular herbicide indicates that the variety tolerated the maximum label rate well, but at higher than the label rate there was significant yield loss. Good crop safety margin means both the rates were tolerated well.

Results and Discussion

The impacts of herbicides during early crop growth stages, at flowering (mainly effect on crop biomass) and on grain yield (see Table 1) of lupin were as follows:

- Lexone® applied at two-leaf stage at both the label recommended 150 g/ha and higher rate caused around 15% necrosis across both the varieties. These symptoms were out grown by the time the crop reached flowering stage and consequently there was no negative effect on grain yield.
- Brodal® + Lexone or Brodal + Simazine mixtures applied at four-leaf stage resulted in visible, 15%, leaf spotting/ bleaching and necrosis on leaves of both the varieties.
- Brodal + Lexone at both the rates caused around 10% biomass reduction in Andromeda. Brodal + Lexone or Brodal + Simazine at higher rates also produced around 10% fewer flowers in Andromeda. As a result, Brodal mixtures with Lexone or simazine at the higher rate caused significant yield loss in both the varieties.
- Brodal 100 mL + Lexone 150 g/ha caused significant yield loss in Andromeda only. This result opposes that seen during 2005 where Brodal 100 mL/ha + Lexone 100 g/ha was tolerated well by Andromeda at both Mullewa and Mingenew trial sites.
- Even though Simazine applied at both the rates before seeding did not cause any visual symptoms, applied at a higher rate it resulted in significantly lower yield in WALAB2014. This needs further investigation.
- A new pre-emergent herbicide Terbyne® (*Terbuthylazine*) was tolerated well by both the varieties. Terbyne belongs to group C and sub-group triazines similar to Simazine.

Table 1: Effect of herbicides on grain yield (% of control) of albus lupin varieties at Mingenew

No	Herbicides (rate/ha)	Timing	Andromeda	WALAB2014
0	Untreated control		100	100
	>>>>>Yield (Kg/ha)		1101	1236
1	Simazine 2 L (*)	Before	110	87
2	Diuron 2 L	seeding	111	116
3	Terbyne 1.4 Kg	"	110	98
4	(*)Brodal 200 mL	2 leaves	121	129
5	(*)Lexone 150 g	"	120	100
6	(*)Brodal 100 mL + Lexone® 150 g	4 leaves	**78**	107
7	(*)Brodal 100 mL + Simazine 0.5 L	"	83	87
8	(*)Brodal 100 mL + Eclipse® 7 g	8 leaves	109	105
9	(*)Eclipse® 7 g	"	96	96
lsd (0.05) control vs herbicides (1-tail)			20	18
lsd (0.05) herbicides vs herbicides (1-tail)			26	23
CV (%)			19	17
(*)=Simazine 500 2 L/ha as a basal treatment. Figures in **BOLD** are significantly lower than untreated control.				

Key Words

Albus lupin, herbicides, tolerance and grain yield

Acknowledgments

Grains Research and Development Corporation (GRDC) for funding and RSU Geraldton for technical assistance.

Project No.: DAW 00191

Paper reviewed by: Wayne Parker

Pesticide application and spray drift management: recent developments

Nicholas Woods

On behalf of the National Working Party on Pesticide Application (NWPPA)

Key Messages

- The Australian Pesticides and Veterinary Medicines Authority (APVMA) implemented regulations on March 1, 2010 that require new pesticides to be assessed for the potential risk of spray drift.
- New label instructions can now contain statements that describe mandatory no-spray zones (buffer zones) in the downwind direction at the time of spray application.
- The labels of currently registered pesticides are also being reviewed to include comprehensive instructions for managing spray drift.
- A National Working Party on Pesticide Application (NWPPA) has been established to provide a forum to assist growers to understand and implement these changes and to work with the APVMA to provide realistic and practical risk management.
- The NWPPA is currently scoping the research required to respond to the APVMA's spray drift operating principles and has endorsed a number of new interim initiatives funded by the Grains Research and Development Corporation (GRDC).
- To address the immediate APVMA regulation impacts, the GRDC has invested in the development of an interim model for buffer zone reduction in pesticide application from ground sprayers. This project submitted data to the APVMA on September 15, 2010, which is currently under consideration by the Regulator.

Background

The Australian Pesticides and Veterinary Medicines Authority (APVMA) outlined new processes for assessing risk from spray drift in July 2008 (APVMA operating principles in relation to spray drift risk). Subsequently, the Regulator released further information (effective March 2010) by means of an Operational Notice (New registration application and label requirements in relation to spray drift management). This was followed by 'Supplement 1' released during November 2010, which defined changes to the definition of 'orchards' and droplet size criteria for orchard air-blast spraying.

As a result, recently-registered products now contain new spray drift statements that specifically define application parameters pertaining to droplet size, meteorological conditions, the use of downwind mandatory buffer distances and record keeping requirements.

Highly-specific downwind mandatory zones can now be incorporated into the label, making it a legal requirement for the operator to leave (under some circumstances) cropping areas unsprayed and untreated on the downwind side of paddocks where adjacent, prescribed susceptible areas have been identified.

The APVMA is now also systematically working through currently-registered spray products to align older labels with these requirements. Two herbicides, MCPA and 2,4-D are among those to be reviewed first. Preliminary Review Findings (PRFs) on MCPA and 2,4-D are expected to be released during 2011.

The provision of additional spray application technology requirements on labels has been recognised by most stakeholders as constructive and informative. However, the use of significantly larger mandatory downwind buffer areas (up to 300 m) has raised concerns, particularly regarding the application of pesticides in areas where geography, established boundaries and field size prevent the practical adoption of such drift mitigation techniques.

The APVMA has recognised that these new spray drift management measures may prevent growers from being able to use many pesticides because of farm size and proximity to sensitive areas. During November 2010, the Regulator provided further information regarding a Drift Reduction Technology (DRT) program. Conceptually, this scheme allows for applicators with access to verified technologies and procedures that reduce pesticide drift, to access smaller downwind buffer distances than those (default) values presented on product labels. The APVMA proposes that upon assessment and validation of appropriate data, a permit proposing a DRT could be issued. DRT permits that are product specific or attached to a particular technology would be available. The Regulator also proposes that the most up-to-date DRT permits would be available on the APVMA website.

National Working Party on Pesticide Application (NWPPA)

Supported by the Grains Research and Development Corporation (GRDC), a new broad-based industry working party (NWPPA) was established during March 2010 to:

- consider the potential outcomes of the spray drift reviews being undertaken by the APVMA
- assist stakeholders to work with the changes that may result from the pesticide review
- support the APVMA to undertake accurate and practical spray drift risk assessments.

To provide a focus for the working party, an interim executive committee was formed. Current interim executive members include Gavan Cattanach (independent Chair, of John Thorp Australia), representatives from the GRDC, the Cotton Research and Development Corporation (CRDC), Horticulture Australia Ltd (HAL), Croplife Australia and pesticide registrants.

As part of an initial response to address the immediate APVMA regulation impacts, the NWPPA endorsed investment by GRDC in two projects:

1. **The expansion of predictive ground-boom spray drift models used by APVMA to accommodate an assessment of nozzles that produce very coarse and extremely coarse droplets, including air induction nozzle technology**

APVMA currently determines spray drift deposition resulting from ground application using a set of 'reference curves' based on a regression analysis of data from field studies undertaken during the 1990s by the United States Spray Drift Task Force (SDTF). These curves are incorporated into the US model spray drift assessment tool (AgDRIFT®). However, these curves do not enable the influence of a large number of independent input values to be determined and are limited in their scope. The GRDC initiative has enabled a new assessment of Canadian research to be undertaken so deposition curves for nozzles that produce very coarse and extremely coarse droplets can be generated. This work is designed to support the reduction of some buffer zones in conjunction with the use of appropriate DRTs.

The GRDC has invested $100,000 in this work, which was carried out by the Centre for Pesticide Application and Safety (CPAS) at the University of Queensland by a team supervised by Dr Andrew Hewitt (project UQ00047).

Findings from this project were submitted to the APVMA on September 15, 2010 and are currently being assessed by the Regulator.

Shrouds are a recognised viable method for reducing the spray drift emitted by boom sprayers equipped with hydraulic nozzles. As part of the same project the GRDC commissioned the wind tunnel evaluation of a commercial spray shroud by the University of Queensland during November 2010. This work is currently being finalised for presentation to the APVMA.

2. Scoping study

During October 2010, the NWPPA engaged Plant Health Australia (PHA) (with funds provided by the GRDC) to provide an independent report to the interim executive committee regarding the spray drift risk assessment of pesticides.

Nicholas Woods, Program Manager for National Strategies and Policy Coordination at PHA (and a former Director of the University of Queensland's Centre for Pesticide Application Safety (CPAS)) is leading the scoping project.

PHA will present a draft response plan to the NWPPA that provides (a) an overview of the current status of the proposed spray application label changes by the APVMA, (b) an analysis of the possible response options available to stakeholders across short and longer time frames, and (c) a proposed model(s) for stakeholder participation and investment.

During November and December 2010, PHA consulted with a wide range of stakeholders with an interest in spray drift risk assessment and the management of pesticides, including the APVMA, researchers, funding agencies, Australian spray technology manufacturers, consultants, applicators and State government agricultural departments.

The PHA report will be finalised for the NWPPA during early 2011. It will set out a range of technical and investment options for implementing a nationally-coordinated response.

As part of this response, the GRDC is committed to a further co-investment of $300,000 a year for three years, as part of a consortium of other parties and agencies. It is intended that this new research will include the development of tools and models that will assist growers and the Regulator to implement effective strategies for the management of spray drift in Australia.

The Adviser Update presentation will provide attendees with the latest information regarding the reviews and the work being supported by the NWPPA.

Key Words:

Pesticides and application, spray drift

Project No.: (UQ00047)

Herbicide tolerance of new desi chickpea varieties

Harmohinder Dhammu and David Nicholson
Department of Agriculture and Food, WA

Key Messages

- Applied at the label rates, Simazine caused significant yield losses of WACPE2136, Lexone® in Genesis™ 836 and WACPE2136.
- Simazine pre-seeding followed by Broadstrike® post-emergent caused significant yield loss in all varieties.
- All varieties registered a low crop-safety margin for Simazine pre-seeding and Lexone® post-seeding and pre-emergence.
- All the varieties tolerated Balance® and Terbyne® well with a good crop safety margin except Genesis™ 836, which registered a low crop safety margin for Balance®.

Aims

The aim of this research was to identify herbicide sensitivities of recently-released and upcoming desi chickpea varieties to enable growers to reduce potential yield losses due to herbicide damage.

Method

Location and year	Mingenew Irwin Group Heavyland site, 2010
Soil type, pH ($CaCl_2$) and OC (%)	Red sandy loam, 4.5 and 0.87
Trial design	Criss-cross, every 5th plot as untreated control.
Varieties	Genesis™ 510 C, Genesis™ 836, PBA Slasher and WACPE2136
Plot size (net) and replications	10.3 m x 1.1 m (5 rows at 22 cm row spacing) and 3 reps.
Sowing date and seeding rate	June 2 and 100 kg/ha
Seed treatments	Before seeding: P- Pickle T® 200 mL/100 kg seed Sown with: Alosca® Group N granular inoculum at 10 kg/ha
Seeding machinery and seeding depth	Cone seeder with knife points, press wheels and harrows, and 6–8 cm deep
Fertiliser	Agstar® Xtra 85 kg/ha, applied with the seed
Soil moisture at seeding 0–10 cm (Gravimetric method) 10–20 cm Rainfall with four weeks of seeding	6.3% 6.4% 103.4 mm
Herbicides application date Before seeding, PSPE, 5–6 nodes Herbicide application machinery (PSPE= post-seeding pre-emergence)	 June 1, 2010 June 2, 2010 and July 1, 2010 Spray rig with shields on boom at a width of 1.5 m. Air-induction nozzles and 75 L/ha water volume used
Visual observations scale Visual observation dates	0 to 100 %, where 0 = no visible injury and 100 = complete plant death June 21, 2010, July 6 and 19, 2010 August 4 and 22, 2010 and September 21, 2010 .
Blanket sprays	Select® (Clethodim) 500 mL/ha on July 16, 2010 and Scud® (Cypermethrin) 400 mL/ha on September 3, 2010. Bravo® (Chlorothalonil) 1.5 L/ha on July 7, 2010 and August 16, 2010 as a preventative measure against ascochyta blight.
Harvesting date	November 11, 2010
Rainfall (mm): May – November	May June July Aug Sept Oct Nov Total 65.8 17 86.4 68.2 7 2.8 0.2 247.4

In this trial the herbicides, which are registered on chickpeas, were evaluated at two rates, maximum label and higher than label rates. **Only label rates are presented in the results.** Low crop safety margin for a particular herbicide indicates that the variety tolerated the maximum label rate well, but at higher than the label rate there was significant yield loss. Good crop safety margin means both the rates were tolerated well.

Results and Discussion

The effect of the herbicides on the chickpea varieties during early crop growth, at flowering and on grain yield were:

- Two weeks after application of pre-emergent herbicide treatments no visible negative effect of herbicides on chickpea seedlings was observed.
- Four weeks after application of pre-seeding and PSPE treatments, simazine and Lexone® at the label recommended rates caused around 15% necrosis across all the varieties. Lexone PSPE caused yellowing of all the varieties.
- Eight weeks after treatment application label rates of Simazine and Lexone continued to show on an average 15 % necrosis. Symptoms were more intense, 15 to 25%, at their higher rates. Broadstrike® treatments also showed necrosis, 15%, though heavily influenced by pre-emergent Simazine 2 L/ha. Terbyne® showed visible necrosis, 15%, at its treatment higher than label rate. Higher rates of Simazine, Lexone, and Broadstrike also resulted in 10–15 % biomass reduction.
- A phytotoxic affect of Simazine and Lexone was visible even up to flowering stage and these herbicides at label rates registered 5–10 % biomass and 10–25% flower reduction across all the varieties. The symptoms were significantly intense at their higher than label rates. As a result Simazine 2 L/ha pre-emergent (label rate) caused significant yield loss in WACPE2136.
- Lexone PSPE caused significant yield loss in both Genesis 836 and WACPE2136.
- Simazine 2L/ha pre-emergent followed by Broadstrike 25 g/ha post-emergent reduced grain yield of all the four varieties significantly.
- Higher rates of Simazine, Lexone and Broadstrike resulted in significant yield loss across all the varieties. Broadstrike results are consistent with last year's trial results (for both the rates).
- July and August were the wetter months with 35% and 28% of total rainfall from May to November at Mingenew, respectively. Within 5–6 weeks of applying treatments, 50 and 17 mm rain fell on July 9 and 12, respectively, which might have resulted in leaching of simazine and Lexone to crop roots. Crop tolerance is based on physical separation of these herbicides from chickpea roots.
- Interaction of soil active and residual herbicides like Simazine and Lexone and heavy rainfalls during early crop growth stages seems to be the main cause of severe crop damage particularly at their higher than label rates.
- A new pre-emergent herbicide Terbyne (*Terbuthylazine*) belongs to group C and sub-group triazines similar to Simazine. Terbyne recorded significantly better crop safety margin for all the varieties than Simazine. It could be due to its higher absorption onto soil particles and organic matter, and less leaching through soil than Simazine.

Table 1: Effect of herbicides on grain yield (% of control) of Desi chickpea varieties at Mingenew

No	Herbicides (rates/ha)	Timing	Genesis™ 510 C	Genesis™ 836	PBA slasher	WACPE 2136
0	Untreated control >>>>>Yield (kg/ha)		100 868	100 933	100 1249	100 1270
1	Simazine 2 L (*)	Pre-seeding	108	120	96	**83**
2	Terbyne 1.4 Kg	"	117	124	104	95
3	Balance 100 g	PSPE	91	91	95	94
4	Lexone 280 g	"	97	**67**	87	**84**
5	(*) Broadstrike 25 g	4–6 nodes	**44**	**64**	**51**	**60**
lsd (0.05) control vs herbicides (1-tail)			23	23	16	16
lsd (0.05) herbicides vs herbicides (1-tail)			30	29	21	20
CV (%)			22	21	15	15

(*) = Simazine 500 2 L/ha as a basal treatment. PSPE = Post-seeding pre-emergent.

Figures in **BOLD** are significantly lower than untreated control.

Key Words

Desi chickpea, herbicides, tolerance, grain yield

Acknowledgments

Grains Research and Development Corporation (GRDC) for funding and RSU Geraldton for technical assistance.

Project No.: DAW 00191
Paper reviewed by: Wayne Parker

Herbicide tolerance of oat varieties

Harmohinder Dhammu
Department of Agriculture and Food, WA, Northam

Key Messages

The oat variety Hotham appears sensitive to 2,4-D amine.

Aims

The aim of this research was to identify herbicide sensitivities of oat varieties to enable growers to reduce yield losses due to herbicide damage.

Method

The herbicide tolerance of 14 oat varieties is summarised in the following table using the following symbols. The herbicide and variety interactions are based on the yield response across herbicide crop tolerance trials, carried out at Katanning, Newdegate, Merredin and Mullewa, Western Australia from 1997–2010.

- not tested.

√ no significant yield reductions at the label recommended rates in (Z) trials.

x% (1/z) yield reduction (warning) significant yield reduction at recommended rate in one trial only out of z trials conducted.

x-y% (w/z) yield reductions (warning) significant yield reductions at recommended rate in w trials out of z trials conducted. Significant event occurring in w trials out of Z trials conducted. For example, (2/5) = tested in 5 trials, 2 trials returning a significant yield loss.

Results

See Table 1.

Note: Always follow label recommendations. DAFWA does not endorse the use of herbicides above the registered rate or off-label use of herbicides or off-label tank mixes. Crop tolerance and yield responses to herbicides are strongly influenced by seasonal conditions.

Key Words

Oats, herbicides, tolerance and grain yield

Project No.: DAW 00191 (GRDC funded)

Paper reviewed by: Jeff Russell

Table 1. Summary of oat herbicide tolerance trials conducted in Western Australia from 1997 to 2010

Varieties >>>>		Carrolup	Coomallo	Dalyup	Hotham	Kojanup	Mitika	Mortlock	Mulgara	Needilup	Pallinup	Possum	Toodyay	Wandering	Yallara
Year of testing and trial sites >		97, 00, 10 ABD	2000 D	2000 D	1997-00 BCD	2006-07 A	2006-07 A	2000 D	2010 A	1997 C	2000 D	2006 A	1999 D	00, 06-07 AD	2010 A
Herbicides/ha	Timing														
Dual® Gold 0.5 L	IBS	-	-	-	-	√ (1)	√ (1)	-	-	-	-	-	-	√ (1)	-
Dual®0.5 L	IBS	-	-	-	-	√ (1)	√ (1)	-	-	-	-	√ (1)	-	√ (1)	-
Diuron 500 1 L	IBS	-	-	-	-	√ (2)	√ (2)	-	-	-	-	√ (1)	-	√ (2)	-
Diuron 500 1 L + Dual® 0.5 L	IBS	√ (1)	-	-	-	√ (1)	√ (1)	-	√ (1)	-	-	√ (1)	-	√ (1)	√ (1)
Diuron 1 L + Dual® Gold 0.5 L	IBS	-	-	-	-	√ (1)	√ (1)	-	-	-	-	-	-	√ (1)	-
Diuron 1 L + Dual® 0.5 L	PSPE	√ (1)	√ (1)	√ (1)	√ (4)	-	-	√ (1)	-	-	√ (1)	-	√ (1)	√ (1)	-
Barrel® 1 L + Eclipse® 5 g	Z12-Z13	√ (1)	-	-	-	-	-	-	-	-	-	-	-	-	-
Broadstrike® 25 g	Z12-Z14	-	-	-	13 (1/4)	√ (2)	√ (2)	-	-	√ (1)	-	√ (1)	-	√ (2)	-
Brominil® M 1 L + Eclipse® 7 g	Z12-Z13	21 (1/1)	-	-	-	-	-	-	-	-	-	-	-	-	-
Eclipse® 7 g + Uptake® Oil 1%	Z12-Z13	√ (1)	√ (1)	√ (1)	√ (2)	-	-	√ (1)	-		√ (1)	-	√ (1)	√ (1)	-
Glean® 12.5 g	Z12-Z13	√ (1)	√ (1)	√ (1)	20 (1/6)	√ (1)	√ (1)	√ (1)	-	√ (1)	√ (1)	√ (1)	√ (1)	√ (2)	-
Glean® 20 g	Z12-Z13	√ (1)	-	-	19 (1/5)	√ (1)	√ (1)	-	24 (1/1)	√ (1)		-	√ (1)	√ (1)	√ (1)
Affinity® 50 g + MCPA (amine) 0.5L	Z13-Z14	√ (1)	√ (1)	√ (1)	√ (1)	√ (2)	√ (2)	√ (1)	-	-	√ (1)	√ (1)	-	27 (1/3)	-
Affinity® 60 g + MCPA (amine) 0.5L	Z13-Z14	√ (1)	-	-	-	-	-	-	15 (1/1)	-	-	-	-	-	√ (1)
Barrel® 1.0L	Z13-Z14	√ (3)	√ (1)	√ (1)	16 (1/6)	-	-	√ (1)	√ (1)	√ (1)	√ (1)	-	√ (1)	√ (1)	√ (1)

IBS=Incorporated by seeding/applied before seeding, PSPE=Post seeding pre-emergent. A= Katanning (Gravelly loamy sand, sandy loam and loam, pH-4.7-5.2), B=Merredin (Red loam over clay), C= Mullewa (Red sandy loam) & D= Newdegate (Gray sandy loam and duplex sand over clay, pH-4.8)

Varieties >>>>		Carrolup	Coomallo	Dalyup	Hotham	Kojanup	Mitika	Mortlock	Mulgara	Needilup	Pallinup	Possum	Toodyay	Wandering	Yallara
Year of testing and trial sites >		97, 00, 10	2000	2000	1997-00	2006-07	2006-07	2000	2010	1997	2000	2006	1999	00, 06-07	2010
Herbicides/ha	Timing	ABD	D	D	BCD	A	A	D	A	C	D	A	D	AD	A
Buctril® MA 1.4 L	Z13-Z14	-	-	-	-	√ (2)	√ (2)	-	-	-	-	√ (1)	-	√ (2)	-
Conclude® 0.7 L	Z13-Z14	√ (1)	-	-	-	-	-		14 (1/1)	-	-	-	-	-	√ (1)
Diuron 0.5 L + 2,4-D 0.25 L	Z13-Z14	√ (1)	√ (1)	√ (1)	√ (1)	-	-	√ (1)	-	-	√ (1)	-	-	√ (1)	-
Diuron 0.35 L + MCPA (amine) 0.4 L	Z13-Z14	√ (2)	√ (1)	√ (1)	√ (6)	-	-	√ (1)	-	√ (1)	√ (1)	-	√ (1)	√ (1)	-
Diuron 0.5 L+ MCPA (amine) 0.5 L	Z13-Z16	√ (1)	-	-	-	√ (2)	√ (2)	-	√ (1)	-	-	22 (1/1)	-	23 (1/2)	√ (1)
Eclipse® 5 g + MCPA LVE 0.5L	Z13-Z16	-	-	-	-	√ (2)	√ (2)	-	-	-	-	29 (1/1)	-	√ (2)	-
Igran® 0.85 L + MCPA (amine) 0.6 L	Z13-Z16	-	-	-	-	√ (1)	√ (1)	-	-	-	-	23 (1/1)	-	√ (1)	-
Precept®1 L	Z13-Z14	-	-	-	-	√ (1)	√ (1)	-	-	-	-	-	-	√ (1)	-
Precept®2 L	Z13-Z14	√ (1)	-	-	-	-	-	-	√ (1)	-	-	-	-		√ (1)
Tigrex® 1 L	Z13-Z14	√ (2)	√ (1)	24 (1/1)	26 (1/6)	√ (2)	√ (2)	√ (1)	√ (1)	26 (1/1)	√ (1)	√ (1)	√ (1)	√ (3)	√ (1)
Tordon® 242 1 L	Z22	√ (1)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tordon® 75D 0.4 L	Z22	15 (1/1)	-	-	-	-	-	-	-	-	-	-	-	-	-
Paragon® 0.5 L	Z15-Z16	-	-	-	-	√ (1)	11 (1/1)	-	-	-	-	-	-	√ (1)	-
MCPA amine (500) 2 L	Z15-Z16	-	-	-	-	√ (2)	√ (2)	-	-	-	-	√ (1)	-	23 (1/2)	-
2,4-D amine 1 L	Z15-Z16	√ (1)	√ (1)	√ (1)	24-43 (3/6)	-	-	√ (1)	-	17 (1/1)	√ (1)	-	21 (1/1)	√ (1)	-
2 4-D amine 625 1.3 L	Z15-Z16	√ (1)	-	-	-	49 (1/2)	√ (2)	-	√ (1)	-	-	32 (1/1)	-	√ (2)	√ (1)
Kamba® 500 0.4 L	Z15-Z16	-	-	-	-	√ (1)	√ (1)	-	-	-	-	-	-	9 (1/1)	-
Logran® 10 g	Z30-Z31	√ (1)	√ (1)	√ (1)	√ (2)	-	-	√ (1)	-	-	√ (1)	-	√ (1)	√ (1)	-
Logran® 10 g	Z69+	-	-	-	-	√ (2)	√ (2)	-	-	-	-	√ (1)	-	√ (2)	

A= Katanning (Gravelly loamy sand, sandy loam and loam, pH-4.7-5.2), B=Merredin (Red loam over clay), C= Mullewa (Red sandy loam) & D= Newdegate (Gray sandy loam and duplex sand over clay, pH-4.8).

The case for seeking registration of metribuzin pre-seeding lupins

Peter Newman
Department of Agriculture and Food, WA

Key Messages

- Mandelup and Coromup lupins appear to be tolerant of metribuzin pre-seeding.
- We will submit this information (along with other trial data) to the APVMA with the aim of registering metribuzin for use pre-seeding lupins.
- We have observed suppression of wild radish and other broadleaf weeds using metribuzin pre-seeding but this varies depending on seasonal conditions.

Background and Aims

One of the major constraints to lupin production in Western Australia is broadleaf weed control, in particular wild radish. Wild radish with resistance to commonly-used herbicides (namely diflufenican) in lupins is widespread throughout the lupin-growing area of WA. The Grains Research and Development Corporation (GRDC) is funding research to discover alternative herbicides for wild radish control in lupins. So far we have not found any new herbicides for this purpose, but we have had some success with improving wild radish control with currently-registered herbicides.

Method

Seven replicated small plot trials (3m x 20m to 26m long) were carried out across five growing seasons. Sites were selected in growers' paddocks where high wild radish densities were expected, with the exception of the Wongan trial, which was carried out on the Wongan Hills Research Station. Growers seeded the trials with knife-point, press-wheel machinery. Treatments were applied by trial spray rigs immediately before seeding. Knockdown herbicides were applied where necessary. All treatments were applied in 67 L/ha of water, TeeJet 02 drift guard nozzles, 2-bar pressure, 12 kph. Crop phytotoxicity assessments were made by visual assessment of lupin biomass (% of nil treatment) six weeks after seeding. Weed density was assessed by counting weeds per quadrat (0.5m x 0.5m quadrat), with eight quadrats per plot. In low-weed-density situations weed density was measured as weeds per plot by counting weeds in a 0.5m x length of plot transect. Harvest yield was assessed by a small plot harvester.

Site	Description
Preston 2010	Yellow sandplain soil West Mingenew; Coromup lupins dry-sown May 18, 2010; high ryegrass burden
Nankivell 2010	Yellow sand East Maya; dry-sown May 3, 2010; high radish burden; dry season, 141 mm growing season rainfall (GSR)
Messina 2009	Yellow sandplain, Eradu; dry-sown May 12, 2009; weed free; average rainfall
Preston 2008	Same paddock as 2010 trial; sown April 30, 2008; excellent season, low radish density; 187 mm GSR
Bothe 2007	Yellow gravelly sand; not harvested due to very dry season; wild radish assessed late during season at flowering of wild radish
Wongan 2007	Yellow sandplain, Wongan Hills Research Station; good growing conditions
Broad 2006	Yellow sandplain North Mingenew, dry-sown May 30, 2006; very dry season 80 mm GSR; significant Simazine damage, possibly due to lupins accessing moisture from topsoil only

Herbicides

Simazine 500 g/L; metribuzin 750 g/kg; Terbyne – Terbuthylazine 750 g/kg

Results

Summary of trials 2006 to 2010

Table 1. Summary of weed control (counts done before post-emergent herbicide), lupin biomass (% of nil treatment, visual assessment) and lupin yield (kg/ha) results from seven replicated small plot trials with similar treatments across five growing seasons in the northern agricultural region, WA. All herbicide treatments were applied pre-seeding of Mandelup lupins (Preston 2010 — Coromup lupins). All rates are in hectares.

		Preston 2010		Nankivell 2010		Messina 2009 weed free		Preston 2008		Bothe 2007	Wongan 2007		Broad 2006	
		Wild radish (plants/ m^2)	Yield (kg/ha)	Wild radish (plants/ m^2)	Yield (kg/ha)	Yield (kg/ha)	Biomass (% of nil)	Wild radish (plants/ plot)	Yield (kg/ha)	Flowering radish (plants/ plot)	Capeweed (plants/ m^2)	Yield (kg/ha)	Wild radish (plants/ plot)	Biomass (% of nil)
1	Nil	4.86	1302	279.60	581	3290	100			7.33	52.20	2057	11.30	100
2	Simazine 2.1 L	2.22	1401	102.50	626	3091.50	86.70	7.70	2861	5.33	5.40	2123	3.70	72
3	Simazine 2.1 L + Metribuzin 150 g	0.59	1565											
4	Simazine 2.1 L + Metribuzin 200 g	2.37	1418	88.80	789	3050	90	10	2962	3.67				
5	Simazine 2.1 L + Metribuzin 300 g									1.67	1.60	2196	0.30	70
6	Simazine 2.1 L + Metribuzin 400 g	0.96	1546	74.60	697	2905.50	81.70	11.70	2713	1.33				
7	Simazine 2.1 L + Metribuzin 600 g	0.72	1540	16.20	583	2549	75	5.30	2865	0.67	0.17	2090	0.30	62
8	Simazine 2.1 L + Metribuzin 1200 g	0.49	1587	5.40	682	2247.5	53.30							
9	Terbyne 1.4 kg	3.26	1303	66.70	676	3488.50	98.30							
10	Terbyne 1.4 kg + Metribuzin 200g	1.41	1584	159.20	774	3216	96.70							
	LSD	1.43	211	94	n.s.	360	12.50	n.s.	238	3.60	6.10	n.s.	3.30	10

Five of these trials were harvested (two trials not harvested due to very dry conditions). All trials showed excellent crop safety of rates up to and including Simazine 2.1 L/ha + metribuzin 400 g/ha. Only the Messina trial during 2009 showed poor tolerance of high rates of metribuzin above 400 g/ha. The Preston and Nankivell sites during 2010 showed exceptional tolerance of lupins to metribuzin pre-seeding. In some cases wild radish density is presented as wild radish/plot due to low wild radish densities in these trials.

Herbicide tolerance trial data - 1998 to 2008

Herbicide tolerance trials carried out by Harmohinder Dhammu and Terry Piper (DAFWA) from 1998 to 2008 included the treatment Simazine 2.5 L/ha + Diuron 1 L/ha + Lexone (Metribuzin 750 g/kg) 133 g/ha. In total 18 separate trials were carried across 10 growing seasons. With several varieties tested at each site a total of 70 separate assessments of this mix were made. Diuron 1 L/ha + Lexone 133 g/ha was incorporated by seeding at 27 of these sites and was applied immediately post plant at 43 of the sites (Simazine was always incorporated by seeding). Of these 70 comparisons there were six observations of yield reductions. Five of these yield reductions were from situations where Diuron + Lexone was applied immediately post plant. Yield reductions from this herbicide mix occurred in the varieties Quilinock, Tanjil, Belara and Kalya.

Discussion

Crop safety

Trials carried out during 2010, along with others during the past five growing seasons, indicate that Mandelup (and Coromup) lupins have excellent tolerance of metribuzin when applied pre-seeding. This practice is currently not registered. The trials carried out in the northern agricultural region (NAR) during the past five years demonstrated that Mandelup lupins have always shown strong tolerance of rates up to Simazine 2.1 L/ha + Metribuzin 400g/ha. Four of the five trials harvested demonstrated good tolerance of Simazine 2.1 L/ha + Metribuzin 600 g/ha.

All of this research will be submitted to the APVMA this year to attempt to add metribuzin pre-seeding of lupins to the herbicide label. The rate that we pursue for this registration will be governed by current maximum residue limit (MRL) data for this product and is likely to be in the order of 150 to 300 g/ha. Given the high level of tolerance shown in these trials across a range of seasonal conditions there is a strong case for the registration of a low rate of metribuzin pre-seeding of Mandelup lupins.

The very high metribuzin rate was included to test the lupin tolerance. This rate is much higher than what is considered to be a safe rate.

Herbicide tolerance trials carried out by DAFWA across 10 years show that lupins have excellent tolerance to Simazine 2.5 L/ha + Diuron 1 L/ha + Metribuzin 133 g/ha. Of the 70 comparisons made of this herbicide mix, yield reductions occurred on six occasions. It is possible these yield reductions were as a result of applying Diuron immediately post-seeding rather than the application of metribuzin. This data provide further evidence of the tolerance of lupins to metribuzin applied pre-seeding and will also be submitted to the APVMA in the pursuit of this label amendment.

Weed control

We have limited efficacy data for the control of wild radish by applying metribuzin pre-seeding due to some trials during the past being weed free. The 2010 trials provide excellent data and demonstrate that useful suppression of wild radish can be achieved. This is demonstrated by the suppression of wild radish evident before applying post-emergent herbicides (see Table 1). However, best results were achieved with 400 to 600 g/ha metribuzin. These rates are likely to be higher than the registered rate should the label application be successful.

Key Words

Lupins, Mandelup, Coromup, metribuzin, wild radish

Acknowledgments

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Direct harvesting canola with desiccation or swathing to reduce ryegrass seed set

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Key Messages

- Desiccation with 3 L/ha of diquat (Reglone®) at 80% canola seed colour change reduced annual ryegrass seed set by 78% at Katanning, Western Australia. Desiccation at 90% seed colour change reduced annual ryegrass seed set by 50% at Mt Barker, WA. Unfortunately diquat at 3 L/ha is currently cost prohibitive.
- Swathing reduced the viable ryegrass seed set outside the swaths dramatically by 98% at Mt Barker where the ryegrass was very tall, however 57% of the ryegrass seed in the swaths was viable. At Katanning only 10% of the ryegrass in the swaths was viable.
- The yield of the swathed treatments was lower than direct harvesting or desiccation with direct harvesting at Katanning but was not significantly different at Mt Barker, which was swathed relatively late.

Aims

To test the techniques of desiccation and swathing of canola on viable ryegrass weed seed numbers at harvest.

Method

Two randomised block experiments with three repetitions were carried out during 2009, one at Katanning Western Australia and one at Mt Barker, WA. Ryegrass head number was measured with two open-ended 0.5m x 0.5 m quadrats per plot at swathing and just before harvest at Katanning and two 0.32m x 0.32 m quadrats per plot at Mt Barker and 30 ryegrass heads/plot were collected at harvest. Grain yields were measured and 30 ryegrass heads/plot were collected from the swaths at Katanning and Mt Barker. Ryegrass head samples from each plot were threshed, seeds per head counted and viability of 100 seeds per sample was tested on each plot using the tetrazolium chloride test. The tetrazolium test avoids the problem of dormant seed that will not germinate in a standard germination test.

Treatments were:

1. Nil, no swath and no desiccation.
2. Swathing (aiming for an average 60% canola seed colour change).
3. Desiccation with 3 L/ha Reglone® (diquat) (aiming for 80% canola seed colour change).

Experiment details are below:

Katanning GSARI

Sown: May 25, 2009 at 25.4 cm row spacing, knife points and press wheels bulk sown across in the direction of the plots with a 20 tine Bourgault airseeder.

Seed: CB Tanami canola at 6 kg/ha.

Fertiliser: 100 kg/ha Agstar Extra Plus (13.9%N, 14.0%P, 9.0%S, 0.5%Zn, 0.25%Cu, 0.001%Mo) banded 5 cm below the seed.

Sprays: May 25, pre-seeding, 100 mL/ha Alphaduo, 200 mL/ha Talstar, 0.5 L/ha Spray.Seed®, 1.1 kg/ha Gesaprim granules
July 3, 1.1 kg/ha Atrazine 900WDG plus 1% Hasten
July 24, 300 mL/ha Aramo® plus 1% Hasten.

Swathing: October 29, (60% seed colour change) with MacDon 3020 PTO swather with 25' cut, Landini Legend 160 Deltasix tractor gear: 1, medium at 1550 rpm at 7.0 km/h (see Figure 1).

Desiccation: November 3, 3 L/ha Reglone (80% seed colour change), Ford Ranger gear: 1, low at 1600 rpm (7.4 km/h) using Turbo TeeJet TT110015 nozzles, 1.9 bar pressure, medium droplets, 460 mL/min = 75 L/ha (see Figure 1).

Harvest: November 25, with a KEW plot harvester with two Harvestaire® crop lifters (see Figure 3).

Figure 1. MacDon 3020 PTO swather on Oct 29, 2009 (left) and desiccation above crop (right).

Mt Barker Research Station

Sown: June 8, 2009 at 25 cm row spacing, SuperSeeder points and walking K-Hart press wheels sown across in the direction of the plots with a Forward 753 combine modified to sow 24 rows on 4 bars.

Seed: Argyle canola at 5 kg/ha but was resown due to water logging with Pioneer 46Y78 Hybrid at 12 kg/ha with commercial ryegrass seed mixed in.

Fertiliser: 103 Agras (16.8%N, 10.0%P, 14.2%S, 0.1%Ca, 0.06%Zn) at seeding, 100 kg/ha urea top-dressed July 30 and 150 kg/ha sulphate of ammonia top-dressed September 14.

Sprays: 25 May 1.0 L/ha Roundup PowerMAX + 1.1 kg/ha Atragranz + 100 mL/ha BS1000
June 12, 200 mL/ha Talstar
July 28, 200 mL/ha Grasidim + 1.1 kg/ha Atragranz + 1.0 L/ha Uptake.

Swathing: December 15, with MacDon 3020 PTO swather with 25' cut, Renault Ares 616 RZ Tractor gear: slow, 3, 3 at 2000 rpm for swathing = 5.4 km/h (see Figure 2).

Desiccation: December 15, 2009 with 75 L/ha water (90% seed colour change) and 11 km/h. Hardi 2500 Ranger boom was used with fourteen Hardi low drift LD-110 025 Lilac nozzles (four end and two centre nozzles blocked), 700 mL/min = 75 L/ha, 1.5 bar pressure see (Figure 2).

Harvest: January 6, 2010 with a KEW plot harvester with two Harvestaire crop lifters.

Figure 2. MacDon 3020 PTO swather on December 15, 2009 (left) and desiccation above crop (right).

Figure 3. Harvesting at Katanning (left) and Mt Barker (right).

Results

Katanning

There were significant differences in viable ryegrass seed numbers at Katanning where desiccation with Reglone reduced the viable ryegrass by 78% compared with the untreated (see Table 1 — note the viable ryegrass/m^2 in the table is the average of the product of head number x seed/head x % viability for each plot). The 30 ryegrass heads/plot collected for testing in Table 1 was collected at random and away from the swaths. Most of the ryegrass was below the swathing height. However, the additional 30 heads/plot collected in the swaths had average seed viability of only 10%; 87% were empty seeds and 3% were non-viable.

The yield of the swathing treatment was less than the direct harvest treatment or desiccation with direct harvesting (see Table 1) ($p < 0.05$).

Table 1. Average annual ryegrass head number, seeds/head, % viability (as determined by tetrazolium chloride test), viable seed production and canola yield

	Treatment	Ryegrass before swathing (heads/m²)	Ryegrass at harvest (heads/m²)	Ryegrass production (seed/head)	Viable ryegrass seeds (%)	Viable ryegrass at harvest* (seeds/m²)	Yield* (t/ha)
1	Nil	34.0	22.0	30.0	79	525a	1.22a
2	Swathing	29.3	18.7	27.8	63	349a	0.91b
3	Desiccation	29.3	6.0	27.1	50	113b	1.25a
	p value	0.549	0.148	0.742	<0.001	0.002	<0.001
	lsd (p<0.05)	n.s.	n.s.	n.s.	18.2	213	0.161
	C. of V. %	53.0	55.7	31.9	25.3	75.2	8.5

* Similar letters indicate where values are not significantly different (p<0.05)

Mt Barker

The swathing was done a little later than desired, at around 90% canola seed colour change, and the ryegrass was very tall and thick. As a result, most of the ryegrass heads ended up in the swaths. Ryegrass heads collected away from the swaths showed very few viable seeds in the swathed treatment (see Table 2). The ryegrass seeds taken from the swaths showed the viability was reduced from 78% to 57% (32% empty seeds, 11% non-viable) so the swathing had reduced the viability.

Even though the yield of the swathed treatments was low they were not significantly different to the direct harvesting or desiccation as the site was quite variable.

Table 2. Average annual ryegrass head number, seeds/head, % viability (as determined by tetrazolium chloride test), viable seed production and canola yield after harvest with swathing or spraying

	Treatment	Ryegrass before swathing (heads/m²)	Ryegrass at harvest (heads/m²)	Ryegrass production (seed/head)	Viable ryegrass seeds (%)	Viable ryegrass at harvest* (seeds/m²)	Yield* (t/ha)
1	Nil	62	38	28	78	884[a]	0.89[a]
2	Swathing	53	5	6	27	14[c]	0.53[a]
3	Desiccation	63	53	19	49	441[b]	0.77[a]
	p value	0.863	<0.001	<0.001	<0.001	<0.001	0.095
	lsd (p<0.05)	n.s.	23.0	10.0	12.5	411	n.s.
	C. of V. %	27.1	41.9	42.0	19.1	77.3	30.5

* Similar letters indicate where values are not significantly different (p<0.05)

Discussion

1. At Katanning desiccation with 3 L/ha Reglone reduced the viable ryegrass seed numbers by 78% compared with the untreated control. Ryegrass heads present at harvest were much less than those present at swathing and spraying of the canola crop. There were seven days of rain totalling 34 mm after swathing and desiccation and before harvest. It is possible this rain caused the ryegrass heads to break down before harvest and therefore not be counted at harvest. Assuming this was the case, even if there were still the same number of ryegrass heads actually present at harvest as there was at swathing/spraying, the number of viable ryegrass after desiccation would still be around 40% less than the nil treatment.

2. Swathing at Katanning was very effective at reducing ryegrass seed set. The time of swathing was probably too early for the ryegrass seeds to develop properly.
3. Viable ryegrass seed after harvest was halved by desiccation with 3 L/ha Reglone compared with the nil at Mt Barker.
4. The ryegrass at Mt Barker was sown during 2009. Swathing at Mt Barker reduced the ryegrass numbers dramatically. This may have been due to the sown ryegrass being taller and later maturing than the natural background population.
   The yield of the swathed treatments at Katanning was lower than direct harvesting or desiccation with direct harvesting. This may have been due to inefficient swath pick-up with crop lifters on the plot header and perhaps the reel helping to bring the swath in shed some seed in front of the knife.
5. The yields were not significantly different at Mt Barker, which was swathed relatively late. The site was very variable, which may have masked any differences. Perhaps the relatively late swathing also improved the swathing yields.
6. Although desiccation with 3 L/ha diquat gave big reductions in ryegrass seed set it is currently cost prohibitive.
7. Swathing alone can cause big reductions in ryegrass seed set in some seasons where ryegrass development is delayed or behind the canola development.
8. In future it would be worth measuring the germination of ryegrass in the plots at the break of the following season as a check of the effectiveness of the treatments.

Key Words

Canola, direct harvesting, swathing, desiccation, ryegrass, seed viability

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Paper reviewed by: Peter Newman

Herbicides for selective spot spraying application on summer weeds

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Key Messages

- Weed sensing and selective spot spraying with machinery such as the Weedseeker® and Weed-It® selective spot sprayers has allowed for cost-effective broadacre control of weeds without spraying the whole paddock area.
- Selective spot spraying of hard-to-kill summer weeds is one application where this technology has a potential to save growers significant funds, usually allocated to herbicides.
- Elevated rates of non-traditional or previously cost-prohibitive herbicides of a different resistance group can now be used to achieve more reliable and faster weed control.
- Alliance, Gramoxone, Basta, Roundup Powermax and Ally provided acceptable levels of control on large roly poly *(Salsola kalivar. kali)* at high rates suitable for selective spot spraying.
- Hammer and Sharpen did not provide acceptable control of roly poly after initial impressive weed burndown.
- Roundup Powermax, Garlon, Grazon, Kamba 500 and Tordon 75D all provided excellent Afghan melon control.
- Grazon, Kamba 500 and Tordon 75D caused herbicide toxicity issues in the following wheat crop.

Aims

- To assess current and novel herbicides and mixes at elevated rates to achieve fast control of summer weeds through weedseeker selective spot spraying.
- To plant trial plots to wheat to assess carryover or plantback issues with these treatments.

Method

Herbicide application

- Trials spray with hand booms – 2 m wide, with Agrotop airmix 110 01 nozzles at 2 bar, 4 km/h at 98 L/Ha (similar application rates and droplet composition as the weedseeker).
- Herbicides applied from 6 am–8.30 am during warm, dry summer spraying conditions — 20–24^{o}C and, 60–50% relative humidity (RH) typical of grower application window during summer spraying. All treatments applied with 1% Bonza spraying oil adjuvant.
- Herbicide mixtures prepared the evening before and stored in two-litre plastic containers.

Weeds

- Afghan melons (*Citrullus lanatus* (Thunb.) Matsum.) 1–2 m diameter (stressed).
- Roly poly (*Salsola kalivar. kali*) 300–700 mm tall (healthy).
- Ratings — 8, 16 and 55 days after application.
- Assessment of subsequent wheat crop health and effect of herbicide carryover on the crop grown in spray plots.

Herbicides used

- Glyphosate 540 g/L, Gramoxone, Basta , Alliance, Ally, Kamba 500, Garlon, Grazon, Tordon 75D, Hammer, Estericide 680, Diuron Sc 500g/L, Hotshot, Sharpen, Bonza oil.

Results

Table 1. Ratings of herbicide efficacy at 16 and 55 days after application (DAA)

(Control ratings 1=poor, 10=excellent)

No.	Treatment		Rate		Afghan melons (1–10) 16DAA	Afghan melons (0–10) 55DAA	Roly poly (0–10) 16DAA	Roly poly (0–10) 55DAA
1	Garlon Bonza		200 1	ml %	9	10	6	4
2	Garlon Bonza		1000 1	ml %	10	10	5	5
3	Roundup Pmax		10,000	ml	10	10	10	10
4	Hammer + BS1000		125 + 0.1	ml %	5	4	5	5
5	Paraquat 250		10,000	ml	8	5**	10	10
6	Grazon Bonza		300 1	ml %	2	2	3	2
7	Grazon Bonza		1000 1	ml %	10	10	5	5
8	Sharpen Bonza		500 1	ml %	2	2	6	3**
9	Diuron BS100		5000 0.1	ml %	5	6	1	0
10	Starane Advance Rup Powermax BS1000		900 3000 0.1	ml ml %	7	7	7	5
11	Alliance		10,000	ml	7	3**	10	10
12	Basta		10,000	ml	10	7	10	10
13	Ester 680 Bonza		10,000 1	ml %	8	8	6	8
14	Metsulfuron Bonza		20 1	g %	7	9	10	10
15	Tordon 75D Bonza		1000 1	ml %	10	10	7	6
16	Tordon 75D Bonza		10,000 1	ml %	10	10	6	6
17	Alliance Ester 680 Bonza		10,000 2000 1	ml ml %	9	5**	10	10
18	Powermax Ester 680 Garlon Al ly LI700		5000 2000 300 5 0.5	ml ml ml g %	10	10	Not applied	Not applied
19	Kamba 500 Bonza		4000 1	ml %	10	10	6	4
20	Hotshot		3000	ml	10	10	5	4
			LSD 0.01		5	5	5	5
			LSD 0.05		4	4	3	4
			CV		29	33	33	40

Afghan melon — *Citrullus lanatus (Thunb.) Matsum*

Garlon, Grazon, Tordon, Hotshot and Kamba 500 all provided effective and rapid control of Afghan melons. Roundup Powermax at 10 L/ha also provided effective control. Ally (metsulfuron methyl) at 20 g with oil also provided reasonable control of Afghan melon at 55 days after application (DAA) and would make an inexpensive and handy tankmix partner in this case. Basta, Gramoxone and Alliance provided impressive intial burndown, but the Afghan melons continued growing and control was not satisfactory at 55 DAA. The high rates of Grazon, Tordon, Kamba 500 and Hotshot caused unacceptable damage of the following wheat crop at the melon site , and would not be advised in this scenario (see Table 1).

Roly poly — *Salsola kalivar. kali*

The non-selective herbicides Roundup Powermax at 10 L/ha, Gramoxone at 10 L/ha, Basta at 10 L/ha and Alliance at 10 L/ha all provided fast and effective control of large roly poly. Ally (metsulfuron methyl) at 20 g with oil also provided effective control of roly poly and is particularly inexpensive. Hammer and Sharpen provided some initial burndown on the outside margins of the roly poly plants, but due to their rapid activity in bright, sunny and warm conditions, they provided little systemic activity and the plants continued growing from the centre. Grazon, Garlon and Tordon provided impressive early yellowing and retardation of roly poly, but during the dry conditions after spraying, showed minimal activity after the initial effects and plants survived. The high rates of Grazon, Tordon and Diuron caused unacceptable damage of the following wheat crop at the trial site, and would not be advised in this scenario (see Table 1 and Figures 1 and 2).

Figure 1. Untreated roly poly.

Figure 2. Roly poly eight DAA with 10 L Basta.

Discussion

Suitable conventional and novel herbicides exist for specific application and control of summer weeds by spot spraying technology. Residual soil herbicide activity must be considered when planting the next crop.

Key Words

Weedseeker, selective spot spraying, roly poly, Afghan melons

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Development of the Harrington Seed Destructor

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Key Messages

- The Harrington Seed Destructor (HSD) system destroyed more than 90% of annual ryegrass (*Lolium rigidum*), wild radish (*Raphanus raphanistrum*), brome grass (*Bromus* spp.) and wild oats seed (*Avena fatua*) during the commercial harvest of a wheat crop.
- Destruction of more than 98% of annual ryegrass seed was maintained despite two to three-fold increases in wheat, barley and lupin chaff levels.

Aims

It has previously been established that the cagemill processing unit of the Harrington Seed Destructor (HSD) can destroy >95% of annual ryegrass (*Lolium rigidum*) seed present in chaff when operating as a stationary unit. The success of the HSD system is dependant on a similarly high weed-seed destruction capacity for this system when operating under normal harvest conditions. During the past three Western Australian crop harvests, the efficacy of HSD system for weed-seed destruction under commercial harvest conditions has been investigated. Specifically, the impact of the HSD system on annual ryegrass, wild radish (*Raphanus raphanistrum*), wild oats (*Avena fatua*) and brome grass (*Bromus* spp.) was investigated. Additionally, the effect of increasing chaff volumes of three crop species, wheat, barley and lupins on annual ryegrass seed was determined.

Methods

2008–2009 Harvest HSD testing

The first HSD prototype (HSD I) was tested for its efficacy in destroying annual ryegrass, wild radish, brome grass and wild oat seed during the harvest of a 3.0 t/ha wheat crop at the Wongan Hills research station during December 2008. Dyed viable seed of annual ryegrass (20,000), wild radish (10,000), brome grass (3000) and wild oat (2000) were introduced into the front of the header at a uniform rate during harvest of 20 m long plots. Chaff, straw and grain samples were collected for each plot. Processed chaff samples were collected in a mesh bag attached to the cagemill and wheat grain samples were collected from the grain tank. Samples were subsequently processed to recover the introduced weed seed and seed fragments. To determine seed viability, germination tests were conducted on seed collected in the chaff fraction.

2009–2010 Harvest HSD testing

HSD I was further evaluated to determine the effects of increasing chaff volumes on its capacity for annual ryegrass seed destruction. Before harvest 10 x 1m crop rows were collected for the determination of grain yield. As in the previous study, 10,000 dyed annual ryegrass seeds were introduced directly into the cagemill while harvesting plots of wheat, barley and lupin crops. To establish varying chaff volumes, four plot widths of 3 m, 5 m, 7 m and 9 m were used. Plots were 20 m long and a constant harvester speed of 6 km/h was maintained throughout. Processed chaff samples for each plot were collected from the cagemill as described above. Chaff samples were sieved and sorted to identify and collect ryegrass seed and seed fragments. To determine seed viability, germination tests were carried out on any seed collected in the chaff fraction.

Results

2008–2009 Harvest HSD testing

The HSD system proved its potential as an effective at harvest weed-seed management system by consistently destroying more than 90% of the seed from four weed species present in the chaff fraction during the commercial harvest of a wheat crop. Approximately 40% of the annual ryegrass seed introduced into the front of the header during harvest was found in the chaff fraction (see Table 1). The subsequent processing of this chaff fraction by the HSD system destroyed 95% of this annual ryegrass seed. Similarly, 28% of introduced wild radish seed were present in the chaff fraction and when subsequently processed resulted in the destruction of 93% of this seed. Seed destruction was higher for brome grass and wild oats with more than 98% of the seed of these species being killed by the chaff processing action.

The high levels of weed seed exiting in the straw fraction highlighted the importance of effective chaff movement through the rear of the harvester. Large proportions of seed from all four weed species exited the header in the straw fraction during harvest. In particular the amount of annual ryegrass seed in the straw fraction represents a ten-fold increase on the 5% value observed in previous studies (Walsh and Powles, 2007). The consequence of high weed-seed levels in the straw fraction is that only 50–60% of seed were present in the chaff fraction, markedly reducing the potential to impact on the weed population. Airflow assessments through the header and into the HSD determined the chaff transfer system was inadequate resulting in large amounts of weed-seed-bearing chaff material exiting in the straw fraction. Subsequent modifications to the chaff transfer system have been implemented towards alleviating this problem.

Table 1. Proportions (%) of introduced annual ryegrass seed exiting in grain, straw and chaff fractions

Values in brackets are standard errors showing variation around the mean of four replicates.

Weed species	Grain	Straw[1]	Chaff (unprocessed)	Chaff[2] (processed)
Annual ryegrass	8.5 (1.1)	51.5	40 (1.5)	4.9 (0.8)
Wild radish	37.3 (2.4)	34.7	28 (3.5)	7.4 (2.6)
Brome grass	15 (1.3)	43.0	42 (4.8)	1.3 (0.1)
Wild oats	26.4 (1.7)	40.6	39 (3.3)	1.0 (0.1)

[1] Seed in straw were calculated by difference from seed proportions in grain and chaff samples

[2] Proportion (%) of annual ryegrass seed in unprocessed chaff surviving HSD treatment

2009–2010 Harvest HSD testing

High weed-seed destruction levels were maintained by the HSD system when subjected to processing high amounts of chaff during the commercial harvest of high-yielding wheat, barley and lupin crops. The efficiency of the HSD system for ryegrass seed destruction was not affected by increasing amounts of wheat and barley chaff. Although higher levels of lupin chaff resulted in more ryegrass seed surviving processing there remained greater than 98% control of annual ryegrass seed. Evaluation of the HSD system was carried out in high-yielding wheat, barley and lupin crops and despite being required to process high amounts of chaff, high (>98%) weed seed destruction levels were maintained. Even where a three-fold increase in chaff levels as measured, less than 2% of the introduced ryegrass seed survived the chaff processing. For wheat and barley chaff there were no differences ($P>0.05$) in ryegrass seed survival with increasing chaff levels. However, for lupins ryegrass seed survival was lowest ($P<0.05$) where lupin chaff levels were low.

Despite similar grain yields for wheat, barley and lupin crops, resulting chaff levels were consistently lower for the barley crop. Grain yields, as determined by hand harvesting, were uniform for the three crops varying by less than 0.5 t/ha. Despite this, barley produced lower ($P<0.05$) amounts of chaff than wheat and lupin crops. In general, barley chaff levels were around half those of wheat and lupin crops respectively. This indicates that chaff processing for weed-seed destruction during harvest potentially may be easier in barley crops.

Table 2. Effect of varying chaff levels on annual ryegrass seed destruction by the HSD system during the commercial harvest of wheat, barley and lupin crops

Crop (grain yield)	Chaff (kg/plot)	Ryegrass seed survival (%)
Wheat (4.4 t/ha)	3.08	0.84
	5.33	1.07
	7.03	0.98
	7.72	1.22
LSD (P=0.05)	2.91	0.39
Barley (4.8 t/ha)	1.52	0.85
	2.35	1.06
	2.73	1.07
	4.58	0.98
LSD (P=0.05)	0.48	0.27
Lupins (4.5 t/ha)	3.73	0.65
	5.03	0.96
	6.38	1.1
	8.89	1.18
LSD (P=0.05)	1.97	0.23

Discussion

Evaluation of the HSD system in commercial harvest situations has determined this system is highly effective (>90%) in destroying annual ryegrass, wild radish, brome grass and wild oat seed during harvest. Additionally, the efficiency of weed-seed destruction was not affected by increasing chaff levels in high-yielding wheat, barley and lupin crops. To ensure the HSD achieves its potential weed seed destruction capabilities it is essential maximum levels of weed seed are collected during harvest and then transferred into the chaff fraction for processing.

Key Words

Cagemill, annual ryegrass, wild radish, wild oats, brome grass

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