Control and seed production of annual ryegrass in wide row lupins in the Western Australian wheatbelt

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Summary Two experiments were conducted at Wongan Hills and Merredin in 2006 to examine on-row and inter-row weed control, and seed production of annual ryegrass in wide row lupins in Western Australia (WA).

At Wongan Hills, annual ryegrass density on the inter-rows was reduced 99–100% by inter-row Spray. Seed® (paraquat + diquat) or glyphosate; 61–63% by inter-row cultivation and 34% by standard practice (simazine + clethodim) in a lupin crop sown in 52 cm wide rows. Crop damage was 1% with inter-row Spray. Seed, 6–12% with inter-row glyphosate and 29–44% in inter-row cultivation treatments. Lupin grain yield loss was 20% in the untreated control, 11–14% with inter-row Spray.Seed, 25–31% with inter-row glyphosate and 39–55% in inter-row cultivation. On-row seed production of annual ryegrass was reduced 33–54% by a banded application of simazine or metolachlor except in one treatment. Inter-row seed production of annual ryegrass was reduced 100% with inter-row glyphosate or Spray.Seed applications, 58–68% with the inter-row cultivation and 26% in the standard practice.

At Merredin, inter-row annual ryegrass density was reduced 98–99% by inter-row glyphosate, 64–65% by inter-row Spray.Seed, 53% by inter-row cultivation and 100% by the standard practice in a lupin crop sown at 66 cm wide rows. Crop damage was 4–8% with inter-row glyphosate application, 9–14% by inter-row cultivation and no damage was recorded with inter-row Spray.Seed application. Lupin grain yield loss was 21% in the untreated control; 1–3% with inter-row glyphosate, 11–14% with inter-row Spray. Seed and 5–14% in inter-row cultivation.

Results showed that glyphosate was as effective on inter-row annual ryegrass as Spray.Seed but was more damaging to lupins than Spray.Seed suggesting that Spray.Seed is an alternative to glyphosate for inter-row weed control in wide row lupins. Given that glyphosate resistance in annual ryegrass is on the rise and paraquat resistance in annual ryegrass has not yet been reported in Australia, this is a promising alternative.

Keywords Wide row lupins, inter-row spraying, Sprayshield, annual ryegrass, glyphosate, Spray. Seed.

INTRODUCTION

Weed control in wide row crops is a traditional practice in summer crops such as cotton, sorghum and maize in some parts of QLD and NSW. Recently this practice is becoming popular in lupin (*Lupinus angustifolius* L.) crops in WA (Blackwell and Collins 2002). One of the main aims for wide row cropping is to control herbicide-resistant weeds in the inter-rows with non-selective herbicides, usually glyphosate, using sprayshields. Intensive use of glyphosate during the fallow period before sowing and on the inter-rows of crops is likely to result in rapid development of resistance to glyphosate in weeds. About 62 glyphosate-resistant annual ryegrass (*Lolium rigidum* Gaud.) populations have already been reported in Australia (Preston 2007), including five from WA (Hashem and Pathan 2007). It is necessary to examine the risks associated with the use of glyphosate for inter-row weed control in wide row lupins within the WA wheatbelt.

The aims of this study were to examine on-row and inter-row weed control, and seed production of annual ryegrass in wide row lupins within the WA wheatbelt.

MATERIALS AND METHODS

Two experiments were conducted in a randomised complete block design with four replications at Wongan Hills and Merredin in 2006. The unit plot size was 2 m × 20 m (4 rows plot^{-1} at 52 cm row spacing) at Wongan Hills and 4.5 m × 20 m (6 rows plot^{-1} at 66 cm row spacing) at Merredin.

Treatments The treatments were: (1) untreated control, (2) weed-free control (simazine 900 g a.i. ha^{-1} overall post-sowing pre-emergent (PSPE) + hand weeding), (3) standard practice (simazine overall 900 g a.i. ha^{-1} pre-sowing + clethodim 60 g a.i. ha^{-1} post-emergent (PO)), (4) apply metolachlor 720 g a.i. ha^{-1} behind the seeder in 15 cm band on rows (OR) + inter-row (IR) glyphosate 540 g a.i. ha^{-1} with sprayshield PO, (5) apply metolachlor 720 g a.i. ha^{-1} behind the seeder in 15 cm band OR + IR Spray.Seed (paraquat + diquat 325 g a.i. ha^{-1}) 1.5 L with sprayshield PO, (6) apply metolachlor 720 g a.i. ha^{-1} behind the seeder in 15 cm band OR + IR cultivation PO, (7) apply simazine 900 g a.i. ha^{-1} behind the seeder in 15 cm band OR + IR glyphosate 540 g a.i. ha^{-1} with sprayshield PO, (8) apply simazine 900 g a.i. ha^{-1} behind the seeder in 15 cm band OR + IR Spray.Seed 1.5 L with sprayshield PO, (9) apply simazine 900 g a.i. ha^{-1} behind the seeder in 15 cm band OR + IR cultivation PO.

Annual ryegrass was the main weed species at Wongan Hills and Merredin but few radish plants were also present at Merredin. IR weeds were sprayed using sprayshields at 8–9 leaf stage of lupin at Wongan Hills and at early pod formation stage at Merredin.

Measurements and statistical analysis Data on weed control (visual assessment), crop damage, grain yield loss of lupins, and annual ryegrass seed production on the lupin rows and inter-rows, were recorded. Weed control, crop damage and grain yield loss were expressed as percentage of the weed-free control. The data were subjected to analysis of variance and means were compared by LSD.

RESULTS

Weed control At Wongan Hills, inter-row (IR) annual ryegrass was reduced 99–100% by IR Spray. Seed or IR glyphosate and 61–63% by IR cultivation regardless of on-row (OR) application of metolachlor or simazine (Table 1). Standard practice (simazine + clethodim) controlled only 34% IR annual ryegrass because this population of annual ryegrass is resistant to ACCase inhibiting herbicides.

At Merredin, IR weeds, predominantly annual ryegrass, were reduced 98–99% by IR glyphosate, 64–65% by IR Spray.Seed, and 53% by IR cultivation regardless of OR application of metolachlor or simazine, compared with 100% IR annual ryegrass control by standard practice (Table 2).

Crop damage At Wongan Hills, crop damage due to IR weed control treatments was 1% with IR Spray. Seed, 6–12% with IR glyphosate and 29–44% in IR cultivation (Table 1). At Merredin, crop damage was 4–8% with IR glyphosate and 9–14% in IR cultivation but no crop damage was observed with IR Spray. Seed (Table 2).

Lupin grain yield loss At Wongan Hills, grain yield loss of lupins was 25–31% with IR glyphosate, 11–14% with IR Spray.Seed, 39–55% in IR cultivation and 20% in the untreated control (Table 1). Lupin grain yield loss at Merredin was 1–3% with IR glyphosate, 11–14% with IR Spray.Seed, 5–14% in IR cultivation and 21% in the untreated control (Table 2).

Annual ryegrass seed production In the untreated control, annual ryegrass seed production determined at Wongan Hills was 92% less on the OR (1026 seed m^{-2}) than on the IR zone (12331 seed m^{-2}). Metolachlor or simazine reduced OR annual ryegrass seed production by 33–54% except in OR metolachlor + IR cultivation treatment where OR annual ryegrass seed production was similar to the untreated control. Greatest IR seed production (12331 seed m^{-2}) was recorded in the untreated control. IR seed production of annual ryegrass was reduced 100% by IR Spray. Seed or IR glyphosate, 58–68% by IR cultivation and 26% by standard practice (simazine + clethodim) (data not presented).

DISCUSSION

IR weed control with IR glyphosate was highly effective on annual ryegrass at both locations. IR Spray.Seed was as effective on IR annual ryegrass as IR glyphosate at Wongan Hills but was less effective at Merredin. IR Spray.Seed was more effective on annual ryegrass than IR cultivation at both locations but both treatments were more effective at Wongan Hills than Merredin where the cultivation treatment was a little too late and the larger weeds tended to transplant. Crop damage and grain yield loss were generally greater at Wongan Hills than at Merredin due probably to closer row spacing at Wongan Hills than Merredin. IR cultivation resulted in greater crop damage and grain yield loss than IR Spray. Seed particularly at Wongan Hills. Crop damage due to IR Spray.Seed was significantly less at both locations than IR glyphosate or IR cultivation. At Wongan Hills, grain yield loss in IR Spray.Seed was not significantly higher than weed-free control but the grain yield losses in IR glyphosate and IR cultivation were significantly higher than IR Spray.Seed. At Merredin, yield loss in IR Spray.Seed was rather high due to poor IR weed control that could be improved by adjusting rate and application time of Spray.Seed. The trend in the annual ryegrass seed production at Wongan Hills was similar to that of IR weed control achieved except in the IR cultivation treatment.

Table 1. On-row and inter-row treatment effects on annual ryegrass control, crop damage and lupin grain yield loss at Wongan Hills[A].

Treatments	IR Weed control (%)	Crop damage (%)	Yield loss (%)
Untreated	0	0	20
Weed-free	100	0	0
Standard practice	34	0	16
OR metolachlor + IR glyphosate	99	12	31
OR metolachlor + IR Spray.Seed	100	1	11
OR metolachlor + IR cultivation	63	44	39
OR simazine + IR glyphosate	100	6	25
OR simazine + IR Spray.Seed	100	1	14
OR simazine + IR cultivation	61	29	55
LSD (P = 0.05)	18.1	8.1	15.7

[A] OR = on-row, IR = inter-row, lupin grain yield in weed-free control (simazine + hand weeding) = 1369 kg ha^{-1}.

Table 2. On-row and inter-row treatment effects on annual ryegrass control, crop damage and lupin grain yield loss at Merredin[A].

Treatments	IR Weed control (%)	Crop damage (%)	Grain yield loss (%)
Untreated	0	0	21
Weed-free	100	0	0
Standard practice	100	0	0
OR metolachlor + IR glyphosate	99	4	1
OR metolachlor + IR Spray.Seed	64	0	11
OR metolachlor + IR cultivation	53	9	5
OR simazine + IR glyphosate	98	8	3
OR simazine + IR Spray.Seed	65	0	14
OR simazine + IR cultivation	53	14	14
LSD (P =.05)	12.4	6.2	11.1

[A] OR= on-row, IR = inter-row, lupin grain yield in weed-free control (simazine + hand weeding) =1326 kg ha^{-1}.

Results indicate that IR cultivation technique employed was neither suitable for effective IR weed control nor safe on lupins. IR weed control was excellent with IR glyphosate but crop damage was greater with IR glyphosate than IR Spray.Seed. Although IR Spray.Seed was less effective on IR annual ryegrass at Merredin due to late spraying at a relatively low rate, IR glyphosate appears to be more damaging to crops than IR Spray.Seed. Given that glyphosate resistance in annual ryegrass is on the rise and paraquat resistance in annual ryegrass has not yet been reported in Australia, IR application of Spray.Seed with sprayshields at appropriate rates and weed stage is likely to minimise the risks of crop damage and glyphosate resistance development in annual ryegrass (Hashem *et al.* 2008).

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