

LUPIN TOLERANCE TO THE HERBICIDE CLOPYRALID WHEN USED IN A ROTATION WITH CEREALS TO CONTROL SKELETON WEED

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ABSTRACT

Skeleton weed is under an eradication program in Western Australia and residual herbicides picloram and more recently clopyralid have been used in high doses. Picloram has a residual effect on lupins several years after use however clopyralid appears safer and can reduce skeleton weed density within a couple of seasons of application to cereal crops. This will allow lupins, which are a major crop in most cropping rotations to remain as part of the rotation.

KEYWORDS

Skeleton weed, clopyralid, herbicide tolerance

INTRODUCTION

Skeleton weed *Chondrilla juncea* L. has been a significant weed of cereal crops in the southern states of Australia and more recently in Western Australia (Panetta and Dodd, 1987). Many studies have been conducted in Australia (Wells, 1969, 1970, 1971a, 1971b and 1971c; Heap, 1993; and Walsh, 1991) to determine the effect of herbicides during cropping or using competing pasture species to reduce the vigour and impact of the weed before planting a crop.

One of the major problems facing landholders treating skeleton weed in Western Australia is the residual nature of the most effective herbicides, picloram and clopyralid, on the legumes in the cropping rotation. Skeleton weed is under an eradication program in Western Australia and initially a single dose of 1100 g ai/ha of picloram was used. This was only applied to small areas, usually less than 1 ha, but as the area of cropping land infested with skeleton weed increased it was no longer economical or environmentally wise to use such high doses of a residual chemical. In Western Australia there is the heavy reliance of a legume crop, mainly lupins, in the rotation to supply additional nitrogen. Most of the herbicides reported as having a lasting effect on reducing the impact of skeleton weed in eastern Australia also result in serious suppression the following year of most legume species due to their persistence in the soil or on stubbles. Kidd and Peirce (1999) showed in South Australia that lupins could still be included in rotations when picloram, one of the residual herbicides used for controlling/eradicating

skeleton weed in Western Australia, was applied at the rate of 150 g ai/ha two seasons before lupins were sown. Recent studies in Western Australia by Peirce and Rayner (2007) indicated that legumes can still remain part of a crop rotation when clopyralid, one of the products researched by Heap (1993), was used to control skeleton weed. Dhammu and Nicholson (2006a&b) showed that not all lupin species were tolerant to clopyralid and that the albus species *Andromeda* and Kiev mutant and the yellow lupin *Pootalong* were very sensitive to post-emergence applications. In addition it was also shown that certain *angustifolius* species of lupins have a higher tolerance to clopyralid than the local historic WA blue cosantini variety of lupin (Peirce and Rayner, 2007).

Results from the legume phase in three of the long term cropping rotation experiments in Western Australia and South Australia are reported.

1. Lupin tolerance to rates of 1–8 L/ha of clopyralid applied pre-sowing on a duplex soil in Western Australia.
2. Lupin tolerance to pre-sowing rates up to 1 L/ha and post-emergent rates up to 100 mL/ha on yellow sand plain soils in northern agriculture areas of Western Australia.
3. Lupin tolerance and skeleton weed control with pre-sowing and post-emergence applications of clopyralid on sandy soils in the eastern grain growing area of South Australia.

These were funded from the Skeleton Weed Eradication Trust Fund, which is raised from levees on grain production, and the Agriculture Protection Board of Western Australia contracted research to be carried out both in Western Australia and South Australia. The research was to investigate what effect a continuous cropping rotation incorporating the residual herbicide clopyralid would have on the reduction of skeleton weed. In addition it would provide information on the effect these residuals would have on the legume crop, in this case lupins, in the rotation. It was necessary to conduct some of the research outside Western Australia because skeleton weed was under an eradication program and there was not sufficient area of skeleton weed in a single infestation to conduct research to obtain measurements on herbicide performance. This

paper summarises the results of data collected during the lupin phase of the rotations.

MATERIALS AND METHODS

EXPERIMENT 1

Area treated with 1, 2, 4 and 8 L/ha of clopyralid (300 g/L) in August ten months prior to cropping to Myallie lupins the following year. Plots were 2.5 m x 5 m in the first year and 7.5 m x 10 m for the remainder of the experiment. The design was a randomised complete block with three replications. Glyphosate was used as a knockdown treatment before seeding in the first year. In following years the use of a knockdown was accompanied by 2 L/ha simazine (500 g/L) and 1.0 L of trifluralin (400 g/L) for grass and broadleaf weed control. Post-emergent applications of 150 mL/ha of diflufenican for control of a range of Brassicacea weeds. At grain maturity plots were machine harvested using a Wintersteiger small plot harvester and yields expressed as a percentage of the untreated plots receiving no clopyralid. In the fourth year plots were retreated using the same rates as used at the start of the experiment only this time they were applied about 3 months prior to sowing.

EXPERIMENT 2

A split plot design having three replications in both the main and sub plots was used for the trial at the Eradu Sandplain Research Annex in 2005. The site was burnt on 5 April. Pre-sowing treatments clopyralid (300 g/L) of 0, 150, 300 and 450 mL/ha were applied to the main plots on 20 April 2005. Spray.Seed® 1 L/ha and simazine 2 L/ha were applied over the entire trial on 6 May. Narrow leaf lupin Mandelup were sown at 100 kg/ha with 100 kg superphosphate on 16 May 2005 using bulk seeding equipment fitted with press wheels. Crop maintenance included dimethoate 800 mL on 25 May and applications of 150 mL/ha Brodal® plus 0.5 L simazine on 14 June. Further grass weed control was carried out on 27 June using Fusilade® 70 mL, Select® 250 mL and Hasten® 500 mL/ha. Post-emergent applications of clopyralid at 0, 50, 75 and 100 mL/ha were applied to the sub plots at two different times 22 June and 19 July 2005. Additional insect control was carried out with the trial treated with Dimethoate 800 mL and Fastac Duo® 300 mL/ha to control aphids and other pests in early and late September. Plots were machine harvested in November.

EXPERIMENT 3

The experiment was located in South Australia on a property some 3 km west of Geranium townsite 200 km east of Adelaide. The site had been used mainly for grazing and cropped approximately every five years. Skeleton weed was the dominant broadleaved weed with *Erodium* spp., capeweed *Arctotheca calendula*, flatweed *Hypochaeris radicata* the other broadleaved weeds present. Silvergrass *Vulpia* spp. was the dominant grass. The site was in pasture in 2001.

The experiment was a randomised complete block design having seven pre-sowing treatments with fourteen post-emergent treatments applied at right angles over each of the seven pre-sowing treatments. The pre- and post-treatments were replicated four times. Pre-sowing plots measured 10 m x 56 m, and post-emergent plots 82 m x 4 m (over seven (10 m) pre-sowing plots plus six x 2 m (12 m) of buffers. The two metre buffer between each pre-seeding treatment was to reduce any affects from spray drift. Each block measured 56 m x 82 m and there were 10 m buffers between blocks. The total area of the experiment, 254 m x 82 m, including buffers was 2.0828 ha. Each post-emergent treatment was applied across all seven of the pre-sowing treatments.

Sowing was done with an experimental seeder using a DBS Ausplow sowing assembly sowing 2 m each run. Sowing was done in the direction of the post-emergent treatments and two seeding runs were made down each 4 m x 82 m post-treatment plot. Five 1 m x 1 m fixed quadrats were located down the centre of each post-emergent treatment plot, with the centre of the first quadrat located 1.5 m in from the start of each plot and the distance between the centre of each quadrat was two metres. An initial count over all the plots on the numbers of skeleton weed rosettes within each quadrat was conducted in June 2002 before treatments were applied to obtain a base line of the population of skeleton weed. Further counts were conducted each year at the end of the season following harvest.

Wheat then barley were sown in the first two years, lupins in the third year, barley in the fourth and lupins in the fifth year of a continuous cropping rotation. In the second crop of lupins pre-sowing treatments of 250 mL and 1000 mL/ha of clopyralid (300 g/L) with 1 L/ha of MCPA (500 g/L) amine were applied some 3-4 weeks before sowing Mandelup lupins. Hand harvested samples were taken from 20 randomly selected lupin plants in each plot from blocks in three of the four replications.

RESULTS AND DISCUSSION

EXPERIMENT 1

Because there was no use of herbicides to control other weeds, mainly capeweed *Arctotheca calendula*, in the first year there was a positive yield response to the clopyralid that was applied some 10 months before sowing Myallie lupins (Table 1). In year two all treatments yielded less than the untreated with the 8 L/ha rate being only 10% less than the untreated. After three years there did not appear to be any negative residual affect on the lupins. By reapplying the clopyralid in the fourth year only the 8 L/ha rate caused any large decrease (20%) in yield. This equates to 16 L/ha of clopyralid in total used on this treatment. In the year following the second application all treatments yielded higher than the untreated. The only explanation for the large positive response with the use of these rates

of clopyralid is that summer rains caused large germinations of capeweed to occur over the summer and autumn months and this weed would have competed for

nutrients and moisture available for the winter growing crop.

Table 1. Effect of four rates of clopyralid on Myallie lupin yields (expressed as percentage of untreated).

Rate clopyralid L/ha	Year 1	Year 2	Year 3	Year 4*	Year 5
1	169	90	110	99	167
2	223	86	102	93	142
4	212	95	128	103	142
8	158	92	113	81	171

* Clopyralid replied at same rates for each treatment.

EXPERIMENT 2

The narrow leaf lupin Mandelup tolerated up to 450 mL/ha of clopyralid pre-sowing and post-emergent applications up to 100 mL without showing any significant yield losses (Table 2). No measurements

were taken but observations noted that clopyralid also was more damaging on the blue (sandplain) lupins contaminating the trial site.

Table 2. Effect of clopyralid on yield (t/ha) of narrow leaf lupins (Mandelup) treated pre-sowing and post-emergence.

Post-emergent		Pre-sowing Clopyralid mL/ha				Post-em. averages
Clopyralid mL/ha	Application time	150	300	450	Nil	
50	22 June 2005	2.44	2.41	2.43	2.52	2.45
75		2.37	2.26	2.33	2.22	2.30
100		2.39	2.17	2.22	2.24	2.25
Nil		2.43	2.33	2.35	2.20	2.33
50	19 July 2005	2.31	2.35	2.35	2.22	2.31
75		2.33	2.26	2.22	2.28	2.27
100		2.35	2.24	2.30	2.24	2.28
Nil		2.30	2.28	2.33	2.26	2.29
Pre-sowing averages		2.37	2.29	2.32	2.27	

lsd (0.05)

Pre-treatments – 0.09

Post-treatments – 0.16

EXPERIMENT 3

No control of skeleton weed caused a total failure of the lupin crop (Table 3). The use of 250 or 1000 mL of clopyralid some weeks before sowing had no detrimental effect on the Mandelup lupins and there was a yield response with increasing the rate from 250 mL to

1000 mL/ha. Post-emergent use in three previous cereal crop seasons also had no detrimental effect. The post-sowing use over the three seasons had caused a significant reduction in skeleton weed density which was reflected in the higher lupin yields.

Table 3. Effect of pre-sowing applications of clopyralid plus MCPA on lupin yield 2006 (g/20 plants).

Crop stage	Post-emergent treatments 2002, 2003 and 2005 applied to cereals	Pre-sowing treatments 2006 Clopyralid + MCPA 1 L/ha Plant counts m ⁻² in parenthesis					
		(Pre treatment no.)	Rate of clopyralid				
			250 mL	1000 mL	Nil		
Z 13 to Z 22	Nil	45.9	(31.5)	76.2	(8.3)	0.0	(62.5)
	clopyralid 300 mL	54.1	(12.1)	92.3	(3.7)	52.6	(17.1)
	clopyralid 300 mL + MCPA 1 L/ha	76.0	(9.8)	117.3	(1.6)	90.3	(8.7)
	clopyralid 300 mL + 2,4-D 1 L/ha	66.8	(10.0)	105.1	(2.1)	55.5	(15.1)
	MCPA 1 L/ha	65.1	(20.6)	96.1	(3.5)	26.9	(28.9)
	2,4-D 1 L/ha	47.4	(20.8)	88.4	(3.2)	20.7	(22.5)
	clopyralid 250 mL + metsulfuron 5 g + MCPA 1 L/ha	70.3	(12.0)	86.5	(4.6)	59.5	(9.2)
Z 49 to Z 59	clopyralid 300 mL	91.0	(4.1)	109.4	(1.0)	83.1	(6.6)
	clopyralid 300 mL + MCPA 1 L/ha	119.0	(1.7)	110.7	(0.6)	82.3	(4.1)
	clopyralid 300 mL + 2,4-D 1 L/ha	69.1	(2.8)	90.6	(0.3)	75.5	(4.6)
	MCPA 1 L/ha	40.0	(11.9)	106.5	(2.6)	10.5	(34.8)
	2,4-D 1 L/ha	66.7	(6.6)	91.6	(2.3)	31.7	(15.7)
	clopyralid 250 mL + metsulfuron 5 g + MCPA 1 L/ha	81.1	(2.8)	102.3	(1.1)	85.4	(4.1)
	Tordon 242 1 L/ha	41.6	(6.5)	103.8	(0.8)	79.9	(8.1)
Pre-sowing means		66.7	(10.9)	98.3	(2.6)	53.8	(17.3)

To compare treatment means for plant counts LSD (5%) = 8.

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