METRIBUZIN AS A BROAD-LEAVED POST-EMERGENCE HERBICIDE FOR NARROW LEAF LUPINS

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Summary. Metribuzin has been suggested as an alternative herbicide to use post-emergence on triazine tolerant lupin cultivars to control broad-leaved weeds. In 1992 a series of field trials were conducted in lupin growing areas of the West Australian wheatbelt to determine both the tolerance and efficacy of metribuzin use post-emergence. Sites chosen had doublegee, wild radish, fumitory plus a variety of grasses surviving the simazine applied immediately before seeding (IBS). The tolerant variety Gungurru allowed good selectivity with metribuzin. Application rates of 70 g/ha a.i. controlled small doublegee and radish. Large weeds required 100 g/ha for control.

INTRODUCTION

Simazine is routinely applied immediately before seeding (IBS) to narrow leaf lupin, *Lupinus angustifolius*, crops as the main herbicide to control the majority of weeds in Western Australia. Post-emergence broad-leaved weed control remains a problem in certain situations. Previous work has shown that the variety Gungurru is more tolerant to triazine herbicides than Danja and some other, older varieties (1). Merrit is also a triazine tolerant cultivar.

The current herbicide options for post-emergence broad-leaved weed control are either simazine top-up or diflufenican. There is little leaf uptake of simazine and moist soil is required for the herbicide to work effectively. Large weeds, especially transplants, are difficult to control as the simazine remains near the surface and their roots extend below the treated layer. Diflufenican, the other option, is used to control wild radish, *Raphanus raphanistrum*, but has a limited weed spectrum.

Metribuzin, a triazinone, has been suggested as an alternative herbicide to use post-emergence on triazine tolerant cultivars. It has the advantages of higher water solubility and leaf uptake than simazine along with a broader weed control spectrum. Herbicide tolerance trials have confirmed that triazine tolerant cultivars also tolerate metribuzin. Variation in metribuzin tolerance of different crop cultivars has been shown in soybeans (5) and wheat (3).

In 1992 a series of field trials were conducted to determine the tolerance and efficacy of metribuzin alone, or in mixtures for post-emergence use on lupins. The target weed species were doublegee, *Emex australis*, wild radish, fumitory, *Fumaria muralis* and a variety of grasses (mainly *Lolium rigidus* and *Bromus* spp.) that had either been transplanted or had survived the IBS simazine application.

METHODS

In 1992 five replicated trials were conducted in commercially grown crops of Gungurru lupins in Western Australia (Table 1). Three sites had weeds surviving the IBS simazine applications at the rate recommended for each soil type, while two had low weed numbers and were used to determine crop tolerance. The trial design used was a randomised block design with 3 replications of plots 3x20 m. The area harvested in each plot was 1.4x20 m.

The herbicide treatments included a metribuzin response curve 50-210 g/ha, diflufenican 75 g/ha, simazine top-ups 500 and 1100 g/ha, and combinations of metribuzin with crop oil, simazine, grass selective herbicides and diflufenican (Table 2). Assessments included visual ratings, weed and lupin plant counts and grain yields.

The yield data was analysed by a nearest neighbour technique (Spatial Analysis of Field Experiments (2)) prior to analysis of variance.

Table 1. Description of 1992 trial sites.

Site	Soil type	BS simazine kg/ha	Dominant weeds	Crop stage sprayed
Wongan Hills	yellow clay sand Uc5.22	1.6	nil	6-8 leaf
Yelbeni	sandy duplex Dy4.82	1.1	nil	3 leaf
Yorkrakine	loamy sand Dy4.83	1.1	doublegee, radish, bromegrass	3-5 leaf
Yealering	loamy sand, poorly drained Dy5.41	1.1	doublegee, radish, ryegrass	6-10 leaf
Mt Barker	loamy duplex Dg1.41	1.1	fumitory, ryegrass	3 leaf

RESULTS AND DISCUSSION

Tolerance. Soon after application of metribuzin there was marked leaf yellowing and leaf tip burning, and at the highest rates there was also leaf drop. The crop growth was retarded by about one week but within 2 to 3 weeks there were no colour differences between treatments. Plots treated with greater than 140 g/ha of metribuzin, or with crop oil additives, were slightly shorter and bushier than untreated plots.

Gungurru lupins tolerated the highest rate of metribuzin tested at all sites without any loss of grain yield (Table 2). The required rate is between 70-100 g/ha depending on target weeds. The resulting yields were similar to those from simazine at each site. Mixtures with diflufenican, grass selectives and simazine were all tolerated in these trials.

The addition of spray oils to metribuzin could not be recommended at the 105 g/ha rate as this treatment showed the greatest visual damage after spraying. This did not translate into significant yield reductions but would cause concern to growers. The possibility of reducing metribuzin rates by the addition of oil has not been investigated. The severity of brown leaf spot (*Pleiochaeta*) was not increased by application of metribuzin at Yorkrakine, the one site infected, though the addition of oil or diflufenican increased the severity of infection.

Yields at both Mt Barker (weedy) and Wongan Hills (weed-free) were increased significantly by herbicide application (Table 2). The yield increase at Mt Barker was problably due to removal of competition from fumitory. The increase in yields at Wongan Hills may have been caused by stress inducing increased pod set or the reduced leaf area in early winter which conserved soil water for use in late spring. The untreated plots were vegetative but didn't set many pods.

Table 2. Yields of Gungurru lupins treated with metribuzin or alternative herbicides at five sites in 1992 expressed as percent untreated.

Post-emergence treatment	Rate g a.i./ha	Wongan Hills	Yelbeni	Yorkrakine	Mt Barker	Yealering
untreated (kg/ha)		1438	948	981	1270	1274
diflufenican	75	106	109	98	109	95
simazine	500	106	108	105	135	95
simazine	1100	108	97	112	135	115
metribuzin	52	113	115	108	118	
metribuzin	70	118	100	109	133	103
metribuzin	105	110	99	106	122	94
metribuzin	210	116	98	99	139	
metribuzin + oil (Ulvapron)	105 + 1%	109	99	92	143	109
metribuzin + simazine	70 + 500	110	100	115	159	99
metribuzin + diflufenican	105 + 50	113	106	104	137	92
metribuzin + sethoxydim	105 + 50	112[a]	108[a]	101	141	117
l.s.d. P=0.05		11	ns	15	22	18

[a] 100g/ha sethoxydim applied at Yelbeni and Wongan Hills

In lupins only 40% of final biomass is produced prior to flowering so flowers compete with lateral branch growth for assimilates. Bulky impressive crops tend to produce disappointing yields and it has been suggested that an environmental stress is needed to increase the number of pods set rather than to produce leafy plants. Metribuzin has been suggested as a growth regulator in lupins to cause stress and increase pod set. However trials where metribuzin has been applied at flowering have not reliably increased yields (Seymour, pers. comm.).

Efficacy. Metribuzin gave good control of doublegees. The rate required for control of small doublegee (3-4 leaf) was 70 g/ha (Table 3) but for larger plants (>5-6 leaf) 100 g/ha was needed (not shown). Low rates of metribuzin (<50 g) did not kill all small doublegee plants but allowed lupins to suppress weeds by shading. The doublegee were prevented from vining through the lupin canopy so avoiding contamination at harvest and reducing seed set. Low densities of doublegee cause yield losses by vining through the canopy and expand to occupy any available space. Small wild radish plants (3-4 leaf) were controlled by 70 g/ha, the same rate as used for doublegee.

In several small ancillary trials, mixtures of metribuzin and simazine, or metribuzin and diflufenican gave the best control of large, transplanted doublegee. In farmer use, the best control of large wild radish plants (up to 1 m in diameter and height) came from a mixture of 105 g/ha metribuzin plus 50 g/ha diflufenican which controlled all plants (Bowran unpublished data). There is no other herbicide option for this size plant.

There appeared to be synergism between mixtures of metribuzin and diflufenican at low application rates. It is possibile that diflufenican, or surfactants in the formulation, are enhancing leaf uptake of metribuzin. Using spray oils could also have this effect as it increased the activity of metribuzin as shown by increased leaf damage in lupins. The addition of crop oils to atrazine significantly increases leaf uptake (4). Leaf uptake is most important with large, established weeds as their deep taproots enable them to escape herbicides applied to the soil surface.

Table 3. Weeds present (plants/m^2) at two sites treated with metribuzin or alternative herbicides. Counts taken six weeks after application

Post-emergent treatment weed stage at application	Rate g a.i./ha	Yorkrakine		Mt Barker	
		doublegee (3-4 leaf)	bromegrass (2 leaf)	fumitory (2 leaf)	ryegrass (2 leaf)
untreated (kg/ha)		9.6	28.9	34.8	60.0
diflufenican	75	5.4	17.9	1.8	51.6
simazine	500	4.7	21.1	0	8.6
simazine	1100	2.1	11.4	0	2.4
metribuzin	52	3.6	23.6	0	46.8
metribuzin	70	2.1	8.6	0	43.8
metribuzin	105	2.6	22.3	0	19.2
metribuzin	210	0.5	12.9	0	15.0
metribuzin + oil (Ulvapron)	105 + 1%	1.5	23.6	0	17.4
metribuzin + simazine	70 + 500	0.5	11.8	0	4.8
metribuzin + diflufenican	105 + 50	1.1	31.5	0	18.0
metribuzin + sethoxydim	105 + 50	5.4	24.3	0	2.0
l.s.d. P=0.05		3.9	17.4	2.3	9.8

Fumitory was controlled by 50 g/ha metribuzin but 0.5 kg/ha simazine gave an equal result (Table 3). At an adjacent trial, fumitory was also removed by either simazine or metribuzin (Gilbey pers. comm.). Economics dictate that simazine would be the better option for fumitory control in moist soil conditions.

Grass control with metribuzin was unreliable. At Mt Barker the better results came from the simazine options (Table 3). Simazine at 1.1 kg/ha controlled 96% of ryegrass, equal to sethoxydim. 105 g/ha of metribuzin gave control of 68% of ryegrass plants but there was little benefit from doubling the rate to 210 g/ha (75% control). This is less than a grass selective herbicide would achieve if there was no herbicide resistance. However, at a herbicide resistant ryegrass site where metribuzin was used as an alternative grass selective herbicide in lupins, control was equal to carbetamex but at lower cost (Gill, pers. comm.). Control of bromegrass in wheat with metribuzin has been unreliable post-emergence, and more effective if applications are followed by rain (3). The Yorkrakine site was dry for two weeks after application and numbers variable across the site so control was erratic.

Using two related chemicals, simazine and metribuzin, in the same lupin crop has implications for herbicide resistance development. Annual ryegrass has not developed resistance to simazine under current lupin cropping rotations, probably due to a limited kill of 60-80% of ryegrass plants. Because metribuzin has the same site of action as simazine their combined use will increase selection pressure for resistance in ryegrass. If metribuzin is used as an alternative to grass selective herbicides ('fops' and 'dims') then these may be saved for less frequent use in other parts of the rotation. The target weed species were not grasses in most situations and grass control was a bonus to controlling broad-leaf weeds.

To conclude, metribuzin was a viable option to control broad-leaved weeds in lupin crops and may have advantages in dry soil conditions or when the target broad-leaved weeds are large. The tolerance of Gungurru to triazines allowed good selectivity at weed control rates.

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