Metribuzin tolerance of EGA Eagle Rock wheat

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Summary Three field experiments were conducted under weed free conditions on a range of soil types in Western Australia from 2003 to 2005 to evaluate the tolerance of wheat cv. EGA Eagle Rock to metribuzin. Blade was included in the experiments as known metribuzin tolerant wheat variety and Camm or Spear as a sensitive variety. The wheat varieties were planted in strips, and cross sprayed with metribuzin alone and in mixtures with other herbicides as pre- and post-emergent applications. The wheat varieties were sown using knife points and press wheels.

The results revealed that EGA Eagle Rock and Blade tolerated pre-emergent metribuzin up to 600 g a.i. ha^{-1} (four times the registered rate) and 150 g a.i. ha^{-1} applied as a tank mix with pendimethalin, trifluralin, diuron or diuron + s-metolachlor. At 450 and 600 g a.i. ha^{-1} metribuzin, Camm and Spear had significantly less grain yield compared to their untreated controls in 2003 and 2005, respectively. EGA Eagle Rock does not appear to have cross-tolerance to triazines at rates that give good broadleaf weed control (e.g. atrazine at 1000 g a.i. ha^{-1}). EGA Eagle Rock tolerated post-emergent metribuzin up to 450 g a.i. ha^{-1}. Blade and Spear had significantly less grain yield at this rate in 2005. Post-emergent tank mixed application of metribuzin at 150 g a.i. ha^{-1} with bromoxynil + diflufenican, MCPA + diflufenican, sulfosulfuron or mesosulfuron-methyl at Z12-Z14 were safe on EGA Eagle Rock. Pre-emergent metribuzin at 150 g a.i. ha^{-1} followed by sulfosulfuron at Z12-Z13 or mesosulfuron-methyl at Z13-Z14 was also safe to the variety.

Keywords EGA Eagle Rock, metribuzin, wheat.

INTRODUCTION

Metribuzin is an inhibitor of photosynthesis that is registered as pre-emergent at 150 g a.i. ha^{-1} alone or in mixture with trifluralin at 480 g a.i. ha^{-1} in wheat (*Triticum aestivum* L.) cv. Blade only. EGA Eagle Rock was released during 2004, has Blade as one of the parents (Blade*2/Sunelg) and is considered tolerant to metribuzin. This variety is Australian hard, has good pre-harvest sprouting tolerance and triple rust and powdery mildew resistance (Garlinge 2005). The use of metribuzin with this variety could help to manage problematic weeds like brome grass (*Bromus* spp.), barley grass (*Hordeum* spp.), ryegrass (*Lolium rigidum* Gaudin) and wild radish (*Raphanus raphanistrum* L.). The objective of this study was to evaluate tolerance of EGA Eagle Rock to metribuzin, alone and in mixtures, both pre-and post-emergent in comparison to Blade (metribuzin tolerant) and Camm or Spear (metribuzin sensitive) wheat varieties.

MATERIALS AND METHODS

Field experiments were conducted on sandy loam (pH 6.4), clay loam (pH 6.0) and sandy (pH 5.5) soils at Mullewa (MW) Research Station, Merredin (ME) Research Station, and Eradu (ER) Sandplain Research Annex during 2003, 2004 and 2005, respectively in the Mediterranean environment of Western Australia. The experiments were laid out in strip plot design with three replications. The varieties were sown in 10 m wide parallel strips at 57, 60 and 78 kg ha^{-1} seed rate, 3–4 cm deep using knife points followed by press wheels on 25 cm row spacing on 6 June 2003, 15 June 2004 and 23 May 2005 at Mullewa, Merredin and Eradu, respectively. Finger harrows were used to fill the seeding furrows at Mullewa during 2003. The soil moisture at planting was 42, 100 and 88 % of the field capacity (0–10 cm) during 2003, 2004 and 2005 respectively. The field capacity and moisture content of the experimental sites was determined by following Gravimetric method. The herbicide treatments were applied in 3 m wide strips using boom sprayer calibrated to deliver 94 L ha^{-1} at 200 kPa with flat fan nozzles. The varieties and herbicide treatments were randomised within each replicate. Systematic untreated control plots were included to check the spatial variability. The net plot size was 9.2 m × 1.38 m, 10 m × 1.7 and 10 m × 1.8 m during 2003, 2004 and 2005 respectively. The experiments were harvested in November at all sites. Total rainfall from May to November at Mullewa, Merredin and Eradu was 182.4, 210.6 and 389.2 mm, in 2003, 2004 and 2005 respectively.

To determine the effect of herbicides on plant density, the wheat plants were counted from two randomly selected 33 cm × 33 cm quadrats per plot, 48, 87, 46 days after seeding (DAS) the experiments at Mullewa, Merredin and Eradu, respectively and reported as plants m^{-2}. Following the same methods, ear heads were counted 129, 149 and 102 DAS. The wheat varieties were also evaluated for visual injury at 2–4 weeks after treatment application and again at crop anthesis using a 0 to 100 % scale, where 0 = no visible injury and 100 = complete plant death. Wheat plant and head counts, and grain yield were analysed by ANOVA using Genstat, and the LSD (P = 0.05) calculated.

RESULTS AND DISCUSSION

Mullewa 2003 Metribuzin at 150 g a.i. ha^{-1} significantly reduced plant density of Camm compared to its untreated control. EGA Eagle Rock and Blade density were not affected significantly up to 225 g a.i. ha^{-1} (Table 1). However, at 450 g a.i. metribuzin ha^{-1}, the number of plants was significantly lower than the control for all varieties.

A similar trend to plant density was observed for the number of ear heads of Blade and EGA Eagle Rock (Table 1). Head counts suggested that compensatory growth of Camm had occurred (Table 1). None of the metribuzin rates tested caused significant yield reduction in EGA Eagle Rock and Blade compared to their untreated controls (Table 2). Metribuzin at 450 g a.i. ha^{-1} caused significant yield reduction in Camm compared to its untreated control and all the other metribuzin rates (Table 2).

Merredin 2004 Application of pre-emergent metribuzin up to 450 g a.i. ha^{-1} did not affect wheat plant count, head numbers or grain yield of any of the varieties significantly (Tables 1 and 2). However, pre-emergent metribuzin 450 g a.i. ha^{-1} caused on average 12% biomass reduction across all the varieties which were visible on 149 DAS the crop (data not shown). Post-emergent metribuzin at 450 g a.i. ha^{-1} reduced plant density and number of heads of Spear significantly without any significant effect on grain yield. Post-emergent metribuzin at 300 g a.i. ha^{-1} + BS 1000 resulted in significant yield reduction in Spear only (Tables 2 and 3). Post-emergent metribuzin at 150 g a.i. ha^{-1} applied mixed with sulfosulfuron and mesosulfuron-methyl caused on an average 15–17 % biomass reduction across all the varieties but there was no significant effect on the grain yield (Table 2).

Atrazine at 1000 g a.i. ha^{-1} resulted in significantly fewer plants and heads across all the varieties and also reduced grain yield of EGA Eagle Rock and Spear significantly. Simazine at 1000 g a.i. ha^{-1} reduced plant density of Spear and heads of both Spear and EGA Eagle Rock significantly, but had no significant effect on grain yield of any variety (Tables 2 and 3). These treatments caused 5–10% biomass reduction in all the varieties, with atrazine effects more pronounced than simazine.

Eradu 2005 As at the Mullewa site, pre-emergent metribuzin at 150 g a.i. ha^{-1} reduced the plant numbers of Spear significantly. Plant densities of all the varieties were reduced significantly by metribuzin at 600 g a.i. ha^{-1}. Head counts indicated that compensatory growth occurred across all the varieties (Table 1).

Metribuzin at 600 g a.i. ha^{-1} did not significantly reduce grain yield of EGA Eagle Rock and Blade, but did significantly reduce grain yield of Spear (Table 2). All rates of post-emergent metribuzin significantly reduced plant density across all varieties except EGA Eagle Rock at 150 g a.i. ha^{-1} (Table 3). The reduced

Table 1. Effect of pre-emergent metribuzin rates on plant density and number of ear heads of different wheat varieties, expressed as per cent of control (0). The figures in the control treatment column are absolute numbers m^{-2} (100 %).

Location	Metribuzin g a.i. ha^{-1}						LSD
Variety	0	150	225	300	450	600	(0.05)
Plant density (% control)							
MW 03[A]							
Blade	180	98	97	*	78	*	19
Eagle	186	96	95	*	81	*	18
Camm	130	69	68	*	21	*	26
ME 04							
Blade	112	104	*	90	110	*	23
Eagle	110	93	*	109	90	*	23
Spear	111	98	*	81	89	*	23
ER 05							
Blade	290	99	*	95	*	67	17
Eagle	342	98	*	100	*	81	14
Spear	344	76	*	55	*	17	14
Number of ear heads (% control)							
MW 03							
Blade	305	93	97	*	78	*	16
Eagle	314	94	96	*	84	*	16
Camm	289	96	88	*	43	*	17
ME 04							
Blade	373	105	*	103	99	*	12
Eagle	399	94	*	97	95	*	11
Spear	383	107	*	96	96	*	11
ER 05							
Blade	419	94	*	105	*	90	13
Eagle	471	95	*	94	*	93	12
Spear	453	100	*	82	*	16	12

[A] MW = Mullewa, ME = Merredin, ER = Eradu, Eagle = EGA Eagle Rock, * = treatment was not tested.

Table 2. Effect of treatments on grain yield (percent of control) of wheat varieties at different locations.

Herbicides g a.i. ha^{-1}	Mullewa 2003			Merredin 2004			Eradu 2005		
	Blade	Eagle[A]	Camm	Blade	Eagle	Spear	Blade	Eagle	Spear
Control (Grain yield kg ha^{-1})	100 (926)	100 (910)	100 (831)	100 (1332)	100 (1360)	100 (1449)	100 (1764)	100 (1532)	100 (2016)
Pre-emergent treatments									
Metribuzin 75	*	*	*	*	*	*	103	100	103
Metribuzin 112.5	100	99	100	106	102	104	*	*	*
Metribuzin 150	103	100	104	112	110	100	97	100	93
Metribuzin 225	100	100	94	*	*	*	*	*	*
Metribuzin 300	*	*	*	108	99	92	113	110	89
Metribuzin 450	101	101	69	96	108	86	*	*	*
Metribuzin 600	*	*	*	*	*	*	102	106	20
Atrazine 250	*	*	*	*	*	*	102	103	97
Atrazine 500	*	*	*	*	*	*	102	110	100
Atrazine 1000	*	*	*	98	73	74	*	*	*
Simazine 500	*	*	*	*	*	*	98	103	92
Simazine 1000	*	*	*	94	88	84	80	87	73
Metribuzin 150 + Pendimethalin 594	*	*	*	102	112	97	113	124	103
Metribuzin 150 + Trifluralin 960	*	*	*	87	105	86	107	117	109
Metribuzin 150 + Diuron 500	*	*	*	109	103	106	*	*	*
Metribuzin 150 + Diuron 500 + S-Metolachlor 240	*	*	*	98	104	88	*	*	*
Post-emergent (Z12-Z14) treatments									
Metribuzin 150	*	*	*	107	110	104	103	111	81
Metribuzin 300	*	*	*	109	92	101	103	109	62
Metribuzin 300 + WA	*	*	*	98	102	77	92	110	66
Metribuzin 450	*	*	*	101	100	88	81	89	25
Metribuzin 150 + Bromoxynil 125 + Diflufenican 12.5	*	*	*	92	94	93	*	*	*
Metribuzin 150 + MCPA 125 + Diflufenican 12.5	*	*	*	89	104	90	*	*	*
Metribuzin 150 + Sulfosulfuron 9.4	*	*	*	95	91	93	*	*	*
Metribuzin 150 (pre-em.) fb Sulfosulfuron 18.75	*	*	*	*	*	*	110	114	107
Metribuzin 150 + Mesosulfuron 4.9	*	*	*	108	104	90	*	*	*
Metribuzin 150 (pre-em.) fb Mesosulfuron 9.9	*	*	*	*	*	*	117	124	113
LSD (0.05)	15	15	17	18	16	17	17	14	14

[A] Eagle = EGA Eagle Rock, Mesosulfuron = mesosulfuron-methyl, WA = wetting agent (BS1000 0.25% v/v), pre-em. = pre-emergent, fb = followed by, * = treatment was not tested.

Table 3. Effect of pre-emergent simazine and atrazine, and post-emergent metribuzin rates (Z12–Z14) on plant density and number of heads of different wheat varieties, expressed as per cent of control (0). The figures in the control treatment column are absolute numbers m^{-2} (100%).

Location	Herbicides g a.i. ha^{-1}									
Variety	Control	Simazine		Atrazine		Metribuzin				LSD
	0	500	1000	500	1000	150	300	300 + WA	450	(0.05)
Plant density (% control)										
ME 04[A]										
Blade	112	*	81	*	66	97	101	109	104	23
Eagle	110	*	84	*	61	98	111	111	91	23
Spear	111	*	75	*	61	93	98	91	71	23
ER 05										
Blade	290	71	67	75	*	82	57	56	38	17
Eagle	342	81	65	77	*	87	72	57	48	14
Spear	344	79	52	69	*	63	28	22	4	14
Number of ear heads (% control)										
ME 04										
Blade	373	*	90	*	87	103	91	98	96	12
Eagle	399	*	83	*	77	96	92	89	91	11
Spear	383	*	79	*	73	97	93	93	86	11
ER 05										
Blade	419	93	87	100	*	101	99	77	74	13
Eagle	471	93	89	100	*	99	93	88	67	12
Spear	453	94	64	86	*	82	47	37	9	12

[A] ME = Merredin, ER = Eradu, Eagle = EGA Eagle Rock, WA = wetting agent (BS 1000 0.25 % v/v), * = treatment was not tested.

plant density of EGA Eagle Rock and Blade was fully compensated with increased heads up to the 300 g a.i. ha^{-1} rate and partially for higher rate. As a result, EGA Eagle Rock tolerated post-emergent metribuzin up to 600 g a.i. ha^{-1} and Blade up to 300 g a.i. ha^{-1}, whereas Spear showed sensitivity to all the rates tested (Table 2).

Simazine (500 and 1000 g a.i. ha^{-1}) and atrazine (500 g a.i. ha^{-1}) reduced plant numbers across all the varieties (Table 3). Grain yields were not significantly reduced with 500 g a.i. ha^{-1} simazine or atrazine and Eagle Rock was the only variety that tolerated the higher rates of simazine (Table 2).

CONCLUSIONS

EEGA Eagle Rock wheat has useful tolerance to pre-emergence metribuzin and is similar to Blade, which has been widely grown to control brome grass with metribuzin. Early post-emergence application of metribuzin at 150 g a.i. ha^{-1} appeared safe to EGA Eagle Rock with good crop safety margins even on a sandy soil. However, metribuzin as post-emergent at 150 g a.i. ha^{-1} is not currently registered in wheat. The partial tolerance of EGA Eagle Rock to simazine and atrazine will be useful where farmers want to grow wheat following lupins (*Lupinus* spp.) or TT canola (*Brassica napus* L.) or summer crops and triazine residues are a concern.

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