Herbicide tolerance in pasture legumes and herbs

Peter Lockley and Hanwen Wu
EH Graham Centre for Agricultural Innovation, Wagga Wagga Agricultural Institute, PMB, Wagga Wagga, New South Wales 2650, Australia
Email: hanwen.wu@dpi.nsw.gov.au

Summary Herbicides are a valuable tool that can be used to facilitate successful establishment of pasture and forage species. Care needs to be taken when choosing which species to include in a pasture mix. This project evaluated the feasibility of using several pre-emergent, post-sowing pre-emergent, early post-emergent and late post-emergent herbicides on a range of pasture legume and herb species. TriflurX® and Stomp® both incorporated by sowing, were found to cause minimal damage to most species. All the post-sowing pre-emergent herbicides evaluated caused unacceptable damage, except atrazine and simazine on woolly pod vetch. Species varied considerably in their tolerance to post emergent herbicides. The results indicate that it is very important to choose species in a forage mix that have similar herbicide tolerance to maximise the herbicide options available. However, herbicides should not be used as the only option to control pasture weeds. Prior preparation of paddocks through use of cropping or pasture cleaning can greatly reduce weed burdens. An integrated approach to weed control will always be the most successful strategy.

Keywords Herbicide, herbicide tolerance, pasture weed management, pasture legumes, pasture herbs.

INTRODUCTION

In recent years a wide variety of highly productive pasture legumes and herbs have become available for sowing in a forage mix. It is important when choosing species to include in such a mix, that they have similar herbicide tolerance to the broadleaf herbicides available for weed control.

Relatively little information is available on herbicide tolerance of new legume and herb species in Southern NSW. A field research project was therefore undertaken to assess the tolerance of a range of forage species to commonly used herbicides and herbicide mixtures.

MATERIALS AND METHODS

2004 A range of legume and herb species were sown in long strips (four replicates) directly into a burnt oat stubble at Wagga Wagga Agricultural Institute on 27 May 2004 (Table 1). The soil was a red-brown earth with pH_{CaCl_2} of 4.5.

All species were sown with a cone seeder fitted with inverted 'T' type narrow points with a 17.5 cm row spacing. Seed rows were firmed with a trailing press wheel. All species were sown at 12 kg ha^{-1} except vetch which was sown at 40 kg ha^{-1}. Fertiliser (13.5% P, 6.5% S) was applied at sowing at 135 kg ha^{-1}.

Herbicides were either incorporated by sowing (IBS), as a post-sowing pre-emergent (PSPE), as an early post-emergent (EPE) at the 3–4 leaf stage, or at full canopy cover (FC) (Table 2).

Herbicides were applied in strips 2 m wide perpendicular to the direction of sowing using a tractor mounted compressed-air sprayer at 150 kPa through XR8002VS nozzles. Rate of water applied was 100 L ha^{-1}. Details of herbicide application rates can be found in Table 2.

Assessment of herbicide damage was made by harvesting an area 1.5 m × 1.45 m using a sickle-bar mower on 26 October 2004.

2005 The experiment was repeated, sown on 17 June due to the late seasonal break. Assessment of herbicide damage was made on 2 November 2005.

Table 1. Pasture species sown for evaluation of herbicide tolerance in 2004 and 2005.

Common name	Botanical name	Cultivar
Annual legumes:		
Arrowleaf clover	*Trifolium vesiculosum*	Cefalu
Balansa clover	*Trifolium michelianum*	Frontier
Berseem clover	*Trifolium alexandrinum*	Elite II
Biserrula	*Biserrula pelecinus*	Casbah
Woolly pod vetch	*Vicia villosa*	Capello
Gland clover	*Trifolium glanduliferum*	Prima
Persian clover	*Trifolium resupinatum* var. *majus*	Laser
Purple vetch	*Vicia benghalensis*	Popany
Rose clover	*Trifolium hirtum*	Hykon
French serradella	*Ornithopus sativus*	Erica
Biennial legumes:		
Sulla	*Hedysarum coronarium*	Aokau
Perennial herb:		
Chicory	*Chicorium intybus*	Puna
Plantain	*Plantago lanceolata*	Tonic

RESULTS AND DISCUSSION

Without in crop weed control the cost of seed, fertiliser and sowing plus any benefit from weed reduction in following years would be totally lost. A 30% yield reduction therefore, even though always statistically significant, is considered an 'acceptable level of damage' to protect that initial investment and any subsequent benefits. Tables 3 and 4 provide yield data (expressed as percentage of untreated) for the legumes and herbs evaluated with the range of herbicides and timings.

Table 2. Herbicides tested and rates of application on annual legumes, biennial legume and perennial herbs.

Trade name	Active ingredient (concentration)	Application rate (ha^{-1})	Adjuvant
Incorporate by sowing (IBS)			
TriflurX®	trifluralin (480 g L^{-1})	1.5 L	
Stomp®	pendimethalin (300 g L^{-1})	1.2 L	
Applied post-sow pre-emergent			
Various	atrazine (500 g L^{-1})	1.5 L	
Various	simazine (500 g L^{-1})	1.5 L	
Spinnaker®	imazethepyr (700 g kg^{-1})	100 g	
Lexone® DF	metribuzin (750 g kg^{-1})	380 g	
Various	atrazine (500 g L^{-1}) and simazine (500 g L^{-1})	750 mL and 750 mL	
Applied post-emergent			
Broadstrike®	flumetsulam (800 g kg^{-1})	25 g	Uptake® 0.5%
Spinnaker	imazethepyr (700 g kg^{-1})	200 g	Hasten® 0.5%
Sniper® [A]	picolinafen (750 g L^{-1})	50 g	
Sniper	picolinafen (750 g L^{-1})	45 g	
Raptor® WG	imazamox (700 g L^{-1})	50 g	Hasten 0.5%
Various	2,4-DB (500 g L^{-1})	3 L	
Jaguar®	bromoxynil (250 g L^{-1}) + diflufenican (25 g L^{-1})	1 L	
Various[B]	MCPA amine (500 g L^{-1})	1.5 L	
Various	MCPA amine* (500 g L^{-1})	750 mL	
MCPA LVE®	MCPA (500 g L^{-1})	750 mL	
Brodal®	diflufenican (500 g L^{-1})	200 mL	
Diuron and Broadstrike®	diuron (500 g L^{-1}) and flumetsulam (800 g kg^{-1})	100 mL and 25 g	Uptake 0.5%
Various	bromoxynil (200 g L^{-1})	2 L	
Dual Gold®	S-metolachlor (960 g L^{-1})	200 mL	
Igran®	terbutryn (500 g L^{-1})	750 mL	
Agtryne MA®	terbutryn (275 g L^{-1}) + MCPA (160 g L^{-1})	1 L	
Tigrex®	MCPA (250 g L^{-1}) + diflufenican (25 g L^{-1})	1 L	
Select®	clethodim (240 g L^{-1})	200 mL	Uptake 0.5%
Verdict®	haloxyfop-R (520 g L^{-1})	100 mL	Uptake 0.5%
Igran® and MCPA amine	terbutryn (275 g L^{-1}) + MCPA amine (500 g L^{-1})	500 mL and 500 mL	
Simazine and Jaguar	simazine (500 g L^{-1}) and bromoxynil (250 g L^{-1}) + diflufenican (25 g L^{-1})	500 mL and 750 mL	
Broadstrike® and Jaguar	flumetsulam (800 g kg^{-1}) and bromoxynil (250 g L^{-1}) + diflufenican (25 g L^{-1})	25 g and 750 mL	
Broadstrike and Igran®	flumetsulam (800 g kg^{-1}) and terbutryn (500 g L^{-1})	25 g and 200 mL	
Broadstrike and MCPA amine	flumetsulam (800 g kg^{-1}) and MCPA amine (500 g L^{-1})	25 g and 500 mL	Uptake 0.5%
Applied at full canopy			
Gramoxone®	paraquat (250 g L^{-1})	2 L	
Roundup® CT	glyphosate (450 g L^{-1})	1 L	
Spray.Seed®	paraquat (135 g L^{-1}) + diquat (115 g L^{-1})	2 L	
Simazine and Broadstrike	simazine (500 g L^{-1}) and flumetsulam (800 g kg^{-1})	1.25 L and 25 g	
Simazine and Tigrex®	simazine (500 g L^{-1}) and MCPA (250 g L^{-1}) + diflufenican (25 g L^{-1})		

[A] Sniper® was applied at 50 g ha^{-1} in 2004 and 45 g ha^{-1} in 2005

[B] MCPA amine was applied at 1.5 L ha^{-1} in 2004 and 750 mL ha^{-1} in 2005

Herbicides incorporated by sowing or applied post-sowing pre-emergent TriflurX® and Stomp® caused minimal yield reduction when incorporated before sowing. Chicory was the most affected by TriflurX, resulting in a yield reduction of 30%.

Both atrazine and simazine applied post-sowing pre-emergent (PSPE) caused significant damage to all species except woolly pod vetch.

Lexone®DF and Spinnaker® both caused unacceptable harvest loss in all species.

Strategic use of TriflurX and Stomp applied pre-emergent appear acceptable for most species and could be used strategically to enhance establishment of legume pastures.

Herbicides applied early post-emergent In some cases there was considerable variation between years with the herbicides applied. For example, Igran® was the safest herbicide over all species in 2004, but caused unacceptable levels of damage in many species in 2005.

Air temperature in the week following application in 2005 was greater than 18°C. The label specifies that greater damage can occur at temperatures above this and emphasises the importance of complying with these directions.

Broadstrike® was the only other EPE herbicide that was generally acceptable in most species. The exceptions to this were biserrula, woolly pod vetch and plantain where damage levels were high.

Broadstrike, either alone or in a mixture should not be applied to biserrula. Bromoxynil was the only herbicide to cause acceptable levels of damage in biserrula.

Raptor® in the one year of testing appears to be an option for all species except biserrula, woolly pod vetch and plantain.

The grass herbicides Select® and Verdict® were safe on all species.

Jaguar® caused harvest loss of between 25 and 70% to all pasture species in both years.

There is generally fewer herbicide options available to control weeds in chicory and plantain compared to most of the legume species. There appears to be little commonality in herbicide options available for chicory and plantain, with the exception perhaps of bromoxynil. Therefore, it would not be advisable to sow these two herbs together in a mix where broadleaf weeds are

Table 3. The effect of several herbicides applied as early post emergent (EPE) (3–4 leaf stage) on yield (expressed as a percentage of the unsprayed control) for a range of pasture species in 2005. Shaded areas indicate severe yield depression of >30%.

* indicate statistically significant yield depression compared to unsprayed control	Yield unsprayed control (kgDM ha^{-1})	Broadstrike	Broadstrike + MCPA amine	Sniper	2,4-DB	Jaguar	MCPA amine	Brodal	Bromoxynil	Igran	Igran + MCPAamine	AgtryneMA	Tigrex	Select	Verdict	RaptorWG	Simazine + Jaguar	Broadstrike + Jaguar	Broadstrike + Igran	MCPA LVE	Diuron + Broadstrike	Spinnaker
		EPE																				
Arrowleaf	8556	97	96	72*	86*	47*	86*	80*	68*	75*	61*	85*	77*	84*	103	88*	35*	58*	91	89*	86*	85*
Balansa	6349	82*	67*	68*	99	62*	85*	72*	63*	44*	65*	62*	64*	94	121	94	16*	43*	46*	73*	59*	71*
Berseem	4002	87	44*	94	70*	77*	82	83	80	83	65*	77*	59*	104	92	91	51*	55*	71*	65*	75*	81
Biserrula	6616	0*	0*	81*	31*	64*	69*	94	105	68*	18*	53*	56*	92	98	67*	56*	1*	2*	50*	1*	31*
Woolly pod	6863	25*	13*	75*	79*	33*	17*	82*	35*	73*	5*	18*	10*	99	97	78*	33*	24*	23*	8*	29*	68*
Chicory	4931	109	28*	46*	31*	17*	17*	63*	71*	52*	23*	58*	3*	96	101	104	13*	17*	75*	4*	74*	40*
Gland	5878	92	70*	39*	56*	26*	99	49*	67*	28*	23*	40*	58*	87	112	96	9*	17*	43*	60*	68*	65*
Persian	3357	84	99	79	87	69*	82	99	81	71*	74*	89	81	83	97	87	14*	41*	77	75*	76	79
Purple vetch	5486	100	43*	78*	41*	75*	41*	112	64*	74*	14*	32*	28*	110	91	97	57*	73*	78*	32*	80*	94
Rose	6254	85*	62*	73*	79*	45*	78*	73*	37*	37*	36*	48*	75*	100	130	89	14*	39*	35*	69*	43*	64*
French Serradella	4477	72*	61*	42*	83	31*	48*	2*	68*	0*	0*	8*	3*	81*	97	88	1*	17*	43*	43*	69*	90
Plantain	5487	61*	31*	15*	61*	0*	33*	26*	61*	73*	71*	47*	75*	14*	91	96	59*	1*	31*	15*	57*	15*

likely to be present. Additionally, care should be taken in the selection of a companion legume for these species to ensure herbicide options are maximised.

Herbicides applied at full canopy stage The only herbicide that may be used successfully at the full canopy stage on most species was simazine + Broadstrike (except on biserrula). All others evaluated caused high levels of damage.

FURTHER INFORMATION

More detailed information on this trial series including photographs of herbicide injury symptoms shortly after herbicide application and at harvest, and detailed data is available on CD from the authors. Email peter.lockley@dpi.nsw.gov.au

DISCLAIMER

Some of the herbicides mentioned here are not registered for use on some species on which they were tested. Only herbicides registered for use on a particular species may be legally applied. Always check the label.

ACKNOWLEDGMENTS

The authors wish to thank the Grains Research and Development Corporation of Australia for the financial support for this research.

REFERENCES

Revell, C.K. (2000). Effect of herbicide treatment on the productivity of some annual pasture legumes Proceedings of the 13th Australian Weeds Conference, eds H. Spafford Jacob, J. Dodd and J.H. Moore, pp 146-9. (Plant Protection Society of Western Australia, Perth).

Valentine and Ferris (2006). The impact of herbicides on pasture legume species – a summary of scientific trial results across eight years. Agribusiness Crop updates. Department of Agriculture and Food Western Australia.

Table 4. The effect application of several herbicides incorporated before sowing (IBS), applied as a post-sowing pre-emergent (PS), at early post emergents (EPE) or at full canopy (FC) on herbage yield (expressed as a percentage of the unsprayed control) of a range of pasture species in 2004. Shaded areas indicate severe yield depression of >30%.

* indicate statistically significant yield depression compared to unsprayed control	Yield unsprayed control (kgDM ha^{-1})	TriflurX	Stomp	Atrazine + Simazine	Atrazine	Simazine	Spinnaker	LexoneDF	Broadstrike	Broadstrike + MCPA amine	Sniper	2,4-DB	Jaguar	MCPA amine	Brodal	Bromoxynil	Igran	Igran + MCPAamine	AgtryneMA	Tigrex	Simazine + Broadstrike	Simazine + Tigrex	Gramoxone250	Sprayseed	RoundupCT
		IBS		PS					EPE												FC				
Arrowleaf	4454	87	101	2*	2*	0*	6*	36*	95	94	79*	76*	50*	81*	67*	74*	117	84	67*	62*	77*	40*	27*	17*	25*
Balansa	4408	91	90	0*	0*	2*	19*	0*	94	95	76*	93	52*	87	76*	76*	104	80*	75*	78*	72*	77*	28*	17*	29*
Berseem	3026	87	106	0*	0*	9*	21*	2*	104	86	78	76*	48*	59*	78	73*	102	66*	68*	65*	74*	43*	51*	34*	34*
Biserrula	2977	78	97	0*	0*	0*	0*	0*	1*	3*	63*	35*	55*	24*	65*	82	95	66*	40*	41*	38*	36*	0*	0*	2*
Woolly pod	5109	90	92	94	87	111	51*	67*	63*	62*	73*	85*	38*	22*	83*	58*	108	71*	49*	18*	85*	49*	46*	35*	67*
Chicory	2726	71*	90	0*	0*	1*	3*	9*	94	69*	52*	60*	10*	20*	27*	68*	85	69*	36*	19*	74*	60*	38*	24*	4*
Gland	4619	98	89	10*	0*	19*	16*	8*	95	84*	65*	67*	35*	78*	44*	81*	48*	57*	53*	63*	91	35*	10*	26*	23*
Persian	2990	85	84	0*	0*	0*	40*	0*	87	95	58*	90	43*	65*	55*	90	70*	69*	43*	40*	74*	61*	45*	16*	9*
Purple vetch	5066	81*	88	32*	14*	62*	59*	29*	88	62*	93	89	48*	22*	97	63*	93	81*	54*	9*	92	50*	45*	29*	73*
Rose	5369	99	99	1*	2*	28*	23*	41*	104	95	77*	94	49*	90	88	61*	99	90	76*	89	71*	87	50*	21*	33*
French Serradella	3538	93	80	0*	1*	18*	62*	1*	99	95	66*	105	53*	75*	55*	97	61*	42*	40*	49*	74*	74*	51*	51*	0*
HDL mix	2239	72	60*	0*	0*	0*	0*	18*	74	58*	39*	74	21*	33*	22*	53*	69	59*	31*	15*	71	30*	16*	14*	18*
Sulla	2642	98	85	2*	0*	0*	11*	4*	90	86	81	61*	49*	57*	52*	57*	88	73*	54*	47*	78	51*	47*	24*	13*