DIFFERENTIAL RESPONSE OF FOUR PASTURE LEGUME SPECIES TO BROAD-LEAF HERBICIDES

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Summary. Results of experiments at Merredin in 1991 and 1992 on the tolerance both within and between four pasture legume species to a range of herbicides for broad-leaved weeds are presented. Leaf abnormalities were produced on some varieties with 2,4-DB and imazathepyr. Biomass reductions at anthesis were greater in the wet year, but imazathepyr and flumetsulam were tolerated best under these conditions. Seed yields were not always indicative of biomass reductions. Clear tolerance problems were experienced with terbutryne + MCPA on the barrel medics and two of the polymorpha medics, with 2,4-DB on Serena medic, and with diflufenican, imazathepyr and flumestulam on Nungarin sub-clover.

INTRODUCTION

Broad-leaved weeds such as doublegee, *Emex australis*, capeweed, *Arctotheca calendula*, and to a lesser extent corkscrew, *Erodium botrys*, continue to be weed problems in Western Australian temperate pastures. Their control has been hampered by a lack of cheap and effective herbicides which are safe to the pasture legume species grown. Broad-leaved weed control in subterranean clover, *Trifolium subterraneum*, has been extensively practiced with herbicides such as 2,4-DB (either alone or in combination with diuron) and with the spray-graze technique using 2,4-D (4). However such herbicides are either relatively expensive or capable of severely damaging the sub-clover.

In the past 10 years in Western Australia both new species and varieties of pasture legumes have been released for which little or no information has been available on their relative tolerances to herbicides. Differential responses to 2,4-DB and bromoxynil in *Trifolium* and *Medicago* species have been reported for Australia (2, 3). In both cases tolerance was assessed on herbage production, with information on seed yields provided indirectly by means of seedling regeneration in the subsequent year in one report (2). Both reports provide evidence for substantial variation both within and between legume species.

This paper presents results of experiments at Merredin in 1991 and 1992 on the differential tolerance both within and between four pasture legume species (subterranean clover vars. Dalkeith and Ningarim; barrel medic vars. Cyprus and Parabinga; polymorpha medic vars. Serena, Santiago and Circle Valley; and sphere medic var. Orion) grown in Western Australia to a range of broad-leaved herbicides.

METHODS

Sites for assessing herbicide tolerance of pasture legumes were established at Merredin on 19 June 1991 and 25 May 1992 on red brown sandy loam (pH of 6.0) over a yellowish red heavy clay at 30 cm (pH of 7.8). The 1991 growing season was generally poor with below average rainfall (146 mm) while 1992 was above average (150 mm of summer-autumn rain and 270 mm of growing season rain).

The experiments were sown with 25 kg/ha of rhizobium-inoculated sub-clover and medic seed with 100 kg/ha superphosphate (9.1% P) at seeding. A strip plot design with 4 replications was used with varieties as main plots and herbicides applied at right angles to the direction of sowing. Plots were 3x3 m. Sub-clover and polymorpha medics were tested in 1991 and all four species in 1992. Treatments were applied at the 3-5 trifoliate leaf stage of the legumes using a vehicle mounted commercial boomspray. Herbicides were applied in 70 L/ha of water using 80015LP nozzles at 150 kPa.

Biomass scores were assessed in spring at flowering of the mid-season variety Santiago using a linear score from 0 to 10 where 1 unit = 10% reduction in biomass. Seed yields were taken from two 0.0625 m^2 quadrats/plot harvested in mid December (sub-clover failed to set seed in 1991 due to the low rainfall in September/October). Seed yields were analysed using a nearest neighbour technique (Spatial Analysis of Field Experiments (1)). Seed yields from both years were quite variable resulting in high coefficients of variation. This variability in yield has been a consistent feature of seed yield results from pasture legume variety evaluation trials in Western Australia and the results reported here are not atypical for such work (D. Gillespie, pers. comm.). Consequently a 90% confidence limit has been used in calculating the seed yield l.s.d.

RESULTS AND DISCUSSION

Morphological abnormalities were produced by a number of herbicides in both seasons. 2,4-DB caused leaf cupping in most varieties but these were most pronounced in Dalkeith and Serena. In the case of Dalkeith the effects were still noticeable at flowering, with the leaves also standing more upright. Serena had darker green leaves, and the formation of flowering buds in the lower leaf axils was either non-existent or reduced. In Orion the main growing point died with subsequent initiation of new growth from the lower leaf axils.

Abnormalities produced by imazathepyr were similar to those of 2,4-DB but these were only in the polymorpha medics, with Serena being most affected. Diflufenican and the bromoxynil + diflufenican mixture gave leaf blotching and yellowing characteristic of diflufenican and this was confined to those leaves present at the time of application. Treatments with diuron, terbutryne and bromoxynil all produced leaf scorch and yellowing, and in the case of the terbutryne substantial plant death. These effects were worst on the medic species.

Biomass scores at flowering were indicative of differences between seasons, species and varieties (Table 1). The reductions in biomass were higher in 1992 than 1991 and this may be due to the wetter conditions making some herbicides more available, as well as an increased level of stress in the legumes. Imazathepyr and flumetsulam were tolerated better under the wet conditions in 1992 when compared to the other herbicides tested. There was little difference in response of the sub-clovers and polymorpha medics to 2,4-DB and the diuron + 2,4-DB mixture which suggests that the cheaper mixture can be favoured over the 2,4-DB alone. Notable species differences were the sensitive response of the medics to terbutryne + MCPA and the higher safety of the barrel medics to 2,4-DB.

Seed yields did not necessarily correspond with the reductions in biomass at anthesis. Many herbicide by variety combinations showed no significant reduction in seed yields even when biomass reductions occurred (Table 2). While seed yields were available for both years for only the polymorpha medics, the changes in seed yields induced by herbicides were consistent over two quite dissimilar seasons. The barrel medics and two of the polymorpha medics showed clear intolerance to terbutryne + MCPA, while Serena showed intolerance to 2,4-DB. Diflufenican, imazathepyr and flumetsulam all caused substantial seed yield reductions on Nungarin.

These results show that the individual species of pasture legumes and the varieties within a species all exhibited differential reaction to broad-leaved herbicides. This agrees with results published elsewhere (2, 3). This differential tolerance could be shown as morphological abnormalities, biomass reductions, and most importantly for Western Australia, as seed yield reductions. Pasture legumes fill a number of roles within the ley farming system including grazing of herbage over the winter/spring, seed for grazing over summer, nitrogen input for subsequent cereal crops and seed production for pasture regeneration. Large reductions in biomass or seed production can negatively affect the roles played by pasture legumes in the system. Providing information on the relative tolerance of varieties to herbicides enables choices to be made which may increase the viability and profitability of the system.

Table 1. Biomass scores at flowering of 8 pasture legumes treated at the 3-5 leaf stage.

Treatment (rate/ha)	Dalk[a]	Nung	Sere	Sant	C.V.	Cypr	Para	Orion
2,4-DB (1.5 kg)	4.9[b]	3.1	2.1	4.4	3.9	-	-	-
	6.4	5.9	6.5	8.2	7.6	5.5	3.3	9.1
Diuron + 2,4-DB	3.4	3.1	2.6	4.4	3.1	-	-	-
(0.1 kg + 0.2 kg)	5.9	5.4	6.8	7.7	7.4	7.3	4.6	4.8
Terbutryne + MCPA	-	-	-	-	-	-	-	-
(0.275 kg + 0.16 kg)	7.4	6.9	9.0	9.4	9.4	10.0	9.8	9.8
Diflufenican (0.1 kg)	5.7	4.4	4.6	4.7	3.6	-	-	-
	3.2	7.2	4.0	3.9	5.9	8.0	5.1	5.1
Bromoxynil + diflufenican	4.4	3.1	4.6	5.9	3.4	-	-	-
(62.5 g + 6.25 g)	4.2	2.1	7.0	7.9	6.9	7.0	3.1	5.1
Imazathepyr (37.5 g)	-	-	-	-	-	-	-	-
	1.2	2.5	2.0	4.9	3.4	2.0	2.1	1.6
Diuron + imazathepyr	4.7	3.4	3.1	4.2	3.4	-	-	-
(0.15 kg + 37.5 g)	6.4	6.4	7.0	6.7	6.2	6.0	4.8	3.6
Flumetsulam (40 g)	-	-	-	-	-	-	-	-
	2.7	2.6	3.7	2.2	2.4	2.0	0.6	2.1
l.s.d. (p = 0.05)	2.4	2.3	2.1	2.2	2.4	-	-	-
	1.2	2.2	1.8	2.1	2.2	2.1	2.0	1.7

[a] Varieties within each species
Trifolium subterraneum - Dalk = Dalkeith, Nung = Nungarin
Medicago polymorpha - Sere = Serena, Sant = Santiago, C. V. = Circle Valley.
Medicago truncatula - Cypr = Cyprus, Para = Parabinga
Medicago sphaerocarpos - Orion

[b] Values for 1991 and 1992 respectively within each variety. - indicates variety not tested for that herbicide in 1991.

These results also highlight the need for further work on pasture legume tolerance to ensure that herbicide labels provide correct information to farmers. New legume species continue to be introduced and in some cases labels do not clearly define the species for which a herbicide is safe. For example, some labels indicate that a herbicide may be used on clover or medics. As the number of commercial species of medic is now over 10, and new herbicides are likely to be introduced for pasture legumes in the future, such a label statement leaves both the farmer and chemical company open to potential problems if no clear statement is made of the herbicide tolerance of the various species and varieties of pasture legumes.

Table 2. Seed yields (as percent of untreated) of 8 pasture legumes treated at the 3-5 leaf stage

Treatment (rate/ha)	Dalk	Nung	Sere	Sant	C.V.	Cypr	Para	Orion
Untreated yield (kg/ha)	-	-	600	601	310	-	-	-
	662	463	909	1193	612	540	448	227
2, 4-DB (1.5 kg)	-	-	66	91	118	-	-	-
	74	92	49	79	95	152	130	80
Diuron + 2, 4-D	-	-	77	94	106	-	-	-
(0.1 kg + 0.2 kg)	83	97	104	86	103	82	148	208
Terbutryne + MCPA	-	-	-	-	-	-	-	-
(0.275 kg + 0.16 kg)	106	107	42	24	73	5	21	67
Diflufenican (0.1 kg)	-	-	68	103	116	-	-	-
	160	48	70	137	116	87	177	199
Bromoxynil + diflufenican	-	-	64	93	109	-	-	-
(62.5 g + 6.25 g)	110	75	73	47	109	134	114	137
Imazathepyr (37.5 g)	-	-	-	-	-	-	-	-
	125	48	120	100	124	75	132	104
Diuron + imazathepyr	-	-	109	124	107	-	-	-
(0.15 kg + 37.5 g)	107	88	75	119	124	137	159	170
Flumetsulam (40 g)	-	-	-	-	-	-	-	-
	146	52	76	116	129	143	154	174
l.s.d. as per cent of untreated	-	-	31	37	33	-	-	-
(p = 0.10)	29	43	40	29	38	63	48	76

[a] Varieties within each species
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[b] Values for 1991 and 1992 respectively within each variety. - indicates variety not tested for that herbicide in 1991.

Most research on pasture legume tolerance to herbicides is also done in the absence of grazing. Such an issue needs to be addressed in future research in order to better understand how legumes that have been damaged by herbicides early in their growth may compensate for that damage. Given that some herbicides such as 2,4-DB and imazathepyr can, apparently, still produce morphological effects as late as flowering on some varieties, the interactions with grazing may be of some importance in considering legume safety.

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REFERENCES

1. Cullis, B., Gleeson, A. and Lill, W. 1989. Safe Manual. NSW Dept. Agric. and Fisheries.
2. Evans, P.M., Smith, R.S., Carpenter, J.A. and Koen, T.B. 1989. Aust. J. of Expt. Agric. 29,785-789.
3. Mullholland, J.G., Dear, B.S., Scott, G.B. and Kaiser, A.G. 1989 Proc. 5th Aust. Agron. Conf., Perth. p452.
4. Pearce, G.A. 1972. J. of Agric. Western Australia 13 (4th series), 16-19.