BROADSTRIKE AND BROADSTRIKE + DIURON USE IN SUBTERRANEAN CLOVER AND MEDIC PASTURES IN WESTERN AUSTRALIA

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Summary Broadstrike® herbicide has been the centrepiece of a project designed to quantify the benefits that arise from controlling broadleaf weeds in pasture.

Broadstrike and Broadstrike + diuron were applied to medic and subterranean clover pastures in 1994 and 1995 and compared with diuron + 2,4-DB, an often used standard, for control of doublegee (*Emex australis*) and capeweed (*Arctotheca calendula*) and the resultant seed set and regeneration of both in the following year. Also measured were the seed set of medic and clover at the end of the first and second years after application and yield and protein content, of the cereal crop planted and harvested in 1995 after one year of legume pasture.

At the end of 1995 (the second year of this three year project), results showed that 25 g ha^{-1} Broadstrike + 100 mL ha^{-1} diuron and 25 g ha^{-1} Broadstrike + 0.5% Uptake spraying oil had achieved significant reductions in weed numbers, significant increases in medic and clover seed set at the end of the second year of pasture and significant increases in wheat yield and protein after one year of legume pasture.

The quantifiable benefits that accrue in succeeding years of cropping rotations, after the removal of broadleaf weeds, support the use of selective broadleaf herbicides, such as Broadstrike, in legume based pastures.

INTRODUCTION

Trial results showing the removal of broadleaf weeds from legume pastures and the benefits that flow from this have not previously been well understood.

Broadstrike herbicide (containing 800 g a.i. kg^{-1} of flumetsulam) is a member of the triazolopyrimidine sulfonanilide family of chemistry (Phimister and Downard 1993) and was introduced into the pasture legume market in Western Australia (WA) in 1995 for control of brassica weeds, volunteer lupins and more recently doublegee, a troublesome weed of pastures in WA.

Data in the public domain shows that the introduction of legume pastures into cropping rotations with cereals has many benefits. They allow for the reduction of carryover diseases such as ‘Take-all’ when host grass weeds in pasture are removed (Sweeny *et al.* 1992), populations of grass weeds such as silver grass (*Vulpia* spp.) and brome grass (*Bromus* spp.) can be reduced prior to planting cereals (where they cannot presently be controlled in-crop) and they facilitate the build up in the soil of organic nitrogen with benefits to following cereal crops (Gartrell 1990, Rowland and Perry 1991 and Scammell *et al.* 1994).

In 1994 DowElanco launched a three to four year project to measure the benefits that might accrue from the use of Broadstrike and mixes with Broadstrike, to control problem broadleaf weeds such as capeweed and doublegee in pasture.

MATERIALS AND METHODS

Five sites (of differing rotational mixes) were selected in 1994. All sites had either capeweed or doublegee present as major problems in the pasture. Where necessary, grasses and insects were removed.

Applications of 25 g ha^{-1} Broadstrike + 100 mL ha^{-1} of diuron (500 g a.i. L^{-1} diuron), 25 g ha^{-1} Broadstrike + 0.5% Uptake spray oil and 200 mL ha^{-1} diuron + 700 mL ha^{-1} 2,4-DB (400 g a.i. L^{-1}) were made using a four wheel drive spraying unit.

The treatments, plus an untreated control, were replicated three times in a randomized blocks design.

During the 1994 season, plant counts and visual biomass assessments were made with seed yields of both weeds and legume being harvested in early summer, prior to grazing by the sheep.

In 1995 regeneration plant counts were made at all sites shortly after the start of the season. Three sites were then sown to wheat and yielded, one medic pasture site was carried on into it’s second year of pasture and two new, two year sub-clover followed by one year wheat, trial sites were established.

Sheep were excluded from the trial paddocks for a minimum of two weeks post-treatment in order to conform to the Broadstrike withholding period.

Once established, the trial areas were grazed by sheep at the stocking rate set by the property owner. These varied between 3 and 10 DSE per hectare.

RESULTS AND DISCUSSION

Two years (to the end of 1995) of interim results have been summarized in Tables 1–8. All trial results were analysed statistically (P=0.05) with LSDs for means separation generated accordingly.

In the five sub-clover sites (Table 1) significant differences between treatments highlighted a trend to higher clover seed yields, at the end of year one, where

Table 1. Post-treatment yields (kg ha^{-1}) of pasture legume species at the end of year 1 (1994).

Trial location	Tenin'wa	W/Hills	3 Springs	Moora	Pingelly	York	Quairad'g	
Pasture species	Medic	S/clover	S/clover	Medic	S/clover	S/clover	S/clover	
Year applied	1994	1994	1994	1994	1994	1995	1995	
Treatment (g or mL ha^{-1})								**Mean**
25 g Broadstrike + 100 mL diuron	209.5	86.02	210.2	145.4	98.47	225.4	245.1	174.3
25 g Broadstrike + 0.5% Uptake	179.2	80.46	193.8	150.0	95.18	185.6	237.7	160.28
200 mL diuron + 700 mL 2,4-DB	174.1	57.45	150.6	142.1	99.19	159.5	95.3	125.46
Untreated control	181.4	75.4	149.5	169.1	100.34	180.7	139.4	142.26
LSD	47.97	15.27	23.03	32.3	10.84	37.95	49.7	
CV	15.79	12.42	8.01	13.05	6.75	12.37	16.97	

Table 2. Post-treatment yields (kg ha^{-1}) of doublegee at the end of year 1.

Trial location	Tenin'wa	W/ Hills	3 Springs	Pingelly[A]	York	Q'ding	
Pasture species	Medic	S/clover	S/clover	S/clover	S/clover	S/clover	
Year applied	1994	1994	1994	1994	1995	1995	
Treatment (g or mL ha^{-1})							**Mean**
25 g Broadstrike + 100 mL diuron	5.3	2.0	9.06	0	0	0	2.73
25 g Broadstrike + 0.5% Uptake	57.7	21.4	12.3	5.0	7.6	7.94	18.66
200 mL diuron + 700 mL 2,4-DB	106.0	4.31	28.16	12.3	6.98	9.35	27.85
Untreated control	338.3	69.3	213.6	22.3	39.5	48.98	122
LSD	75.2	43.11	50.25	11.6	12.64	12.3	
CV	28.25	88.89	46.77	58.61	58.24	46.5	

[A] growth of both weeds and sub-clover was inhibited at this site due to adverse soil conditions (low pH).

Table 3. Post-treatment capeweed flower counts (plants m^{-2}) made in September/October of the year of treatment.

Trial location	3 Springs[A]	Moora	York	Q'ding	
Pasture species	S/clover	Medic	S/clover	S/clover	
Year applied	1994	1994	1995	1995	
Treatment (g or mL ha^{-1})					**Mean**
25 g Broadstrike + 100 mL diuron	7.7	27.4	9.7	12.3	14.27
25 g Broadstrike + 0.5% Uptake	24.97	118.7	14.0	14.3	42.99
200 mL diuron + 700 mL 2,4-DB	36.9	172.2	31.0	36.7	69.2
Untreated control	132.4	242.6	56.0	67.7	124.68
LSD	5.77	13.15	26.5	16.1	
CV	13.24	5.74	47.94	24.65	

[A] Capeweed and doublegee present as the major weeds at this site.

Broadstrike was used indicating greater selectivity of Broadstrike to sub-clover.

Treatment differences, in the amount of medic seed set at the end of the first year after treatment were less significant but the same selectivity trend was also evident.

All treatments significantly (5% level) reduced doublegee seed set relative to the untreated control (Table 2). The best treatment was 25 g ha^{-1} Broadstrike + 100 mL ha^{-1} diuron, followed by 25 g ha^{-1} Broadstrike alone and then 200 mL ha^{-1} diuron + 700 mL ha^{-1} 2,4-DB.

Significant capeweed control was achieved by all treatments in the four sites (Table 3). The order of herbicide effectiveness was similar to that for doublegee.

Pasture regeneration plant counts made at the start of the season following herbicide applications (Table 4), indicate that the combination of weed control and crop safety ensured significantly increased regeneration of both sub-clover and medic pasture.

The large (significant at two sites) differences between Broadstrike alone and diuron + 2,4-DB in medic regeneration cannot simply be explained by the differences between the treatments and their effects on crop and weeds in the previous year. These differences indicate the possibility that some of the seed set in the diuron + 2,4-DB plots in the previous year, may have been non-viable.

Also, at both medic sites the regeneration counts were lower in the diuron + 2,4-DB plots than those in the untreated control plots, despite the fact that in the previous year, diuron + 2,4-DB had significantly reduced capeweed flowering and doublegee seed set thus further supporting the argument that some of the seed set in these plots may have been sterile.

Doublegee regeneration counts the following year (Table 5) show Broadstrike + diuron and Broadstrike to be very effective treatments for doublegee control in legume pastures (regeneration was 22.2 and 29.3%, respectively, of that in the untreated control).

Table 4. Pasture legume regeneration plant counts (numbers m^{-2}) made at the beginning of 1995, the second year after treatment.

Trial location	Tenin'wa	W/Hills	3 Springs[A]	Moora	
Pasture species	Medic	S/clover	S/clover	Medic	
Year applied	1994	1994	1994	1994	
Treatment (g or mL ha^{-1})					**Mean**
25 g Broadstrike + 100 mL diuron	257.4	251.3	348.0	295.0	287.93
25 g Broadstrike + 0.5% Uptake	241.7	236.7	262.0	268.7	252.27
200 mL diuron + 700 mL 2,4-DB	120.9	140.7	160.0	191.7	153.32
Untreated control	73.3	149.0	153.7	211.0	146.75
LSD	25.93	31.9	120.9	66.1	
CV	9.16	8.01	25.34	14.31	

[A] Capeweed and doublegee present as the major weeds at this site.

Table 5. Doublegee regeneration plant counts (numbers m^{-2}) made at the beginning of 1995, the second year after treatment.

Trial location	Tenin'wa	W/Hills	3 Springs[A]	
Pasture species	Medic	S/clover	S/clover	
Year applied	1994	1994	1994	
Treatment (g or mL ha^{-1})				**Mean**
25 g Broadstrike + 100 mL diuron	25	26.7	40.7	30.8
25 g Broadstrike + 0.5% Uptake	32	45.0	44.7	40.57
200 mL diuron + 700 mL 2,4-DB	39	43.7	51.3	44.67
Untreated control	146	88.0	181.7	138.57
LSD	17.8	22.3	27.2	
CV	18.04	21.97	17.2	

[A] Capeweed and doublegee present as the major weeds at this site.

Table 6. Capeweed regeneration plant counts (numbers m^{-2}) made at the beginning of 1995, the second year after treatment.

Trial location	3 Springs[A]	Moora	
Pasture species	S/clover	Medic	
Year applied	1994	1994	
Treatment (g or mL ha^{-1})			**Mean**
25 g Broadstrike + 100 mL diuron	17.7	17.7	17.7
25 g Broadstrike + 0.5% Uptake	42.3	44.3	43.3
200 mL diuron + 700 mL 2,4-DB	72.0	79.3	75.7
Untreated control	111.7	163.0	137.4
LSD	44.6	37.6	
CV	36.7	24.7	

[A] Capeweed and doublegee present as the major weeds at this site.

Table 7. Changes in pasture composition between 1994 and 1995 at the Tenin'wa site, as measured by seed set at the end of both years and regeneration numbers at the beginning of year 2 (1995).

Plant species	Medic[A]	D'gee[A]	Medic[B]	D'gee[B]	Medic[A]	D'gee[A]
Year applied	1994	1994	1994	1994	1994	1994
Year harvested	1994	1994	–	–	1995	1995
Treatment (g or mL ha^{-1})						
25 g Broadstrike + 100 mL diuron	209.5	5.3	257.4	25	344.1	5.03
25 g Broadstrike + 0.5% Uptake	179.2	57.7	241.7	32	332.2	15.35
200 mL diuron + 700 mL 2,4-DB	174.1	106.0	120.9	39	130.6	61.04
Untreated control	181.4	338.3	73.3	146	64.7	85.59
LSD	47.97	75.2	25.93	17.8	26.2	12.4
CV	15.79	28.25	9.16	18.04	7.35	18.2

[A] Seed set in kg ha^{-1}.
[B] Plant counts m^{-2} (regeneration in 1995).

Table 8. Yield (tonnes ha^{-1}) and protein percentage of wheat planted in 1995 after one year of pasture manipulation with Broadstrike in 1994.

Trial location	3 Springs		Moora		W/Hills			
Pasture species	Sub-clover		Medic		Sub-clover			
Year applied	1994		1994		1994			
Treatment (g or mL ha^{-1})	**Yield (kg ha^{-1})**	**% Protein**	**Yield (kg ha^{-1})**	**% Protein**	**Yield (kg ha^{-1})**	**% Protein**	**Mean yield (kg ha^{-1})**	**Mean % protein**
25 g Broadstrike + 100 mL diuron	1760	10.11	3878	10.03	1718	9.81	2452.0	9.98
25 g Broadstrike + 0.5% Uptake	1697	10.13	3693	10.03	1611	9.7	2333.7	9.95
200 mL diuron + 700 mL 2,4-DB	1555	9.73	3576	9.34	1595	9.56	2242.0	9.54
Untreated control	1496	9.05	3320	9.24	1509	9.61	2108.3	9.3
LSD	92.96	0.18	339.3	0.44	82.6	0.17		
CV	3.4	2.24	5.74	2.82	3.15	1.06		

All three herbicide treatments significantly reduced the numbers of doublegees regenerating the following season.

Capeweed regeneration data (Table 6) from two sites, emphasize the positive effect that good capeweed control in the previous year can have on weed regeneration during the succeeding year. Capeweed regeneration was lowest in the 25 g ha^{-1} Broadstrike + 100 mL ha^{-1} diuron plots followed by the Broadstrike and then the diuron + 2,4-DB treatments.

Broadstrike + diuron significantly reduced regeneration numbers (12.9% of that in the control) when compared with diuron + 2,4-DB.

In Table 7, if one follows the numbers of legume crop and weed seeds set in year 1 through to the regeneration counts at the start of year 2 and finally to the weed and pasture legume seed set at the end of year 2, it becomes evident that the biological balance has shifted firmly away from the weed in favour of the pasture legume crop.

The results show that over a two year pasture phase the most effective treatment is Broadstrike + diuron followed by Broadstrike alone.

Further reductions in doublegee seed production and increases in medic seed set were still being measured at the end of the second year after application, despite the fact that no broadleaf herbicide had been applied in the second year.

Three sites were planted to wheat in the year following the use of broadleaf treatments in pasture. The yields and protein content of the grain are summarized in Table 8 and show that after only one year of broadleaf weed manipulation, the benefits flowed on to the succeeding cereal crop. At all three sites the Broadstrike treatments significantly out-yielded the untreated control whilst at two of the sites the Broadstrike + diuron treatment significantly out-yielded diuron + 2,4-DB.

Protein content was highest in those plots where Broadstrike + diuron or Broadstrike + Uptake were used and they in turn were significantly higher than those of either the diuron + 2,4-DB or untreated control plots.

CONCLUSIONS

In the two years of the study so far, Broadstrike + diuron has proved to be the most effective treatment for control of capeweed and doublegee.

Its selectivity to legume species combined with its effectiveness on certain broadleaf weeds allows primary producers to maximize production in both years of a two year legume pasture rotation.

The benefits of broadleaf weed removal also flow through into succeeding cereal crops as increases in yield and grain protein.

Significant reductions in subsequent broadleaf weed regeneration, may encourage the use of herbicides with different modes of action in the cereal phase, or allow a break from herbicide usage in the second year of pasture, thus reducing the selection pressure being placed on these weeds.

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