IMPROVED SELECTIVE WEED CONTROL IN ESTABLISHED LUCERNE

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Summary

Many annual grass and broadleaf weeds in lucerne, especially barley grass (*Hordeum* spp.), are not always well controlled by desiccant and foliar-absorbed herbicides. Results are given from nine replicated field trials in which the soil residual herbicides, atrazine, simazine and diuron, are compared with 2,2-DPA and paraquat. Lucerne showed good tolerance to most of these treatments when applied during winter dormancy. The control of barley grass, the main weed, was generally satisfactory and observations were made on the suitability of these treatments for broad spectrum weed control.

INTRODUCTION

MEEKLAH (1964, 1966) and Cassels (1966), showed that low rates of soil residual herbicides applied to established lucerne during winter dormancy gave good control of barley grass (*Hordeum* spp.) for at least one season.

In the low rainfall areas of Central Otago, established lucerne showed good tolerance to most of these treatments when applied during mid-winter or early spring, before initiation of active lucerne growth. This timing also appeared to result in the best control of barley grass, although in some situations the addition of a foliar-absorbed knockdown herbicide appeared necessary.

The present study was designed to establish overall performance of selected treatments under varying conditions for the control of barley grass. Treatments were applied to lucerne in Otago, Canterbury and in the Taupo district during late winter and early spring. The effects of treatment on lucerne production and overall weed control were assessed. It is clearly evident that the herbicidal efficiency of low rates of soil residual herbicides is not confined to barley grass alone and the possibilities of such treatments for broad spectrum weed control are discussed.

EXPERIMENTAL

Details concerning location of trials, dates of treatment, replication, and major weed species present at time of treatment are shown in Table 1.

Treatments used and rates of application are shown in Tables 2 and 3. All application rates are expressed in lb active ingredient per acre. Yield data are expressed in lb dry matter per acre. The abbreviation W.A. indicates the addition of non-ionic surfactant (Multi-film X-77) at the rate of 1 pint per 100 gal of spray liquid.

Treatments were applied with an Oxford precision sprayer operating at 30 lb/sq. in. and delivering the equivalent of 30 gal per acre. Plot size used was 31 ft × 14 ft. None of the sites were grazed during the course of the trial, being either fenced off or located in paddocks destined for

TABLE 1: MAJOR WEEDS PRESENT IN TRIALS

<i>Trial No.</i>	<i>Location</i>	<i>Date Applied 1967</i>	<i>No. of Replicates</i>	<i>Major Weeds Present</i>
1	Idaburn	Aug. 3	4	<i>Hordeum</i> spp. 25% <i>Capsella bursa-pastoris</i> 15% <i>Erodium</i> spp. 10% <i>Poa pratensis</i> 15% <i>Taraxacum officinale</i> 10%
2	Idaburn	Aug. 16	6	<i>Hordeum murinum</i> 20% <i>P. pratensis</i> 15% <i>Erodium</i> spp. 20% <i>T. officinale</i> 15%
3	Pleasant Point	Aug. 22	6	<i>H. murinum</i> 10% <i>T. officinale</i> 5% <i>Anthoxanthum odoratum</i> 10% <i>Bromus mollis</i> 15% <i>Veronica</i> spp. 5% <i>Sherardia arvensis</i> 5% <i>Stellaria media</i> <i>Cerastium glomeratum</i> } 5%
4	Lincoln	Sep. 12	6	<i>Poa annua</i> 15% <i>Erodium</i> spp. 15% <i>Lolium perenne</i> 15%
5	Reporoa	Jul. 20	3	<i>L. perenne</i> 30% <i>A. tenuis</i> 15% <i>Dactylis glomerata</i> 5% <i>Holcus lanatus</i> 5%
6	Reporoa	Sep. 15	5	As above
7	Ranfurly	Jul. 18	6	<i>H. maritimum</i> 40% <i>H. jubatum</i> 40%
8	Ranfurly	Aug. 16	6	<i>H. murinum</i> 30% <i>Erodium</i> spp. 15% <i>P. pratensis</i> 15%
9	Idaburn	Aug. 16	6	<i>H. murinum</i> 70% <i>Erodium</i> spp. 5%

hay. After each yield assessment, the entire trial was cut to a uniform height with a sickle bar mower.

Yields were taken by cutting two yard square samples from each plot. Cuttings were weighed and sub-samples taken for dissection and dry matter determination. Results obtained from the six yield trials are shown in Table 2. The number of cuts taken from each trial varies and the totals shown do not necessarily indicate total seasonal production. Successive cuts were continued, however, until no significant treatment differences were evident. Dry matter determination was not made on the first yield cut from Trials 5 and 6 and the totals shown in Table 2 are for the second and third cuts only.

Table 3 shows visual ratings of grass and broadleaf weed control from three of the yield trials, together with results from three further trials which, because of poor growing conditions, were unsuitable for yield purposes. The assessments were made by two or three independent observers, each rating on a 0 to 10 scale (0=no effect, 10=maximum effect). The figures in Table 3 represent the mean value of two such observations, one made in late spring, the other in mid-summer.

TABLE 2: YIELD OF LUCERNE DRY MATTER AND TOTAL DRY MATTER
(lb D.M./acre)

Treatment (lb)	Lucerne			Total			Lucerne			Total		
	(1)			(2)			(3)			(4)		
	Trial number			Trial number			Trial number			Trial number		
	No. of cuts			No. of cuts			No. of cuts			No. of cuts		
2,2-DPA 3.7	...	...	...	7,007 abAB	8,283 ab	...	2,782 NS	3,078 NS	...	4,349 aA	4,671 NS	3,804 aA
paraquat 0.5	...	...	...	7,353 abAB	7,945 ab	...	2,964 NS	3,131 NS	...	4,337 aA	4,747 NS	3,537 aAB
atrazine 1.6	...	...	...	7,265 abAB	8,305 ab	...	3,005 NS	3,059 NS	...	4,375 aA	5,534 NS	3,011 abABC
2,2-DPA 0.75/atrazine 0.8	...	...	...	8,099 aAB	8,290 ab	...	2,873 NS	3,026 NS	...	3,003 aA	3,771 NS	...
2,2-DPA 0.75/atrazine 0.8/WA	...	...	...	7,201 abAB	7,523 ab	...	2,640 NS	2,722 NS	...	3,019 abABC	3,666 bB	...
2,2-DPA 1.5/atrazine 0.8	...	...	...	8,436 aA	8,911 a	...	2,962 NS	3,055 NS	...	3,691 aA	4,256 abAB	...
2,2-DPA 1.5/atrazine 1.6	...	...	...	6,489 bAB	6,906 b	...	2,715 NS	2,858 NS	...	2,448 bcBC	3,270 bB	...
2,2-DPA 1.5/diuron 1.6	...	...	...	6,032 bB	8,310 ab	...	2,440 NS	3,665 NS	...	2,356 bB	3,959 NS	1,949 cC
Untreated	...	...	...	15.4	11.2	...	32.1	29.3	...	16.4	15.9	21.1
CV %	...	...	...	...	...	...	...	...	...	...	...	22.5

Treatment (lb)	Lucerne			Total			Lucerne			Total		
	(1)			(2)			(3)			(4)		
	Trial number			Trial number			Trial number			Trial number		
	No. of cuts			No. of cuts			No. of cuts			No. of cuts		
2,2-DPA 3.7	...	...	...	6,658 b	6,961 bB	...	4,349 aA	4,671 NS	...	3,804 aA	5,013 aA	...
paraquat 0.5	...	...	...	7,298 ab	7,739 abAB	...	4,337 aA	4,747 NS	...	3,537 aAB	4,027 bAB	...
atrazine 1.6	...	...	...	7,103 ab	7,209 bAB	...	4,375 aA	5,534 NS	...	3,011 abABC	4,035 aAB	...
2,2-DPA 0.75/atrazine 0.8	...	...	...	7,387 ab	7,478 abAB	...	3,003 aA	3,771 NS	...	...	...	...
2,2-DPA 0.75/atrazine 0.8/WA	...	...	...	7,193 ab	7,347 abAB	...	...	...	...	3,019 abABC	3,666 bB	...
2,2-DPA 0.75/atrazine 0.8/10% oil	...	...	...	7,193 ab	7,347 abAB	...	...	...	...	3,691 aA	4,256 abAB	...
2,2-DPA 1.5/atrazine 0.8	...	...	...	7,053 ab	7,178 bAB	...	4,712 aA	4,849 NS	...	2,448 bcBC	3,270 bB	...
2,2-DPA 2.24/atrazine 0.8	...	...	...	7,161 ab	7,276 bAB	...	...	...	...	...	...	...
2,2-DPA 1.5/atrazine 1.2	...	...	...	7,703 a	8,148 aA	...	2,356 bB	3,959 NS	...	1,949 cC	3,364 bB	...
2,2-DPA 1.5/atrazine 1.6	...	...	...	9.5	7.8	...	16.4	15.9	...	21.1	22.5	...
Untreated	...	...	...	...	...	...	...	...	...	...	...	...
CV %	...	...	...	...	...	...	...	...	...	...	...	...

RESULTS

CROP TOLERANCE

From the results given in Table 2, it is clear that, with the exception of Trial 4, none of the treatments reduced total lucerne yield. This is also true for the individual cuts comprising the total yields.

The exception, Trial 4, can be regarded as a tolerance trial since weeds contributed only 5% of the total yield produced over four cuts. It is also significant that this trial was laid down after the commencement of active spring growth when the crop was three inches in height. This is much later than would be recommended.

In trial 4, 2,2-DPA at 3.7 lb yielded 20% less lucerne than the untreated controls in both the first and second cuttings, the differences being significant at the 1% and 5% levels, respectively. Over four consecutive cuts, it was the only treatment to produce significantly less lucerne than untreated control.

Atrazine at 1.6 lb alone and in combination with 1.5 lb 2,2-DPA as well as the diuron/2,2-DPA treatment yielded 15% below the untreated at the first cut only, the differences reaching significance at the 5% level. These differences were not evident either in later cuts, or total lucerne yield for four cuts.

All other treatments did not differ significantly from untreated.

WEED CONTROL

The difference between the total yields and the lucerne yields shown in Table 2 represents the total production of weeds. These figures generally correlate well with the visual weed control ratings given in Table 3. In Trial 1, however, several treatments, and particularly atrazine at 1.6 lb, gave much higher weed yields than expected. This was because one side of the trial was located near a wet hollow where dandelion (*Taraxacum officinale*) was the dominant species and was not well controlled by any treatment in the affected plots. The competitiveness of dandelion towards lucerne is not well known.

Grasses

Barley grass was present in six trials (Trials 1, 2, 3, 7, 8 and 9) and was the only grass present in Trials 7 and 9.

Atrazine, both alone and in mixture with 2,2-DPA, gave a consistently high level of barley grass control, proving more effective than 2,2-DPA alone, paraquat and diuron/2,2-DPA treatments in all instances except Trial 8 where treatments containing the low rate of atrazine (0.8 lb) gave a similar result to 2,2-DPA alone.

2,2-DPA alone proved the least effective treatment for barley grass control in five out of the six trials. In the case of the exception (Trial 8) this treatment was similar to those containing 0.8 lb of atrazine in that only a trace of barley grass remained.

Paraquat gave good barley grass control in five trials but was not superior to treatments containing atrazine in any case. With the early (mid-July) treatment in Trial 7, paraquat gave only fair barley grass control.

Diuron/2,2-DPA gave satisfactory barley grass control in all trials.

In Trials 1, 2 and 8, barley grass and Kentucky bluegrass (*Poa pratensis*) were present. 2,2-DPA gave the best results on *P. pratensis* and treatments containing 2,2-DPA were better in this respect than those without. In Trials 2 and 8, the high rate of atrazine (1.6 lb) alone was similar to 3.7 lb of 2,2-DPA alone. It appears that the rate of 2,2-DPA

TABLE 3: VISUAL RATINGS OF GRASS + BROADLEAF WEED CONTROL
(0 - 10 Scale)

Trial No.	Treatment (lb)	(1)		(2)		(3)		(7)		(8)		(9)	
		Grasses	B. leaf	Grasses	B. leaf	Grasses	B. leaf	Grasses	B. leaf	Grasses	B. leaf	Grasses	B. leaf
		Date of Assessment		26/10/67 16/1/68	27/10/67 16/1/68	7/12/67 8/2/68	25/10/67 24/3/68	26/10/67 24/1/68	26/10/67 24/1/68				
2,2-DPA 3.7	...	6.0	1.8	8.1	4.3	9.6	2.5	5.2	9.0	4.3	6.8	4.0	
paraquat 0.5	...	9.1	5.5	7.8	5.1	7.0	2.5	6.9	7.6	6.3	9.0	9.1	
atrazine 1.6	...	9.6	6.6	9.0	7.3	9.8	6.5	9.8	8.6	5.4	9.9	9.6	
2,2-DPA 0.75/atrazine 0.8/W.A.	...	9.0	6.3					10.0	7.0	3.8			
2,2-DPA 0.75/atrazine 0.8	...	9.5	7.0	6.9	5.7	6.5	6.1	9.9	8.7	5.1	10.0	9.6	
2,2-DPA 1.5/atrazine 0.8	...	9.5	7.6	8.9	6.3	7.1	4.0	10.0	9.8	8.0	9.9	9.7	
2,2-DPA 1.5/atrazine 1.6	...	9.5	7.7	9.7	7.4	9.8	6.0	10.0	10.0	10.0	10.0	9.7	
2,2-DPA 1.5/simazine 1.6	...							10.0					
2,2-DPA 1.5/diuron 1.6	...												
2,2-DPA 1.5/diuron 1.6	...	1.0	1.5	7.6	5.9	5.3	3.6	6.5	7.0	7.0	9.4	9.7	
Control	...			1.0	1.0	1.0	1.0	0.3	1.1	1.0	1.0	4.0	

influences the level of control of *P. pratensis* but atrazine as the residual component has contributed more than diuron.

Perennial rhizomatous grasses predominated in Trials 5 and 6. Atrazine at 1.2 lb with 2,2-DPA at 1.5 lb gave good results from early treatment (mid-July) but with later applications high rates with 2,2-DPA appear necessary. 2,2-DPA alone applied early gave good control of these grasses, but proved inadequate when applied later. Paraquat was the only treatment in these two trials which gave consistently good results from both early and late applications.

Sweet vernal (*Anthoxanthum odoratum*) and goose grass (*Bromus molis*) present in Trial 3 were adequately controlled by all treatments. 2,2-DPA and atrazine alone and combined gave best results on these weeds.

Broadleaf Weeds

Deep-rooted perennial dicotyledonous weeds did not appear to be affected by any treatment used. Other weeds which appeared rather tolerant to the treatments were plantain (*Plantago* spp.), dandelion, hawkbit (*Leontodon hispidus*), hawksbeard (*Crepis capillaris*) and catsear (*Hypochaeris radicata*).

Storksbill (*Erodium* spp.) was present on most sites and in Trials 8 and 9 was the only broadleaf weed species. This weed was generally adequately controlled by paraquat and 1.6 lb rates of both atrazine and diuron. Shepherd's purse (*Capsella bursa-pastoris*), was generally controlled by all treatments except 2,2-DPA.

Atrazine at 0.8 lb with 2,2-DPA at 0.75 lb generally performed well on most annual broadleaf species and was noticeably better than diuron on speedwell (*Veronica* spp.) and field madder (*Sherardia arvensis*).

Although 2,2-DPA is a specific grass herbicide, it gives some suppression of a number of broadleaf species, including storksbill and shepherd's purse and when combined with the residual herbicide may enhance the activity on many species.

DISCUSSION

Early in this study it was clear that the 2,2-DPA/residual herbicide combinations used were giving control of a much wider range of weed species than previously envisaged and further trials were designed to evaluate weed control of species other than barley grass.

All three residual materials used in the trials have a pre-emergence action. Atrazine, however, also exhibits considerable post-emergence activity, thus making it of greater interest in that the amount of knock-down herbicide additive required for post-emergence effect is considerably reduced.

In most of the trials, the increase in crop vigour from reduced weed competition masked the absolute effect of treatment on lucerne dry matter yields. In Trial 4 where few weeds occurred, some suppression was evident in the first cut with 1.6 lb of atrazine and diuron alone and in combination with 2,2-DPA. Only 2,2-DPA at 3.7 lb gave a depression in total lucerne dry matter, as shown in Table 2. There appears to be a two times safety factor with the atrazine 0.8 lb + 2,2-DPA 0.75 lb mixture, even with late application. However, more information is required on the absolute safety of higher rates of application with this mixture under different soil types and moisture conditions.

In the other trials, no post-treatment symptoms were evident in crops dormant at time of treatment. Some temporary chlorosis was noted with

1.6 lb lb rates of atrazine and diuron when treatments were applied after the initiation of spring growth.

Since the selectivity of all the residual materials used is more positional than truly physiological, it is possible that on light, free-draining soils, heavy rain following application could reduce crop tolerance by moving the chemical down into the root zone of the crop. In Trials 5 and 6, between two and four inches of rain were recorded in each of the three months immediately following treatment but no obvious loss of crop tolerance was noticed.

For most effective control of annual grasses and broadleaf weed species with residual materials, early application seems essential. From the results of this and other studies, a June/July application appears most satisfactory.

Atrazine at 0.8 lb will kill barley grass up to the three true leaf stage but the addition of 0.75 lb of 2,2-DPA improves the reliability of control and in most cases is essential for complete control with simazine or diuron. With early application, 2,2-DPA or paraquat alone seldom give acceptable control of barley grass because of the prolonged seed germination period.

2,2-DPA at 3.7 lb generally gave good control of perennial grasses such as *P. pratensis* but mixtures of 1.5 lb 2,2-DPA and 0.8 lb atrazine also showed promise. At 1.5 lb 2,2-DPA and 1.6 lb atrazine, results were often better than 2,2-DPA at 3.7 lb alone, provided applications were made early. The addition of either a non-ionic surfactant or emulsifiable oil may further be a means of increasing the foliar activity of atrazine. This treatment has considerable potential merit for the control of all grass weeds which occur in lucerne with the real possibility of better lucerne tolerance than 2,2-DPA at 3.7 lb alone.

Both atrazine and diuron showed considerable activity on many annual broadleaf weeds, but atrazine appears to be more active at lower rates than diuron. At 0.8 lb atrazine plus 0.75 lb 2,2-DPA, shepherd's purse, chickweed (*Stellaria media* and *Cerastium glomerata*), speedwell and field madder were all well controlled. Storksbill was only partially controlled at this rate, but the addition of surfactant improved control and at the higher rates (2,2-DPA 1.5 lb plus atrazine 1.6 lb), control of this weed was quite good.

The combination of 2,2-DPA at 0.75 lb plus atrazine at 0.8 lb has shown good selectivity to lucerne and a high degree of activity against barley grass and many broadleaf weeds. At double this rate of application many perennial grass weeds appear susceptible and useful control of storksbill seems possible.

Further information is required on the overall performance of such mixtures in relation to rates, timing of application, suitable adjuvants, and overall crop tolerance on different sites.

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