LUCERNE TOLERANCE TO DALAPON

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SUMMARY

THE results are described of a series of trials studying the effect on lucerne of dalapon alone and in combination with TCA on both weed-free and grass-infested stands.

Up to 10 lb of dalapon per acre was applied to established lucerne in early spring, and though severe reductions in yield occurred at the first hay cut of the season, there was no permanent or prolonged effects on yield.

Treatment after the first cut, after the last cut, and in the late dormant stages, however, delayed the recovery of lucerne. Observations showed that infestation of flat-weeds was likely to occur where lucerne recovery was slow due to treatment at times other than early spring.

INTRODUCTION

The control of weed grasses in establishing and established lucerne stands is a problem which has attracted the interest of weed control workers in many countries. Foreman (1956), Fitzgerald (1956), Green et al (1956), Sand (1957), and Vengris (1955), also workers at the Wisconsin Agric. Expt. Station (1955-56 report) are some who have reported on this subject. Generally the evidence quoted in the majority of published work on this subject shows that dalapon is the best herbicide yet discovered for this particular purpose. The importance of this development will be self-evident to many lucerne growers, as grass weeds are probably the biggest single factor causing the deterioration of lucerne stands.

Unfortunately lucerne is not completely tolerant to dalapon, and this paper will deal with the results achieved from trials investigating times of application on established lucerne which have been carried out at Invermay Research Station.

EXPERIMENTAL METHOD

All the trials to be discussed were randomised block trials laid down on New Zealand certified lucerne sown on Taieri alluvial silt loam. Rates quoted are in terms of pounds of actual commercial grade dalapon (74 per cent acid equivalent) per acre: similarly rates of sodium trichloroacetate are in pounds of commercial grade TCA (79.3 per cent acid equivalent) per acre. All applications were made by motorised plot sprayer or an Oxford precision sprayer; approximately 30 gallons of water per acre were applied unless otherwise stated.

Yield estimates were taken in all cases from cuts made whenever control plots in the lucerne had reached the correct stage of cutting for hay.

RESULTS

Initially we examined the question of whether the few inches of lucerne growth present in early spring should be removed to reduce translocation of dalapon-TCA mixtures. A mixture of 5 lb of dalapon and 5 lb of TCA was applied on 20/9/56 after spring growth had commenced to lucerne about 6 in. high, and to lucerne which had been trimmed to remove about 90 per cent of its leaf area. The trial area was weed free. It is obvious from Table 1 that differences only occurred at the first cut and these were probably due mainly to the herbage lost when trimming. There was no difference from the second cut onward between trimmed and un-trimmed plots nor between these treatments and control.

TABLE 1—EFFECT OF 5 lb OF DALAPON + 5 lb OF TCA PER ACRE ON WEED-FREE FOUR-YEAR-OLD LUCERNE

Stage and date of application	26/10/56*	8/1/57	1/3/57	10/4/57	Total of four cuts	Per cent of control
1. Onset of spring growth, 20/9/56	1,590 b B	3,660 a A	2,270 a AB	1,500 a A	9,010 b B	86
2. Onset of spring growth, trimmed 20/9/56	800 c C	3,680 a A	2,180 a AB	1,400 a AB	8,060 c C	76
3. After first cut, 16/11/56		1,810 b B	1,930 b B	1,040 b B	7,800 c C	74
4. Control	3,040 a A	3,690 a A	2,310 a A	1,430 a A	10,480 a A	100
Coefficient of variation (per cent)	10.8	5.5	7.2	14.8	4.6	

*Control mean calculated from treatments 3 and 4 at this date.

TABLE 2—EFFECT OF 10 lb OF DALAPON PER ACRE ON WEED-FREE FOUR-YEAR-OLD LUCERNE

Stage and date of application	30/10/56*	9/1/57	4/3/57	10/4/57	Total of four cuts	Per cent of control
1. Onset of spring growth, 30/8/56	1,720 b B	4,350 a A	2,610 a A	1,350 a A	10,040 b B	81
2. After first cut, 16/11/56		1,590 b B	2,090 b B	1,010 b B	8,350 c C	67
3. Control	3,700 a A	4,520 a A	2,850 a A	1,350 a A	12,440 a A	
Coefficient of variation (per cent)	9.5	6.2	11.4	7.5	4.8	

*Control mean calculated from treatments 2 and 3 at this date.

TABLE 3—EFFECT OF 5 lb OF DALAPON + 5 lb OF TCA PER ACRE APPLIED AFTER THE LAST CUT

	22/11/57	25/1/58	15/4/58	Total	Per cent of control
After last cut applied 19/4/57	3,480 b A	3,310 b B	1,900 a	8,680 b B	83
Control	4,300 a A	4,210 a A	1,910 a	10,420 a A	
Coefficient of variation (per cent)	11.2	6.1	8.9	5.7	

EFFECT OF 10 lb OF DALAPON PER ACRE APPLIED AFTER THE LAST CUT

	22/11/57	28/1/58	15/4/58	Total	Per cent of control
After last cut applied 19/4/57	3,100 b B	3,580 b B	2,020 a	8,690 b B	78
Control	4,700 a A	4,320 a A	2,120 a	11,140 a A	
Coefficient of variation (per cent)	5.4	7.5	4.6	4.6	

TABLE 4—DORMANT AND EARLY SPRING APPLICATIONS OF 10 lb OF DALAPON PER ACRE

	23/11/57	23/1/58	15/4/58	Total	Per cent of control
Late dormant, applied 12/8/57	2,320 b B	3,990 b A	1,670 b A	7,980 b B	76
Early spring, applied 13/9/57	1,510 c C	4,120 ab A	1,800 ab A	7,420 c B	71
Control	4,310 a A	4,400 a A	1,810 a A	10,520 a A	
Coefficient of variation (per cent)	6.0	8.0	6.2	4.1	

Subsequently a further application of dalapon + TCA was made on lucerne regrowth, about 6 in. high after the first cut, and it is clear from Table 1 that reduction in lucerne vigour was severe and extremely persistent.

The results of a second trial studying applications in early spring and after the first cut but using a high rate of dalapon are shown in Table 2.

Again it is clear that treatment at the onset of spring growth is to be recommended, because though the initial lucerne suppression is severe, recovery is quick and complete.

Application after the last cut of lucerne had been removed was also studied in two trials on the same lucerne stand, with somewhat parallel results in that lucerne recovery was not complete after the first cut, and significant reductions occurred at both cuts following treatment (see Table 3).

The application of 10 lb of dalapon per acre at a late dormant stage was also studied in a weed-free five-year-old stand of lucerne, and the results are shown in Table 4. At this stage the lucerne was carrying 2 in. of frost-damaged tillers commonly evident on lucerne stands throughout the winter in this area. This treatment was compared with an early spring treatment, applied to lucerne which had made some growth since breaking dormancy and tillers varied from 3 to 5 in. high.

Spraying at the late dormant stage was delayed by severe winter conditions, and the dalapon was applied as soon as a thaw had taken place. This spraying date was rather late, but weather conditions are generally unfavourable about this time (in this area), and where dormant application is required spraying will often be delayed until an improvement occurs in the weather, generally in early August.

A typical pattern again emerges from the results in Table 4 in which early spring treated plots recovered completely by the second cut, whereas the dormant application failed to recover completely during that season. However, analysis of yields at the beginning of the following season showed no significant differences between treatments.

A more detailed examination of the place of dormant applications of dalapon in relation to spring applications was commenced at the beginning of winter in 1958 on an 18-month-old stand of weed-free lucerne. As this particular trial was one of the final investigations in this series, the rate of 4 lb of dalapon per acre recommended locally for control of grass weeds was used as a standard treatment (volume per acre about 14 gallons).

Note: Weather conditions following application were satisfactory in all cases except for 13/5/58 and 18/7/58, where in each case heavy rain fell within 24 hours and continued for two days.

TABLE 5—EFFECT OF 4 lb OF DALAPON PER ACRE ON ONE AND A HALF-YEAR-OLD LUCERNE APPLIED OVER THE WINTER AND SPRING OF 1958

	Cut 1 21/11/58		Cut 2 31/12/58		Total of first 2 cuts
13/5/58	3,720 a	AB	2,730 ab	A	6,450 abc AB
18/6/58	3,230 bc	BCD	2,670 b	A	5,900 bc B
18/7/58	3,620 ab	ABC	2,920 ab	A	6,540 ab AB
14/8/58	3,060 c	CD	2,730 ab	A	5,790 c B
21/8/58	3,290 bc	BCD	3,160 a	A	6,460 abc AB
1/9/58	2,940 c	D	3,020 ab	A	5,960 bc B
5/9/58	3,060 c	CD	3,070 ab	A	6,130 bc B
17/9/58	2,970 c	D	3,100 ab	A	6,060 bc B
Control unsprayed	3,950 a	A	3,080 a	A	7,030 a A
Coefficient of variation (per cent) ..	8.1		9.5		6.6

Drought conditions became obvious following Cut 2 in December, severely affecting plot yields and increasing the error.

It will be seen from Table 5 that the pattern of application was to commence spraying at monthly intervals from 13/5/58 until mid August, about which time relatively rapid climatic changes could be expected, and at this point the tempo of spraying was increased to weekly intervals until mid September. Unfortunately the pattern of yields is inconsistent where dalapon was applied on 13 May and 18 July before heavy and prolonged rain.

However, the same trend emerges from this as from previous trials, though in this case the differences between winter and early spring applications are not nearly so distinct. Winter applications are shown to result in slightly higher yields than spring application at the first cut, yet are lower than spring applications at the second cut. There were no significant yield differences for the remainder of the season.

Apart from the above strict tolerance trials on weed-free lucerne work was carried out on grass-infested stands, and samples of herbage were dissected to give relative values of lucerne and weed-grass production. Rates of 3 and 5 lb of dalapon per acre both alone and in combination with 5 lb of TCA were applied to a grass-infested four-year-old stand of lucerne at two stages, late dormant (1/8/57) and early spring (11/9/57). Dissection of species from yield cuts taken throughout the 1957-58 season showed that lucerne yields followed the pattern shown in tolerance trials to a large extent. Table 6 shows the average total yield of lucerne produced by each main group of treatments, namely dormant, spring, and control, at each cut. An extension of this table shows the mean total yields (that is, grass + lucerne) derived from the same main group of treatments.

TABLE 6—APPLICATION OF A GROUP OF DALAPON PLUS TCA TREATMENTS AT TWO MAIN TIMES

	Mean lucerne yield from dormant treatments	Mean lucerne yield from spring treatments	Mean lucerne yield from controls
Cut 1	2,700	2,080	1,295
Cut 2	3,555	3,850	2,125
Cut 3	1,960	1,840	985
Total for season	8,215	7,770	4,405

	Mean total yield from dormant treatments	Mean total yield from spring treatments	Mean total yield from controls
Cut 1	3,615	2,660	6,330
Cut 2	3,960	4,400	3,755
Cut 3	2,305	2,390	2,660
Total for season	9,880	9,450	12,745

Observations toward the end of the cutting season revealed that flatweed infestation was more severe in dormant treatments than in spring-treated plots, but this factor must be balanced against the fact that grass control was slightly better with dormant treatments.

Further work on an 18-month-old stand infested with *Poa annua* indicated that 2 and 3 lb of dalapon applied in early spring can be used in certain situations for grass control without apparent reduction in true lucerne yields. In this trial 5 lb reduced yields at the first cut of the season, though subsequent yields were normal. TCA at 10 and 15 lb was included for comparison, and it can be seen from Table 7 that it caused more lucerne damage than dalapon.

One hand-weeded treatment was included, using a method which removed all *Poa annua* from between the lucerne drills, but the plants remaining

TABLE 7—YIELDS OF LUCERNE FROM A PO4 ANNUA-INFESTED STAND SPRAYED 30/8/57

	Control	Dalapon 2 lb	Dalapon 3 lb	Dalapon 5 lb	TCA 10 lb	TCA 15 lb	Hand- weeded
Cut 1 (grass + weeds + lucerne)	---	---	---	---	---	---	---
Cut 1 (lucerne only)	---	---	---	---	---	---	---
Cut 2	---	---	---	---	---	---	---
Cut 3	---	---	---	---	---	---	---
Total lucerne produced	---	---	---	---	---	---	---
	4,240	3,440	3,080	2,690	3,460	3,170	3,650
	2,710	3,310	3,020	2,330	2,700	2,500	2,880
	4,120	4,560	4,240	4,140	4,130	4,120	4,120
	2,090	2,280	2,170	2,050	2,150	2,050	2,000
	8,920	10,150	9,430	8,520	8,980	8,670	9,000

TABLE 8—EFFECT OF 5 lb OF DALAPON ON THE YIELD OF GRASS-INFESTED LUCERNE VARIETIES

Date of cutting	N.Z. certified	Du Puits	Soche- ville	Hunter River	Provence	Rhizoma	Med. glut- inosa
A. UNSPRAYED. TOTAL YIELD, THAT IS, GRASS WEEDS + LUCERNE							
16/10/57	2,180	1,900	1,700	1,200	2,220	1,880	2,090
6/1/58	5,580	5,980	6,180	4,140	5,310	5,500	5,530
4/3/58	4,060	3,860	4,100	2,010	4,090	3,430	3,780
Total	11,820	11,740	11,980	7,370	11,620	10,810	11,400
B. UNSPRAYED. YIELD OF LUCERNE ONLY							
16/10/57	1,590	1,410	1,090	600	1,530	860	1,130
6/1/58	4,520	3,830	4,510	2,690	4,140	3,850	4,090
4/3/58	4,060	3,860	4,100	1,770	4,090	3,430	3,780
Total	10,170	9,100	9,700	5,060	9,760	8,140	9,000
C. SPRAYED. YIELD OF LUCERNE ONLY							
16/10/57	1,300	1,170	1,120	490	1,400	790	870
6/1/58	5,090	5,200	5,180	4,160	4,830	5,040	5,010
4/3/58	3,680	3,860	4,090	2,450	3,470	3,220	3,370
Total	10,070	10,220	10,390	7,100	9,700	9,070	9,250

in the lucerne drills still gave appreciable competition, thus the treatment did not compare favourably with the best of the chemical treatments.

The results for Cut 1 in Table 7 show firstly the total yield, that is, lucerne + grass weeds + miscellaneous weeds. The second line shows the true lucerne yield obtained from dissected samples. Though *Poa annua* was still present in the base of some plots at the second and third cuts, it was very prostrate and low producing, in consequence little, if any, found its way into the sample and these yields may be considered true lucerne yields.

A portion of a trial of seven lucerne varieties sown in a randomised block of four replicates was sprayed with 5 lb of dalapon (in 12 gallons of water per acre) in early spring and the yields recorded (see Table 8) for one whole season.

Yield differences in this trial indicated that there was no difference in varietal susceptibility, but the design did not permit statistical analysis of yield data.

Section A of Table 8 shows the total yield of lucerne plus grass weeds. Section B shows the estimated lucerne yield obtained by dissection. Section C gives also the actual yields of lucerne, spraying having given complete control of all grass weeds. Following the expected depression in yield at the first cut following spraying, yields return to slightly higher levels than unsprayed, marked increases being noted in the variety Hunter River, which lacks the vigour necessary to compete with grass weeds.

Negligible increases were noted in the case of varieties such as N.Z. Certified and Provence, which possess the vigour necessary to keep free from grass weed infestation or are relatively unaffected by it.

DISCUSSION AND CONCLUSIONS

This work indicates that it is difficult to avoid some reduction in yield, but that up to 10 lb of dalapon applied in early spring, just as the lucerne is coming away and is from 2 to 4 in. high, results in a yield depression at the first cut only. Treatment at any stage other than early spring results in the yield reductions being more persistent. It seems very likely that increased lucerne damage resulting from treatments applied in winter is the result of the slow decomposition of dalapon in cold soils, thus facilitating root absorption with subsequent slow recovery. The reason for increased damage from mid season, that is, after first cut, treatments is not clear.

It will be noted from Table 5 that differences between dormant and spring applications were not as large as were expected from preliminary work, but this was the first trial in which a moderate (and economic) rate of dalapon had been employed. Grass control from dalapon applied in winter is extremely good, and there would appear to be a need for evaluation of low rates in mid winter for grass control, though the flatweed problem would still remain. It has become clear throughout more than three years' work on dalapon tolerance and grass control in lucerne that treatments at times other than early spring are prone to increase flatweed infestation (particularly *Bellis perennis*). This must be due to the fact that ground cover is reduced for too long a period. To minimise the ingress of flatweeds spraying should be delayed until late August-mid September (in the Invermay area) and it does not matter even if the lucerne has reached 6 in. in height, providing the grasses can be adequately reached by the spray.

It would appear from the results presented that the optimum time of application of dalapon is in early spring just as the lucerne is breaking dormancy, and other times of application are judged against this standard.

Early spring is considered the best time for the following reasons:

(a) Grasses are just beginning to make growth at this time of the year and are reasonably susceptible to dalapon.

(b) It is difficult to suppress growth from good healthy lucerne at this time of the year, and so the ground is devoid of cover for only a relatively short period.

(c) Low soil temperatures reduce the breakdown or decomposition of

dalapon, Thiels (1955), thus where winter applications of dalapon reach the soil the herbicide persists and is more prone to result in damage to the lucerne through root absorption: conversely where soil temperatures are higher bacterial decomposition of dalapon is quicker and root absorption is reduced.

Finally, in a paper related to the control of grass weeds in lucerne reference must be made to a practice which can almost be termed as biological control, and that is the practice of growing a suitable companion grass such as cocksfoot in alternate rows with the lucerne. This should be considered seriously where the climate is conducive to grass infestation of lucerne stands.

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DISCUSSION

Q.—In Otago much of the lucerne is grazed. Would it not be beneficial to have grasses present to increase the production?

A.—Yes. In the experiments the highest yields were from the plots where there were grasses with the lucerne.

Q.—What is the effect of treatments in warmer districts where the lucerne is not entirely dormant in winter?

A.—The lucerne is not entirely dormant in winter at Invermay.

Q.—Has Mr Meeklah any results over seasons? Is there any evidence in the second season after spraying that there is an increase in yield over the unsprayed?

A.—Yes. In one trial yields were increased over two years. There was little difference between spraying in the dormant period and in spring. The total production of lucerne plus grasses on the unsprayed portion was slightly, but probably not significantly, lower than on trial plots.

Q.—What is the effect of spraying on the life of the stand?

A.—If grassy weeds are present, there is deterioration of the stand of lucerne.

Comment: In the Bay of Plenty 6 lb of dalapon applied in August, when the lucerne was coming out of dormancy, did not control Indian doud.

A.—Autumn is the best time to apply dalapon to control resistant grasses.

Q.—Has any work been done with quantities of dalapon greater than 10 lb? What is the maximum rate which can be used?

A.—There has not been much work done with rates over 10 lb. The lucerne is usually severely damaged by rates of 10 lb.

Q.—Has any work been done with dalapon plus amitrol?

A.—No. Lucerne would be too susceptible.

Q.—How much dalapon is needed to kill Yorkshire fog?

A.—About 5 lb or less.

Comment: During the field trip there will be an opportunity to see the results of spraying Yorkshire fog with the logarithmic sprayer. The rate of application decreased from 20 lb to 2½ lb. Survival of the fog was noted at about 4 lb and lower rates.

Q.—What is the best treatment for barley grass in lucerne?

A.—Barley grass is easily controlled by 2 to 5 lb of dalapon in spring.

Comment: In trials in irrigation races 200 lb of TCA was not sufficient to kill lucerne with 18 in. of rain. The lucerne was severely suppressed but after five or six months it came back to normal production.

Q.—Why was the mixture of dalapon and TCA used in the trials?

A.—It was thought that TCA would have a residual effect and prevent re-infestation by seedling grasses. Actually no benefits could be observed from the addition of TCA.