THE EFFECT OF PICLORAM ON PASTURE PRODUCTION AND COMPOSITION

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Summary

The effects of rates and times of application of picloram alone and in combination with either 2,4-D or 2,4,5-T are compared on perennial ryegrass (*Lolium perenne*)/white clover (*Trifolium repens*) swards located at Ruakura, Marton and Invermay.

Results show that, regardless of rate, place or time of application, all picloram treatments reduce pasture production. This decrease is due to the complete elimination of white clover by picloram, the yield loss being almost equivalent to that which the clover would have given if it had been present.

Complete re-establishment of white clover does not occur until the second spring/summer period after spraying.

Using picloram/2,4-D—2,4,5-T mixtures, there is some evidence of synergism but this requires confirmation by further investigation.

INTRODUCTION

PICLORAM is an extremely effective herbicide and is currently widely used, particularly for the control of hard-to-kill broadleaf weeds. However, its potential use in both pasture and crop situations is limited because picloram is well known to be persistent in soil and highly toxic to legumes.

The experiments reported here were designed to investigate the specific effects of picloram on pasture production and composition when applied overall to ryegrass (*Lolium perenne*)/white clover (*Trifolium repens*) pastures at different rates, times of application and locations, both alone and in combination with 2,4-D or 2,4,5-T.

The results are presented only briefly and are to some extent interim because final data from all the trials are not yet available. Nevertheless, all trial data cover a period of at least 18 months after spraying and are worth giving at this time.

When all final results are known and have been collated, they will be presented in full elsewhere at a later date.

EXPERIMENTAL

Because there are four experiments and a diversity of treatments, the majority of experimental details are given briefly in tables.

The pastures at the three sites were ryegrass/white clover dominant with varying, but relatively minor, proportions of other species—mainly *Poa trivialis* at Marton, *Poa* spp. and flatweeds at Ruakura, and *Bromus mollis* at Invermay.

All trials layouts were randomized blocks. Management technique at Ruakura was alternate mowing and grazing. The same technique was used at Marton until autumn 1966 when one section was sprayed with paraquat and oversown with a ryegrass/white clover mixture; thereafter, each section was treated as a separate trial. At Invermay, trial management consisted of periodic grazing and closing for silage or hay cuts.

At both Marton and Invermay, herbage dissection analysis was taken at every cut. At Ruakura, herbage analysis was only intermittent but point analysis data were obtained.

All trials received adequate dressings of fertilizer.

RESULTS

PICLORAM ALONE

Effect on Pasture Composition

All rates of picloram rapidly and completely eliminated white clover and any broadleaf weeds from sprayed pasture, irrespective of the time of application or trial location. Grasses appeared to be tolerant of picloram and gaps left by the susceptible plants were soon filled, mainly by perennial ryegrass; the weed/grass percentage did not increase greatly (Fig. 1).

The species/yield percentages illustrated in Fig. 1 are derived from cuts at which there were clear differences in pasture composition but only after any initial or temporary effects had passed and before white clover re-established on sprayed plots.

Once a particular species balance on sprayed plots was established, there was remarkably little change in pasture composition, regardless of treatment or site, until white clover entered the sward.

Fig. 1: Pasture species composition (% of yield) of sprayed and unsprayed pasture.

Trial No. and Location	Soil Type	Date Sprayed	Gal. Water per acre	Pasture Height (in.)	Growth vigour	Chemical Treatments*
1. Ruakura	Horotiu sandy loam Marton loam	21/4/65	30	3-6	Moderate	X Y Z ₁ Z ₂
2. Ruakura		14/9/65	30	3-5	Strong	
3. Marton		1/12/64	20	2-3	Fair	
4. Invermay	Alluvial silt loam	29/11/63 28/12/63 17/2/64	20 20 20	1-3 3-5 2-3	Good Fair/Good Fair	

*See table below.

Chemical Treatments (rates in lb a.i./acre) for Each Experiment

		Picloram									
		0	0.125	0.18	0.25	0.36	0.5	0.72	1.0	1.08	
amine	2,4-D	X	X	Z ₂	X	X	X	X	Z ₁	Z ₁	
	amine	Y			Y		Y	Y			
		Z	X			Z ₂		Z ₂			
amine	2,4-D	0.5	X								
	amine	1.0	X	X							
			Y	Y							
amine	2,4-D	2.0	X								
	amine		X					X			
			Y					Y			
amine	2,4,5-T	1.33	X								
	amine	4.0	Y								
								X		Y

Fig. 2: Clover re-establishment after spraying in summer and autumn.

Re-establishment of white clover in the sprayed pasture was affected by the time of application of picloram but not by the rate used or by the location of the trial.

Although data are still incomplete, the results available indicate that following spring spraying it takes about two years for white clover to become fully re-established, but only about 18 months when picloram is applied in autumn.

The first sign of clover returning in treated swards was seen about 6 to 8 months after autumn spraying but not for 9 to 12 months after spring/summer treatment. Clover re-establishment from the time that the first plants were seen to full production usually took about 12 months. During this time establishment was usually very slow for the first 9 months and the clover occurred as isolated plants or in distinct, unevenly distributed patches. Figure 2 is a composite graph showing typical clover re-establishment after spraying in late spring and summer compared with autumn application.

Re-establishment of clover is normally difficult because of the competition offered by the established grasses. However, grass growth normally declines in late spring/early summer and it is at this time that the clover usually gains a strong foothold and its percentage increase in the sward is then very rapid. Figure 2 clearly illustrates this.

To summarize, it is not until the second spring/summer season following spraying that white clover becomes fully re-established.

Effect on Pasture Production

The initial effect of picloram was to reduce total yield markedly but this was then followed by a temporary increase in grass production which was probably brought about by nitrogen release from dead clover. However, the increased grass yield soon faded and the production on sprayed plots was then dependent on grass growth alone unassisted by additional nitrogen.

There were no clear differences between rates of application of picloram, either initially or subsequently. This was true for all experiments regardless of the site or time of application. Because the range between the lowest and highest rate used was relatively large, this lack of either initial or total effect is, perhaps, rather surprising.

Fig. 3: Seasonal yields for picloram (means of all rates) applied in autumn and spring at Ruakura.

Results showed the time of application of picloram to be relatively important on pasture production effects. Figure 3 illustrates the seasonal production following autumn and spring spraying.

Figure 3 shows that after autumn spraying there was a considerable time lag before marked yield differences occurred. In spring, the lag period was much shorter. Loss of production is almost entirely dependent upon the absence of clover (see later) and this is why the seasonal yield differences between sprayed and unsprayed pasture were so marked during the time of year when clover is normally making active growth.

It has already been demonstrated that clover recovery takes place in the second spring/summer period after spraying. Presumably because of this, there are strong indications that pasture production returns to normal more rapidly after autumn application than after spring or summer spraying. However, adequate data are not yet available to confirm this.

Annual yields after spraying at all locations are compared in Table 1.

TABLE 1: COMPARISON OF ANNUAL YIELDS (D.M. lb/acre) IN THE FIRST YEAR AFTER SPRAYING

Place	Control Yield	Picloram Treat.* Yield Diff. from Control	% Loss in Production using Picloram
Ruakura	13,060	—1,520	—12
Marton	8,290	—1,450	—17
Invermay	11,730	—3,020	—26

*Means of all rates and times of application.

The results presented show marked percentage differences in yield loss between locations. However, Table 2 shows that this is almost entirely due to the loss of production of white clover. The yield of white clover on unsprayed pasture at Invermay was greater than at Marton. Therefore, the elimination of clover by picloram brought about a correspondingly greater loss in production.

Although percentages of grass in sprayed pasture were increased by about 25% (Fig. 1) this offset yield loss by only about 5%.

At Ruakura and Invermay, but not at Marton, symptoms of nitrogen deficiency were observed on treated plots during summer.

PICLORAM IN COMBINATION WITH 2,4-D AND 2,4,5-T

2,4-D and 2,4,5-T were included in the trials as standards for comparing rates of picloram alone and picloram/2,4-D—2,4,5-T mixtures.

At both times of spraying, 2,4-D damage to white clover at Ruakura was only transient. At Marton it was severe, but total yields were not significantly lower than control for more than two months after spraying.

At Ruakura 2,4,5-T 1.33 lb had no effect at all on white clover at either time of application. However, at Marton, where it was applied at 4 lb, the clover content was reduced to about 10% of control, recovery was very slow and was not complete until the end of summer 1965–6, 15 months after spraying.

The effect of 2,4-D and 2,4,5-T in combination with picloram is not clear at present, partly because of conflicting evidence and partly because of lack of adequate statistical data. A comparison of total yields for all treatments 12 months after spraying is given in Table 3.

When the observed percentage loss in yield is greater than expected, the combination is synergistic; when less than expected, it is antagonistic. If the observed and expected responses are equal, the combination is additive.

Table 3 shows that synergistic effects are indicated for both mixtures when applied at Ruakura in autumn. The total yield loss for the picloram/2,4-D mixture, for example, is 1,230 lb D.M. per acre more than expected.

Ruakura spring applications do not show overall synergism but the highest rate combination of picloram/2,4-D does.

At Marton, the antagonistic effect shown for the picloram/2,4,5-T mixture occurs because both herbicides at their respective rates reduce yield and affect pasture composition to the same degree in the first year after spraying if used alone. Even a slightly greater approach to an additive result could not be expected unless the herbicide combination affected grass production.

When all data finally become available, they will be statistically examined to show the extent and duration of synergism.

DISCUSSION

Although all final results are not yet available, some interesting facts have been brought out by the experiments described.

It has been found that, when applied overall to predominantly ryegrass/white clover pastures, all the rates of picloram used, ranging from 0.125 to 1.08 lb, effectively eliminate white clover regardless of the time of application or location.

TABLE 2: COMPARISON OF ANNUAL YIELDS (D.M. lb/acre) IN THE FIRST YEAR AFTER SPRAYING AT MARTON AND INVERMAY

	Control			Picloram*		
	Ryegrass	Other Species†	Total	Ryegrass	Other Species†	Total
MARTON						
Yield (D.M. lb/acre)	4,810	1,660	8,290	5,050	1,790	6,840
% Yield relative to control total	58	20	100	61	22	83
% Yield difference from control				+ 3	+ 2	- 17
INVERMAY						
Yield (D.M. lb/acre)	6,340	1,500	11,730	6,970	1,630	8,710
% Yield relative to control total	54	13	100	59	14	74
% Yield difference from control				+ 5	+ 1	- 26

*Means all rates.

†Principally weed grasses.

TABLE 3: COMPARISON OF TOTAL YIELDS (D.M. lb/acre)
12 MONTHS AFTER SPRAYING TO SHOW PICLORAM/2,4-D—
2,4,5-T EFFECTS

	Treatments—All Rates				
	Control	2,4-D	2,4,5-T	Picloram + 2,4-D	Picloram + 2,4,5-T
RUAKURA—AUTUMN					
Mean total yield	13,850	14,370	14,100	12,530	11,790
Yield as % control	100	104	102	90	85
<i>E</i> * for picloram/2,4-D mixtures = 94. <i>E</i> for picloram/2,4,5-T mixtures = 92.					
RUAKURA—SPRING					
Mean total yield	13,600	13,920	12,990	11,870	11,740
Yield as % control	100	102	96	87	86
<i>E</i> for picloram/2,4-D mixtures = 89. <i>E</i> for picloram/2,4,5-T mixtures = 84.					
MARTON					
Mean total yield	8,290	7,830	6,610	6,840	6,420
Yield as % control	100	94	80	83	78
<i>E</i> for picloram/2,4-D mixtures = 78. <i>E</i> for picloram/2,4,5-T mixtures = 66.					

**E* is the "expected" yield (Colby, 1967) expressed as a percentage of the control.

If picloram is applied when clover is in, or just entering a period of growth, the initial total yields are lowered more rapidly than if the herbicide is applied during a period of dormancy. Clover did not usually re-establish in the sward until the second spring/summer period after spraying. It may be that the winter rains following autumn applications assist in leaching picloram from the upper 2 or 3 in. of soil quite effectively, so allowing earlier re-establishment of clover than if the pasture is sprayed in spring or summer.

The return of clover into the pasture is normally prevented by competition effects from the established grass, but during the late spring and early summer grass growth usually declines and it is usual for clover to

first gain entry into the weakened sward at this time. However, it is usually about a year from the time of entry of the first few plants into the pasture until the species balance is satisfactory, with the clover then contributing an adequate amount of production.

Both ryegrass and weed grasses are tolerant of picloram and in sprayed swards the grass component is usually increased by the amount by which white clover or other legumes, broadleaf weeds, etc., were present before spraying. However, this usually compensates only very little for the production formerly provided either directly or indirectly by the clover when it was in the pasture. Nitrogen deficiency in the grass frequently becomes noticeable, particularly during the summer, on picloram-sprayed plots. The nutritional balance of the sward while clover is absent is clearly poor.

Synergistic effects of mixtures of picloram with 2,4-D or 2,4,5-T are indicated. When further data are available this may show up to a greater or less extent.

The effects of oversowing following spraying were not mentioned in the results because comparative data are not yet available.

The first traces of clover showed up in spring following autumn application of picloram at Ruakura and it may well be possible to re-establish clovers at this time by using suitable techniques.

The results reported here indicate quite clearly that the use of picloram as an overall spray in normal pasture situations cannot be recommended. Spot-spraying with picloram in pasture to control weeds has been used with success for some time now and there can be no objection to this as long as the user is aware of the potential hazards.

REFERENCE

Colby, S. R., 1967: *Weeds*, 15: 20.