THE ADDITION OF PARAQUAT AND DIQUAT TO 2,4,5-T FOR GORSE CONTROL

P. P. WILLIAMS

Imperial Chemical Industries (N.Z.) Ltd., Hamilton

P. C. PALMER

Imperial Chemical Industries (N.Z.) Ltd., Palmerston North

Summary

The bipyridylum herbicides, paraquat and diquat, are shown to have activity on gorse (*Ulex europaeus*) at rates of from 1.0 to 3.0 lb active ingredient per 200 gal of water. Autumn application of these chemicals is seen to have a place in areas restricted by Vineyards Regulations. Mixtures of paraquat and diquat at lower rates with 2,4,5-T butyl ester improve the effectiveness of autumn and winter application and to this extent overcome the restriction of seasonability associated with 2,4,5-T. A feature of the bipyridyls, both alone and in mixture with 2,4,5-T, is the rapid collapse of sprayed gorse. The implications of this effect in a programme of gorse eradication are discussed.

INTRODUCTION

2,4,5-T applied from September to February is the standard chemical treatment for gorse (*Ulex europaeus*) control in New Zealand. Autumn and winter applications are characterized by slow activity and variable end results.

Currie (1959) reported that 2,4,5-T applied at 4.95 lb a.i. per 300 gal/acre on April 8 was very slow in showing any effect and not until mid-August could one observe some 70 to 80% of the bushes browning off. By January the effectiveness of the application was variable, results ranging from 50 to 90% final kill. Other workers have attempted to explain variable results from autumn and winter application in terms of seasonal climatic differences (Leonard, 1958; Matthews, 1960).

This limited seasonal activity of 2,4,5-T has the disadvantage of concentrating gorse spraying into a time of the year already heavily committed with other farm operations. Contractors are also faced with the problem of unbalanced seasonal utilization of plant and labour.

The Vineyards Regulations (1962) further restrict the use of 2,4,5-T.

In connection with this restriction, staff of an Auckland Borough Council observed that gorse was controlled by paraquat. As these observations were made on winter application of paraquat, it was decided to investigate the role of the bipyridyls (both diquat and paraquat) in extending the effective season of gorse control.

This paper reports results obtained so far from a series of trials laid down to study the effect of mixtures of paraquat and diquat with 2,4,5-T for out-of-season gorse spraying.

TABLE 1: TRIAL LOCATION AND METHOD

<i>Location</i>	<i>Times of Application</i>	<i>Replications</i>	<i>Method of Application</i>
Waiuku	12/5/66	6	Handgun at 100 lb/sq. in.
Hamilton	30/3/67, 4/7/67	5	Handgun at 100 lb/sq. in.
Masterton	22/9/67, 3/1/68	6	Handgun at 100 lb/sq. in.
Palmerston North	30/6/67, 18/12/67	6	Handgun at 200 lb/sq. in.
Waipu	8/4/68, 26/7/68	5	Handgun at 200 lb/sq. in.
	31/10/68, 23/1/69		
	23/4/68, 31/8/68		
	3/1/69		

TABLE 2: SUMMARY OF TREATMENTS

(The following treatments were applied at all times for the site shown.
Rates are expressed as pounds a.i. per 200 gal water.)

<i>Treatment</i>	<i>Waiuku</i>	<i>Hamilton</i>	<i>Masterton</i>	<i>Palmerston North</i>	<i>Waipu</i>
2,4,5-T butyl ester					
3.6	x	x	x	x	x
7.2				x	x
paraquat 0.25			x		
0.5		x	x		
1.0	x				
2.0	x				
3.0	x				
diquat 0.25			x		
0.5		x	x		
1.0	x				
2.0	x				
3.0	x				
paraquat + 2,4,5-T butyl ester					
0.25 + 1.8			x		
0.5 + 1.8		x			
diquat + 2,4,5-T butyl ester					
0.25 + 1.8			x		
0.5 + 1.8		x			x
0.5 + 2.7				x	
diquat + 2,4,5-T amine salt					
0.25 + 3.15				x	x
0.5 + 2.7				x	x
0.5 + 1.8				x	x
1.0 + 1.8				x	
1.0 + 0.9					x

EXPERIMENTAL

The majority of gorse spraying in New Zealand is with ground equipment using a handgun and rates calculated on a dilution basis rather than per unit area. All trials conducted to date have been on a dilution basis using a conventional handgun.

Plots comprise single bushes graded into blocks according to size. Spraying was to the point of run-off.

Times were recorded to provide a check of the quantity applied per bush.

METHOD OF ASSESSMENT

A plot receives the maximum score if it is completely brown and no regrowth is showing.

If regrowth has commenced, then plots are rated down the scale on the basis of both extent and vigour of this regrowth.

In the table of results, scores have been converted to 0 to 10 scale where 10 represents complete effect.

Assessments are made by two independent observers.

TABLE 3: ACTIVITY OF 2,4,5-T BUTYL ESTER BY SEASON AND RATE

<i>2,4,5-T at 3.6 lb/ 200 gal</i>	<i>6 mon</i>	<i>12 mon</i>
Spring		
Hamilton	10	10
Palmerston North	10	—
Summer		
Hamilton	10	9
Masterton	10	9
Autumn		
Waiuku	6) Average "out-	9) Average "out-
Hamilton	9) of-season"	8) of-season"
Palmerston North	7) score = 7.	9) score = 9.
Waipu	6)	9)
Winter		
Hamilton	6)	9)
Masterton	8)	9)
Palmerston North	9) (7 at 9 mon)→	)
Waipu	8) (10 at 9 mon)→	)
<i>2,4,5-T at 7.2 lb/ 200 gal</i>		
Spring		
Palmerston North	10	—
Autumn		
Palmerston North	10	10
Waipu	8	10
Winter		
Palmerston North	10 (10 at 9 mon)→	
Waipu	7 (10 at 9 mon)→	

RESULTS

2,4,5-T ACTIVITY

The trials have confirmed that spring and summer application of the butyl ester of 2,4,5-T at 3.6 lb per 200 gal of water provides effective control of gorse. Autumn and winter applications at this rate are slow to act, although by twelve months control is generally acceptable. These results are shown in Table 3.

Doubling the rate of 2,4,5-T to 7.2 lb/200 gal has not consistently improved the speed of action from autumn and winter applications, but this treatment has given good results by nine and twelve months in the two trials shown in Table 3.

BIPYRIDYL ACTIVITY

Results for diquat and paraquat are shown in Table 4.

TABLE 4: ACTIVITY OF BIPYRIDYLS BY RATE

(Summary of results from three trials and four times of application.)

lb a.i./200 gal	6 mon		12 mon	
	diquat	paraquat	diquat	paraquat
0.25	7	7	6	5
0.5	6	7	6	6
1.0	10	9	8	7
2.0	10	9	10	7
3.0	10	10	9	10

Paraquat and diquat have significant activity on gorse. This activity was related to rate and both herbicides gave similar results.

TABLE 5: AUTUMN/WINTER ACTIVITY OF MIXTURES OF BIPYRIDYL WITH 2,4,5-T

paraquat	diquat	Treatment (rates per 200 gal)		6 mon	12 mon
		2,4,5-T butyl ester	2,4,5-T amine salt		
0.25		1.8		8	9
0.5		1.8		9	9
	0.25	1.8		8	7
	0.5	1.8		10	9
	0.5	2.7		9	9
	0.25		3.15	8	7
	0.5		2.7	8	8
	0.5		1.8	9	7
	1.0		1.8	8	6
	1.0		0.9	10	9
Average mixture effect with 2,4,5-T as ester				9	9
Average mixture effect with 2,4,5-T as amine				9	7

AUTUMN AND WINTER ACTIVITY OF MIXTURES — BIPYRIDYL/2,4,5-T

The mixtures had a high level of effect at six months which continued to be acceptable by the twelve months assessment (Table 5).

There was an indication that mixtures based on the butyl ester of 2,4,5-T were superior to those based on the amine salt. Rapid collapse of bushes was again a feature, attributable presumably to the bipyridyl component.

DISCUSSION

The trials reported have confirmed the effectiveness of 2,4,5-T ester when this chemical is applied to gorse during spring and summer.

Autumn and winter applications of the butyl ester of 2,4,5-T 3.6 lb were slow to act, although by twelve months control was generally acceptable in these trials.

Whilst speed of action in itself is not the final criterion in selecting a chemical for gorse control, a delay of up to six months before much effect is seen and at least twelve months before the start of plant-breakdown would seriously detract from a gorse control recommendation.

The bipyridyls, paraquat and diquat, show significant activity in their own right at higher rates on gorse. This activity is characterized by both speed of action and rapidity of breakdown of bushes. Diquat or paraquat at rates from 1.0 to 3.0 lb/200 gal could therefore be useful, particularly when applied in autumn for the control of gorse in metropolitan areas and districts affected by the 1962 Vineyard Regulations.

Mixtures of 2,4,5-T plus paraquat or diquat act more rapidly and produce a final effect equal to that of 2,4,5-T ester alone. The restriction of slow activity of 2,4,5-T ester when applied in autumn and winter can therefore be overcome by the addition of diquat or paraquat.

The feature of rapid action and quicker breakdown can be used to advantage in a programme of gorse eradication by improving the effectiveness of stock management, thereby enhancing the chances of pasture establishment the following spring.

Experimental work is continuing to determine the optimum ratio of bipyridyl to 2,4,5-T ester for autumn and winter spraying.

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REFERENCES

- Currie, J. D., 1959: *Proc. N.Z. Weed Control Conf.*: 65.
Matthews, L. J., 1960: *Dept. Agric. Bull.* 329: 111.
Leonard, O. R., 1958: *Proc. N.Z. Weed Control Conf.*: 51.