SELECTIVE CONTROL OF CLEAVERS (Galium aparine) IN CONSERVATION HEADLANDS WITH QUINMERAC

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ABSTRACT

Trials were carried out with quinmerac applied at different rates and timings, to confirm its efficacy in controlling *Galium aparine* in a headland situation, and to investigate its degree of selectivity with respect to other weed species. Eleven small plot trials were carried out in 1989 using a backpack sprayer with hand held boom, and a further two in 1990 involving larger plots with herbicide applied by full width farm sprayers. Good control of *G. aparine* was achieved in all trials. *Veronica* spp., *Papaver rhoeas* and *Lamium purpureum* were also susceptible, but all other species were resistant. It is concluded that quinmerac has potential for selective control of *G. aparine* in Conservation Headlands.

INTRODUCTION

The term 'Conservation Headland' refers to a system of modified pesticide use whereby the use of herbicides affecting broadleaved weeds is minimised and summer insecticides are avoided, on the outermost few metres of cereal crops. This allows the survival of the less damaging components of the arable flora typically found in cereals, along with the associated phytophagous invertebrate fauna. These provide food sources for other faunal groups, including gamebirds (Potts, 1986) and predatory arthropods important in biological pest control (Chiverton & Sotherton, in press). Details of the technique, the agronomic consequences and the benefits for farmland wildlife have been described elsewhere (Boatman & Sotherton, 1988; Boatman, 1989; Sotherton *et al.*, 1989).

Herbicide use on Conservation Headlands is restricted to those with specific activity against species most damaging to crop production, and which are therefore not tolerable to farmers (Boatman, 1987; 1989). Surveys of farmer opinion have shown that the species which causes greatest concern to farmers in field margins is cleavers (*Galium aparine*) (Boatman, 1989). It is a very competitive weed which can cause large losses of yield (Wilson & Wright, 1987).

There is at present no herbicide approved for use on cereals which gives truly selective control of *G. aparine*. Quinmerac (BAS 518H; Wuerzer *et al.*, 1985) has been reported to be effective against *G. aparine* with activity against only a very limited range of other species (Nuyken *et al.*, 1985; Bond & Burch, 1987; Boatman, 1989).

The experiments reported here were carried out to confirm the efficacy of quinmerac against *G. aparine* at the crop edge (where *G. aparine* is often more abundant then in the rest of the field and crop competition is often lower), to determine the optimum dose and timing for use in this situation, and to provide further information on its spectrum of activity. Results on the use of quinmerac in field boundary vegetation, have been reported elsewhere (Bain & Boatman, 1989).

MATERIALS AND METHODS

Field experiments were carried out in headlands of cereal fields, selected for the presence of *G. aparine* and a range of other broadleaved species at sites throughout the south of England (Table 1). Soil types were: calcareous silt (sites 1, 6, 9, 12, 13), loam (2, 5, 7, 8), clay loam (4), calcareous clay (10, 11) and silty clay with flints (3).

Eleven experiments were carried out in 1988/89 (three main sites, eight subsidiary sites) and two in 1989/90. Treatment details were as follows:

quinmerac dose (kg AI/ha)	timing	1988/89 main	1988/89 subsidiary	1989/90
0.5	Oct/Nov	✓		✓
0.75	"	✓		✓
1.0	"	✓		
0.5	Dec	✓		✓
0.75	"	✓	✓	✓
1.0	"	✓		
0.5 + 0.5	Oct/Dec	✓		
0.75 + 1.14 kg AI/ha diclofop-methyl	Dec	✓		
0 (untreated)		✓	✓	✓

1988/89 experiments

The full range of treatments were applied to the main sites in 1988/89. The mixture with diclofop-methyl was included to test for compatibility, since this herbicide is recommended for selective grass weed control in Conservation Headlands (Boatman, 1987). Only one spray treatment, intermediate in dose, was applied to the eight subsidiary sites, to determine the range of between-site variation in levels of control.

Herbicides were applied with an Oxford Precision Sprayer fitted with Lurmark 02-F80 nozzles at a pressure of 2.5 bars and a volume rate of 218 l/ha. Application dates are given in Table 2. Plots were positioned with their long axis running from the crop edge to the first tramline, a distance which varied between 6 and 12 m. They were 3 m wide in all cases. There were four replicates of each treatment, arranged in a randomised block design.

Growth stages of crop plants, *G. aparine* and other species present were recorded at spraying (Table 1). Crop and *G. aparine* % cover, weed density and vigour scores were recorded from ten 0.25 m^2 quadrats in each plot four and eight weeks after spraying. Percentage cover of crop, and all weed species were recorded post-ear emergence, in late June, in ten 0.25 m^2 quadrats per plot.

1989/90 experiments

Treatments were similar to those applied in the previous year, but using farm sprayers instead of a backpack sprayer. Spray pressure was 2.5-3 bars and volume rate 250 l/ha. Individual plots were 20 m long and plot width varied between 6-12 metres, according to the distance between crop edge and tramline. Each treatment was replicated twice, in a randomised block design. Dates of herbicide application, crop and *G. aparine* growth stages are presented in Table 1.

TABLE 1. Dates of herbicide application and growth stages of crop and *G. aparine* at spraying.

Year	Site	Date of spraying	Mean crop growth stage[1]	*G. aparine* growth stage range[2]
1988/89	1. Hants	20 Oct	11	expanded cots - 1 whorl
		7 Dec	14/20	expanded cots - 25 mm
	2. Cambs	28 Oct	12	expanded cots - 1 whorl
		21 Dec	13/22	expanded cots - 6 whorls
	3. Dorset	22 Oct	11	expanded cotyledons
		12 Dec	13/21	expanded cots - 100 mm
	4. Berks	10 Nov	13/22	expanded cots - 2 whorls
	5. Oxon	11 Nov	11	expanded cots - 2 whorls
	6. Hants	10 Nov	13/21	expanded cots - 2 whorls
	7. Berks	24 Jan	13/21	expanded cots - 1 whorl
	8. Hants	23 Nov	10	expanded cots - 4 whorls
	9. Hants	21 Nov	11	expanded cots - 2 whorls
	10. Glos	11 Nov	14/22	expanded cots - 4 whorls
	11. Cambs	21 Dec	14/22	1 whorl - 25 cm
1989/90	12. Wilts	17 Nov	-[3]	expanded cots - 150 mm
		19 Dec	-	150-250 mm
	13. Hants	13 Nov	-	100-250 mm
		5 Jan	-	100-250 mm

1 after Tottman, 1987, *Ann. Appl. Biol.* **110**, 441-454
2 after Lutman & Tucker, 1987, *Ann. Appl. Biol.* **110**, 683-678
3 not recorded

The appearance of plants of *G. aparine* and other broadleaved species present in sprayed plots was assessed eight weeks after spraying, in comparison with untreated plots, as in the previous year. Because some species had senesced by the time of the June assessment in 1989, an earlier assessment was made in 1990. Broadleaved weeds were assessed in experiment 13 by counting numbers in ten randomly placed 0.25 m^2 quadrats in each plot in April and early May. In experiment 12, poor growth of the crop and abundance of species with a prostrate, spreading habit, particularly chickweed, precluded the separation of individual plants. Headland quadrats in these plots were therefore scored on the 'Domin Scale'. For the purposes of analysis, Domin scores were transformed into percentage cover using the method of Currall (1987). Percentage cover of *G. aparine* was assessed in July in ten 0.25 m^2 quadrats in each plot.

RESULTS

Only results from the later assessments, in June 1989 and in May and July 1990 are presented.

1988/89 experiments

Very high levels of control of *G. aparine* were achieved: control by 0.75 kg AI/ha was greater than 92% in all experiments, and greater than 99% in six of the eleven experiments (Tables 2 & 3). There was no significant difference between any of the herbicide treatments in the main sites (Table 2).

TABLE 2. Percentage cover of *G. aparine* in late June 1989 following treatment with quinmerac in autumn 1988 at main sites. (Figures in parentheses are arcsine transformed data. Standard errors refer to transformed data. Figures in bold type are percentage control).

Site	Treatment (dose kg AI/ha and timing) 0	0.5 Oct	0.75 Oct	1.00 Oct	0.5 Dec	0.75 Dec	1.00 Dec	0.5 Oct + 0.5 Dec	0.75 Dec + diclofop-methyl	SE
1	1.3	0	<0.1	0	0	<0.1	0	0	0	
	(6.3)	(0)	(0.3)	(0)	(0)	(0.5)	(0)	(0)	(0)	0.4***
		100	**99.2**	**100**	**100**	**97.7**	**100**	**100**	**100**	
2	24.0	0.2	<0.1	0	<0.1	0	0	0	1.3	
	(29.3)	(2.4)	(0.3)	(0)	(0.3)	(0)	(0)	(0)	(3.2)	1.2***
		99.0	**>99.9**	**100**	**>99.9**	**100**	**100**	**100**	**94.8**	
3	3.4	0.5	0.2	<0.1	0.1	0.1	0	<0.1	0.1	
	(10.0)	(2.6)	(1.7)	(0.5)	(1.4)	(0.9)	(0)	(0.3)	(1.1)	1.0***
		86.6	**94.8**	**99.1**	**96.2**	**97.1**	**100**	**99.7**	**97.5**	

TABLE 3. Percentage cover of *G. aparine* in late June 1989 following treatment with quinmerac in autumn 1988 at subsidiary sites. (Figures in parentheses are arcsine transformed data. Standard errors refer to transformed data. Figures in bold type are percentage control)

Dose (kg AI/ha)	Site 4	5	6	7	8	9	10	11
0	32.3	30.2	7.1	4.9	9.9	40.9	1.0	21.6
	(34.6)	(33.0)	(15.0)	(12.6)	(16.6)	(39.7)	(5.5)	(27.6)
0.75	0	0.3	0.4	0.1	0.7	0.4	0	0
	(0)	(2.8)	(2.9)	(1.0)	(4.1)	(3.4)	(0)	(0)
	100	**99.0**	**94.4**	**98.0**	**92.9**	**99.0**	**100**	**100**

SE Treatment = 0.7***; SE Site = 1.4***; SE Treatment x site = 1.9***

Papaver rhoeas and *Veronica persica* were also susceptible to quinmerac, high levels of control resulting from all treatments where these species were present. Once again there was little difference between treatments (Table 4). Earlier assessments indicated that *Veronica hederifolia* and *L. purpureum* were also susceptible, but these species had senesced by the time of the later assessment.

Species present at one or more sites in sufficient quantities to permit statistical analysis, but for which no significant effects of the herbicide were detected, included *Geranium molle*, *Myosotis arvensis*, *Stellaria media*, *Tripleurospermum inodorum* and *Viola arvensis*. Other species present at levels too low for statistical analysis, but for which no obvious treatment effects were detected, included *Aphanes arvensis*, *Fallopia convolvulus* and *Senecio vulgaris*.

TABLE 4. Percentage cover in late June 1989 following treatment with quinmerac in autumn 1988 at main sites. (Figures in parentheses are arcsine transformed data. Standard errors refer to transformed data).

	Treatment (dose kg AI/ha and timing)									SE
Site	0	0.5 Oct	0.75 Oct	1.00 Oct	0.5 Dec	0.75 Dec	1.00 Dec	0.5 Oct + 0.5 Dec	0.75 Dec + diclofop-methyl	
Papaver rhoeas										
1	5.3	<0.1	<0.1	0	0.3	0.1	<0.1	0	0.1	
	(12.9)	(0.6)	(0.8)	(0)	(1.9)	(1.4)	(0.5)	(0)	(1.2)	0.9^{***}
2	1.7	<0.1	0	0	0	0	<0.1	0	0	
	(7.0)	(0.5)	(0)	(0)	(0)	(0)	(0.3)	(0)	(0)	0.6^{***}
3	2.6	1.0	0	<0.1	0.5	0.2	0.2	0	0.1	
	(8.4)	(3.0)	(0)	0.5)	(3.3)	(1.5)	(1.7)	(0)	(0.9)	1.3^{**}
Veronica persica										
1	0.9	<0.1	<0.1	<0.1	<0.1	<0.1	0	<0.1	0.1	
	(5.5)	(0.3)	(0.5)	(0.5	(0.3)	(0.8)	(0)	(0.3)	0.6	0.4^{***}
2	5.6	0.1	0.1	0	0.1	0.1	0	0	0.2	
	(13.1)	(1.7)	(1.1)	(0)	(1.0)	(1.6)	(0)	(0)	(1.4)	1.0^{***}

1989/90 experiments

Levels of *G. aparine* control (measured as percentage cover in July) in experiments 12 and 13 were comparable with those measured in the previous year at a similar time, ranging from 89 to 98 %, with little difference between treatments (Table 5).

The only other species to show significant effects of herbicide use was *V. persica*. This was completely controlled by both doses at the earlier timing in experiment 12, with the low and high doses giving 78 and 93% control respectively at the later timing (Table 6). In experiment 13, there was a similar effect of timing (through not significant at P<0.05), but levels of control were markedly lower (Table 6). Numbers of *L. purpureum* were lower in treated plots in experiment 13, though the difference was not statistically significant. In contrast, *Legousia hybrida* was present in significantly greater numbers in experiment 13, where herbicide was used

(Table 6). This may be a result of reduced competition from *G. aparine* and/or *V. persica* in treated plots.

TABLE 5. Percentage cover of *G. aparine* in July 1990, following treatment in autumn 1989. (Figures in parentheses are arcsine transformed data; standard errors refer to transformed values. Standard errors only given for differences significant at P<0.05. Figures in bold type are percentage control).

Experiment	Treatment (dose, kg AI/ha and timing) 0	0.5 Nov	0.75 Nov	0.5 Dec/Jan	0.75 Dec/Jan	SED* UH	UDT	DT
12	50.2	1.8	2.7	5.3	4.1			
	(45.1)	(7.5)	(9.4)	(13.3)	(11.1)	3.9	(NS)	(NS)
		96.4	**94.6**	**89.4**	**91.8**			
13	6.3	0.2	0.1	0.5	0.1			
	(12.6)	(2.7)	(2.0)	(2.9)	(1.9)	3.6	(NS)	(NS)
		96.8	**98.4**	**92.1**	**98.4**			

* UH = SED for comparing untreated with herbicide treated; UDT = SED for comparing untreated with each level of dose <u>or</u> timing; DT = SED for comparing levels of dose <u>or</u> timing.

TABLE 6. Percentage cover, derived from Domin Scores (Expt. 12, see text) or numbers per 0.25 m^2 (Expt. 13) of broadleaved weeds in May 1990, following treatment in autumn 1989. (Figures in parentheses are arcsine transformed data; standard errors for these data refer to transformed values. Standard errors only given for differences significant at P<0.05).

	Treatment (dose, kg AI/ha and timing) 0	0.5 Nov	0.75 Nov	0.5 Dec/Jan	0.75 Dec/Jan	SED*	
<u>Experiment 12</u> (% cover)							
Veronica persica	4.76	0.0	0.0	1.03	0.33	UH	0.91
	(12.56)	(0.0)	(0.0)	(5.75)	(3.22)	UT	1.00
						T	0.81
<u>Experiment 13</u> (plant numbers)							
V. persica (13)	5.40	2.85	1.60	3.50	4.75	UH	0.79
Legousia hybrida (13)	4.15	7.70	5.75	5.50	7.15	UH	0.85

* UH = SED for comparing untreated with herbicide treated; UT = SED for comparing unsprayed with each level of timing; T = SED for comparing levels of timing; UD = SED for comparing untreated with each level of dose; D = SED for comparing levels of dose; (NS) = no significant differences.

Other species sufficiently abundant at one or more sites to permit statistical analysis, but which showed no treatment effects, were *A. arvensis*, *Capsella bursa-pastoris*, *Fumaria officialis*, *S. media*, *T. inodorum*, and *V. arvensis*.

DISCUSSION

A high degree of control of *G. aparine* was achieved at all sites in both years.

The only other species effectively controlled by quinmerac in these experiments were *V. persica, V hederifolia* and *P. rhoeas*. *L. purpureum* showed susceptibility but levels of control were variable. These species are not thought to be important as insect host plants. All other weed species present appeared to be resistant, including *F. convolvulus*, *T. inodorum* which are important insect food plants, and *S. media*, the seeds of which (along with *F. convolvulus*) are eaten by adult partridges (Potts, 1986). It is concluded that quinmerac is an appropriate herbicide for us in Conservation Headlands.

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