AN EVALUATION OF THE SOLID STREAM TECHNIQUE OF INSECTICIDE APPLICATION FOR CONTROL OF BLACK BEETLE IN PASTURE

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Summary

Insecticides applied by solid stream liquid jetting onto pasture at 15.0 cm nozzle spacings gave slightly reduced black beetle (*Heteronychus arator*) control compared to equivalent application rates of broadcast granules in field trials, but gave comparable control at 7.5 cm spacings. The trials included investigations of the effects of nozzle spacings, concentration of insecticide mixture, water rates and rates of insecticide applied per hectare, and a screening of different chemicals using the solid stream technique.

INTRODUCTION

Insecticides are usually applied against black beetle as granular formulations broadcast onto pasture. This application method requires moist soil at the time of application and rain soon after to carry the toxicant into the soil before photo-chemical and other degradation occurs (Udy 1977). An alternative method in which the chemical is applied in liquid form in a fine jet close to the ground has been successfully developed for grass grub control in Canterbury (Trought and Wood 1970). The potential advantages of this "jet squirt" or solid stream technique over broadcast granules include less dependence on weather, less harm to wildlife, shorter withholding periods, reduced application rates and cost advantages.

Blank and Olson (1978) reported findings from one trial in which solid stream applications were similar to granular treatments against black beetle. The aim of the field trials described here was to develop the solid stream method of insecticide application to its maximum efficiency for control of black beetle larvae in pasture, and to compare further the effectiveness of the solid stream technique with broadcast granules.

METHOD

The trials were conducted in the Waikato from 1977, on predominantly ryegrass (*Lolium perenne*)/white clover (*Trifolium repens*) dominant spring pasture, with varying amounts of paspalum (*Paspalum dilatatum*). Soils were volcanically derived and ranged in texture from light (ash) to heavy (alluvial) silt loams.

The apparatus for solid stream applications comprised a 5 m long, 1.9 cm diameter alkathene water pipe boom, with 5 cm long x 0.89 mm internal diameter trickle irrigation tube whiskers inserted at regular intervals (Trought 1971). Liquid formulations made up in water were jetted onto pasture at 140 kPa. Insecticide was applied at a boom height just clearing the pasture surface.

In trials 1 - 3 and 7 - 9, tractor speed was 7.4 km/h, with a constant nozzle output of 0.37 litres/min. Insecticide dosage/ha was increased by either reducing the nozzle spacing (which increased the volume of water applied/ha), or by increasing the concentration of fluid applied. In trials 1 and 2, both nozzle spacings and the concentration of isazophos were varied (treatments given in Tables 1 and 2). Trial 3 investigated two rates of diazinon (1.0 and 2.0 kg/ha) at three nozzle spacings as in trial 2. In trials 4-6 isazophos was applied in four water rates (achieved by varying the tractor speed), using a single nozzle spacing (7.5 cm) and concentrations which gave the

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application rates shown in Table 3. Trials 1, 2 and 4 - 6 included a standard of isazophos granules (1.5 or 2.0 kg/ha) surface broadcast by hand shaker, and trial 3 a similar standard of fensulfothion (2 kg/ha). Trials 7 - 9 compared a range of insecticides (Table 4) applied by the solid stream method in 400 litres/ha at a nozzle spacing of 7.5 cm, with granular applications also included in trial 9.

Trials were laid down in randomised blocks with 4 or 5 replicates, a plot size of 5 x 10 m and 5 m buffers between blocks. Insecticides were applied in early December to pasture 2 - 8 cm in height after grazing by sheep or dairy cattle. Moisture conditions at application were never less than adequate for the efficient activity of granular treatments (Udy 1977). All trials were assessed during February, prior to the emergence and dispersal of adults, using a 10 cm diameter soil corer to determine black beetle numbers. Twenty-five to forty samples were assessed during February, prior to the emergence and dispersal of adults, using a 10 cm diameter soil corer to determine black beetle numbers. Twenty-five to forty samples were taken per plot, depending on populations present at each site.

Analysis of data was based on log_ex transformation of the numbers sampled per plot, with the data presented in the tables as percent reduction in untransformed numbers relative to untreated.

RESULTS

Trial 1 (Table 1)

There was a significant ($P < 0.001$) linear decrease in black beetle numbers as the nozzle spacing decreased between 30 cm and 7.5 cm. Halving of nozzle spacing gave a 52% reduction in numbers. When both the nozzle spacing and concentration of fluid were halved (i.e., kg insecticide/ha was held constant) there was an overall reduction in numbers of 27%.

TABLE 1: Reduction in black beetle numbers using isazophos at three nozzle spacings and four application rates (Trial 1)

Nozzle spacing (cm)	Water rate (litres/ha)	% reduction at four rates of isazophos (kg/ha)			
		0.5	1.0	2.0	4.0
7.5	400	-	-	88*	95*
15.0	200	-	67*	76*	-
30.0	100	36	54*	-	-
broadcast granules				79*	

untreated No./m² ± SE = 47.7 ± 5.6.

No significant interactions. * indicates treatments significantly different from control ($P < 0.05$).

Trial 2 (Table 2)

There was a significant ($P < 0.05$) linear increase in control as application rate increased, but nozzle spacings were not significantly different overall. There was a suggested improvement ($P < 0.10$) in control at the 7.5 cm spacing, compared with the other spacings, at 1.0 and 2.0 kg/ha application rates.

Trial 3

There were no significant differences between the rates of diazinon used, or the nozzle spacings tested, and no diazinon treatment was significantly different from untreated controls (average reduction 21%). Fensulfothion granules gave a significant reduction of 69% ($P < 0.01$) compared with numbers on untreated plots of 60/m² ± 15.

Trials 4-6

Black beetle numbers on all insecticide treatments were significantly lower than on untreated plots ($P < 0.01$), with no significant differences between the rates of isazophos (trial 4) or water rates (Trials 4 - 6) (Table 3).

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TABLE 2: Reductions in black beetle numbers using isazophos at three nozzle spacings and two application rates (Trial 2)

Nozzle spacing (cm)	Water rate (litres/ha)	% reduction at three rates of isazophos (kg/ha)		
		0.5	1.0	2.0
3.8	800	25	46	57*
7.5	400	28	79*	79*
15.0	200	54	46	71*
broadcast granules				68*

untreated No./m² ± SE = 34.5 ± 14.5

* see Table 1

TABLE 3: Reduction in black beetle numbers using isazophos at four water rates

Water rate (litres/ha)	% reduction at insecticide rates (kg/ha)			
	Trial 4		Trial 5	Trial 6
	1.0	2.0	1.5	1.5
100	59	76	71	100
200	81	62	67	100
400	59	65	73	100
800	62	89	89	100
broadcast granules		76	88 ¹	98
Untreated No./m ² ± SE	46 ± 21		70 ± 38	44 ± 19

¹ Broadcast at 2 kg/ha (trial 5)

Trials 7 - 9 (Table 4)

Reductions greater than 41% were significantly different from untreated ($P < 0.01$). In addition to the treatments shown in Table 4, parathion 80 EC, trichloronat 55 EC, fonofos 47 EC and chlorpyrifos 40 EC applied at 2.0 kg/ha gave 0 to 41% reductions in trial 7, while lindane 20 EC and 20 G (2.0 kg/ha) gave reductions of 44 and 35% respectively, in trial 9. For isofenphos, isazophos and triazophos, solid stream applications over all three trials gave similar reductions to granular applications in trial 9.

TABLE 4: Reduction of black beetle in screening trials using solid stream applications

Treatment	% reduction at insecticide rates (kg/ha)				
	Trial 7	Trial 8		Trial 9	
		1.0	2.0	2.0	2.0 (granular)
isofenphos 50 EC, 5 G	89	98	100	100	86
isazophos 50 EC 10 G	82	97	97	90	88
triazophos 40 EC 5 G	89	76	92	82	81
diazinon 80 EC 20 G	86	47	75	18	52
fenamiphos 40 EC		54	86	78	
bendiocarb 80 WP 5 G		74	80	32	56
Untreated No./m ² ± SE	33 ± 9	74 ± 7		65 ± 2	

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In an overall analysis of 15 trials, including those reported here, granular applications just failed to give significantly better control than the solid stream applications at the 15.0 cm nozzle spacing ($0.10 > P > 0.05$, 13 comparisons). There was no significant difference between granules and solid stream at the 7.5 cm spacing ($P > 0.10$, 14 comparisons). Comparing nozzle spacings, control was improved by a reduction from 15.0 to 7.5 cm ($P < 0.05$, 5 comparisons) but there was no further improvement by a reduction to 3.8 cm ($P > 0.10$, 4 comparisons).

DISCUSSION AND CONCLUSIONS

The solid stream method at the 7.5 cm nozzle spacing gave comparable control to granular treatments at the recommended insecticide rate (2.0 kg/ha) (Tables 1 to 4). In some trials (Blank and Olson 1978; Watson and Webber 1976; Tables 1 to 4) liquid or granular treatments applied at 1.0 kg/ha have given similar control to the recommended rate. The conditions (soil type, soil moisture, pasture conditions, timing) in which reduced rates are consistently effective require definition.

Although at present limited by the availability of suitably registered chemicals, the solid stream method offers an alternative to granular applications for control of black beetle, with some potential advantages in cost and application efficacy. Further comparisons of these two applications techniques are required under soil conditions adverse to the efficient activity of granular applications. The apparatus required for solid stream application is inexpensive and readily constructed (Trought 1971), and enables more accurate distribution of insecticide compared with many farm granule applicators (Sims 1977).

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