EVALUATION OF A NEW SLUG BAIT INCORPORATING THIODICARB

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ABSTRACT

The effectiveness of thiodicarb and methiocarb molluscicide baits was compared in bioassays investigating the effect of bait exposure to simulated rainfall on slug survival, and a small plot field trial investigating the prevention of damage to cabbage transplants. Thiodicarb appeared to be more effective in killing slugs under the higher moisture levels than under the lower levels in the Invermay bioassay but not in the Ruakura bioassay. The field trial results indicate no differences between slug mortality associated with the two types of bait, at the rates used, and both provided similar levels of protection to cabbage transplants.

Keywords. *Deroceras reticulatum*, methiocarb, molluscicide, slugs, thiodicarb

INTRODUCTION

The grey field slug (*Deroceras reticulatum*) is an agricultural and horticultural pest widely distributed in New Zealand. Good control of this species can be achieved by cultivation and seed-bed preparation (Glen and Wilson 1995) but in the absence of soil disturbance, chemical control with molluscicides is regarded as the most reliable method (Godan 1983). Methiocarb and metaldehyde are the most effective active ingredients in commercial formulations currently available with methiocarb being considered superior to metaldehyde (Godan 1983). Bran based baits incorporating one of these molluscicides are often the only feasible method of slug control. These baits rely on moisture to enhance their attractiveness to slugs but too much moisture causes the baits to deteriorate. Rhone-Poulenc New Zealand Ltd have introduced to New Zealand a flour based bait, Larrbait, incorporating thiodicarb (4%) as the active ingredient. This base was considered more resistant to moisture than the conventional bran base and therefore might remain attractive to slugs longer when exposed to moisture. Thiodicarb has been shown to be as effective as methiocarb and in some cases more effective than metaldehyde in causing slug mortality in small plot trials (Firth *et al.* 1991) and in Europe a long period of activity has been achieved in field trials (Gauiliard and Laverriere 1989). This investigation compared the effectiveness of thiodicarb baits with methiocarb slug baits, for grey field slug control in two laboratory bioassays, and a small plot field trial.

METHOD

Laboratory investigations

Bioassays were conducted at Invermay and Ruakura. At Invermay thiodicarb and methiocarb (Mesurol, active ingredient 2% methiocarb) baits were broadcast on sieved sterilised moist soil (soil moisture 67.4%, SEM=0.4) and exposed to simulated rainfall by using a hand actioned atomiser to apply 10, 20, 30 or 40 mm of water over the soil and baits at a rate of 10 mm per day. The 10 mm treatment was applied on day 3, the 20 mm treatment on days 3 and 4, the 30 mm treatment on days 2,3 and 4 and the 40 mm treatment on days 1,2,3 and 4. The treatments were held at 4°C until day 5 when six replicate samples of five baits from each treatment were exposed to five slugs (mean extended length = 21.4 mm (SEM=0.3)) in petri dishes containing moist

Proc. 48th N.Z. Plant Protection Conf. 1995: 314-317

filter paper which did not contact the baits. The dishes were placed in a dark constant temperature cabinet at 14°C. Untreated control dishes were set up as above but with no slug baits. Slug mortality was assessed after 48 h. The data were analysed by a generalised linear model allowing for binomial distribution and with a logit link function.

A similar procedure was followed at Ruakura but an oscillating overhead flat spray nozzle replaced the atomiser and a 70 mm treatment (applied over 7 days) was included. The treatments were applied to eight replicates of slug baits broadcast at 300 g ai/ha in 170 x 170 mm plastic enclosures (with drainage holes). Five slugs were introduced to each enclosure 24 h after the last simulated rainfall. Enclosures without baits were used as a control treatment. Slug mortality was assessed after 1, 4 and 7 days. The data were analysed by analyses of variance.

Field investigation

A small plot trial with a randomised block design was established on a cultivated Wingatui silt loam at Invermay near Mosgiel. Forty, 1.2 x 1.7 m, plots, in ten blocks, were planted with 20 cabbage (var. Yates Gourmet) transplants at the four leaf stage. Three days after planting the treatments; methiocarb baits at 150 g/ha (recommended rate = 120-200 g/ha), and thiodicarb baits at 200 and 300 g/ha were broadcast onto the plots. An untreated plot was included in each block. Slugs were collected 1 week before the investigation and held at 4 °C with white clover (*Trifolium repens* L) and perennial ryegrass (*Lolium perenne* L) provided as food. Sixty slugs (mean length 28 mm, SEM=0.8) were introduced to each plot the day after molluscicide application. Slug movement between plots was prevented by a copper sulphate treated wooden barrier surrounding each plot, embedded 5 cm into the soil (packed hard against the wood) and extending 10 cm above the soil surface. A 60 mm thick layer of untreated sawdust, 100 mm wide, was spread around the inside and outside edges of each plot to fill and cover any cracks in the soil. To monitor plant survival in the presence of only resident slugs in the trial area three blocks of thirty plants were planted adjacent to the trial.

Visual assessments of plant damage, classified as either minor damage (<10% leaf missing), medium damage (10 to 50% leaf missing) or major damage (>50% leaf missing) and the number of damaged leaves per plot were made 2, 5, 10 and 14 days after slug introduction. The number of plants destroyed was assessed at day 14. Dead slugs were counted and removed whenever they were observed, and surviving slugs counted and removed from the plots on day 14 and the following 2 days.

Leaf damage and slug recovery data were log transformed and subjected to analysis of variance. Back transformed means are presented in the tables. The numbers of plants destroyed were analysed as a generalised linear model with a binomial distribution and fitted with terms for blocks and treatments.

RESULTS AND DISCUSSION

Laboratory investigation

In the Invermay bioassay all slugs in the petri dishes without baits were alive after 48 h. Mean slug mortality in the petri dishes containing methiocarb baits was similar for all treatments but in the thiodicarb treatments mortality was significantly lower at 0, 10 and 20 mm simulated rainfall than at 30 and 40 mm (Table 1). Methiocarb treatments were associated with higher slug mortality at 0 and 20 mm simulated rainfall than thiodicarb baits at the same levels but at higher levels there were no significant differences between the two baits (Table 1).

In the Ruakura bioassay no deaths had occurred by day 1 although slugs in both treatments exhibited signs of poisoning. By day 4 significantly more slugs had died in all the thiodicarb treatments and the methiocarb treatments exposed to 0, 10 and 20 mm simulated rain than in the untreated control enclosures ($P<0.05$) but there was no significant mortality, relative to the untreated control, in enclosures where methiocarb baits had been exposed to 30 mm or more simulated rain (Table 2). The only significant difference between molluscicides occurred at the 70 mm level on day 4 when there was 28% mortality with thiodicarb compared to 5% with methiocarb (SED=9) (Table 2).

By day 7 significant mortality was effected by all treatments except methiocarb exposed to 70 mm simulated rain ($P<0.05$) with highest mortality again associated with 10 mm simulated rain. There were no significant differences between molluscicides except at the 70 mm level when thiodicarb was associated with significantly greater slug mortality than methiocarb (Table 2). This suggests that when conditions are wet thiodicarb may give better control of slugs than methiocarb.

TABLE 1: Percent slug mortality (SEM) 48 hours after exposure to baits treated with different amounts of simulated rainfall in Invermay bioassay.

	Simulated rainfall (mm)				
	0	10	20	30	40
methiocarb	53 (9)	37 (9)	50 (9)	43 (9)	37 (9)
thiodicarb	23 (8)	23 (8)	17 (7)	47 (9)	53 (9)

TABLE 2: Percent slug mortality 4 and 7 days after exposure to baits treated with different amounts of simulated rainfall in Ruakura bioassay.

	Simulated rainfall (mm)				
	0	10	20	30	70
Day 4					
untreated	5				
methiocarb	42	52	28	15	5
thiodicarb	33	48	33	23	28
average SED 9					
Day 7					
untreated	8				
methiocarb	65	75	55	37	28
thiodicarb	62	67	52	55	42
average SED 11					

Field investigation

Soil conditions were moist at the beginning of the trial and 27.4 mm rain fell over the duration of the investigation. Air temperature ranged from 0 - 17°C with a daily mean of 8 °C (SEM=0.5). These conditions suited slug survival (98% in untreated plots) and the rainfall was within the range simulated in the bioassays.

Similar amounts of minor damage to the cabbages were recorded in all treatments at the first assessment with more severe damage only occurring in the untreated plots. After 5 days damage had increased, but there were no significant differences between molluscicides (Table 3). Significantly more medium damage ($P<0.01$) occurred in the untreated plots than any of the molluscicide plots (Table 3). By day 10 there was significantly more major damage in the untreated plots than the molluscicide plots ($P<0.01$) (Table 3) and more major damage associated with the lower rate of thiodicarb than the other molluscicide treatments ($P<0.05$ (LSR 1.7)). At the final assessment there was again significantly more major damage in the untreated plots than any of the molluscicide treatments but with no significant differences between molluscicide treatments.

After 14 days the number of plants destroyed was significantly greater in the untreated plots than in the molluscicide plots ($P<0.01$) (Table 3). Thiodicarb baits at the lower rate were associated with greater plant loss than methiocarb ($P<0.05$) (Table 3) but there was no significant difference between methiocarb and the higher rate of thiodicarb. All cabbages planted adjacent to the trial survived.

TABLE 3: Number of cabbage leaves with minor, medium or major damage 5, 10, and 14 days after planting (back transformed data).

Damage	Untreated	Methiocarb 150 g ai/ha	Thiodicarb 200 g ai/ha	Thiodicarb 300 g ai/ha	Average LSR ¹ (P<0.01)
Day 5					
minor	4	8	13	11	2.7
medium	12	3	2	4	2.8
major	5	2	3	1	3.0
Day 10					
minor	7	11	14	15	1.7
medium	8	7	7	6	2.2
major	36	4	8	4	2.3 ²
Day 14					
minor	3	7	9	9	3.5
medium	7	6	9	6	3.6
major	49	9	14	9	3.0
Percent plants destroyed (SEM) after 14 days					
destroyed	25 (3.00)	3 (1.10)	8 (1.85)	5 (1.46)	

¹ least significant ratio average, ² LSR (P<0.05) presented in text

Slug recovery averaged 99% (SEM=2.5) across all treatments. In the untreated plots 98% of the slugs were recovered alive but in the molluscicide treated plots live slugs comprised only 2% (SEM=1) of those recovered. There were no differences in the numbers of slugs recovered between the molluscicide treatments. Firth *et al.* (1991) found that thiodicarb and methiocarb baits gave similar levels of slug control to each other when used at rates similar to those used in this experiment and the results of this investigation support that finding.

CONCLUSION

Although there were differences between slug mortality associated with thiodicarb and methiocarb slug baits in the bioassays, the field trial indicated no such differences between the two types of bait at the rates used. More plant damage and greater plant losses were associated with thiodicarb used at the lower rate than either the higher rate of thiodicarb or methiocarb but the differences were small.

ACKNOWLEDGEMENTS

The investigation was commissioned by Rhone-Poulenc Rural, Rhone-Poulenc New Zealand Ltd. The authors thank Mr P.D. Johnstone and Dr N. Cox for the statistical analyses.

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