THE EFFICACY OF VARIOUS BAIT PRODUCTS AGAINST THE GREY FIELD SLUG, *DEROCERAS RETICULATUM*

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ABSTRACT

The grey field slug, *Deroceras reticulatum*, is one of the most dominant slug pests in temperate climates. In mild, moist conditions populations can rapidly reach economically damaging levels. Large-scale control relies heavily on the use of molluscicide baits. The active ingredients in molluscicides are often in themselves repellent to slugs and must be formulated with other more palatable substances to ensure sufficient ingestion. A study was undertaken to compare the efficacy of four bait products at various time intervals after application to bare soil. Slug morbidity following bait application 48 h prior to exposure was significantly higher for methiocarb products while metaldehyde products experienced reduced efficacy after the same time period.

Keywords: *Deroceras reticulatum*, molluscicides, methiocarb, metaldehyde, chemical control.

INTRODUCTION

The grey field slug, *Deroceras reticulatum* (Müller), is a surface active generalist slug species that has reached pest status in many temperate areas, including the UK and northern Europe where it is indigenous, and parts of the USA (Godan 1983) and New Zealand (Barker 1999) to which it has been introduced via trade. It thrives in disturbed habitats such as agricultural land and is also found in gardens, grassland and hedgerows (Runham & Hunter 1970). *Deroceras reticulatum* is able to reproduce throughout the year when conditions are humid and moist, with population peaks in spring and autumn.

In New Zealand the main sign of slug attack reported for establishing crops, such as cereals and renovated pasture, is grazing of young shoots, which retards growth and can lead to a thin crop stand; in severe cases this may result in complete loss of plants (Port & Port 1986). It is a particular risk during periods where the temperature at night is warm enough for slug activity (above 2°C), but too low in the daytime (below about 5°C) for plant growth.

Control of slugs on an agricultural scale currently relies heavily on the use of molluscicide baits (Glen & Moens 2002). The main active ingredients are metaldehyde or methiocarb and these are formulated with a base, commonly a cereal or bran, which acts as a feeding stimulant and attractant to slugs. Paradoxically the active ingredients are repellent to slugs with increasing concentration and hence, the amount of bait eaten declines (Wright & Williams 1980). As a consequence the percentage of active ingredient included in pellets is determined by a balance between efficacy and palatability (Howling 1990).

Agronomic practices such as direct drilling into the residue of previous crops (zero-tillage) encourage the growth of slug populations by providing cover from adverse conditions and negating the mechanical injury to resident slug fauna caused by ploughing (Hammond et al. 1996). Widespread uptake of these practices means that molluscicides remain an important component of slug control strategies, and there is a demand to improve their performance. The study described in this paper was undertaken to assess the efficacy of selected commercially-available bait products at various time intervals following application.

METHODS

Adult *D. reticulatum* were collected from paddocks at Ruakura Research Centre, Hamilton. They were maintained in cultures at 10°C for up to 5 days prior to use to enable elimination of any individuals that were not healthy.

Experiments were carried out in a soil extraction facility (approximately 15±2°C) at the Research Centre. There were four bait products (Table 1) plus an untreated control (oat bran applied at 3.5 g per arena).

TABLE 1: Slug bait products tested, with commercial application rates.

Trade Name	Formulation	Active ingredient	Rate of ai (g/ha)
Mesuro! Pro	Pellets	Methiocarb (2%)	160
Mesuro! S/S	Pellets	Methiocarb (2%)	160
Metarex	Pellets	Metaldehyde (5%)	400
Slug Out	Granules	Metaldehyde (1.8%)	180

Rectangular arenas measuring 52 × 33 × 22 cm were filled to a depth of 10 cm with finely sieved Horotiu sandy loam, which was watered with a timed dose. The rims were painted with Fluon® (polytetrafluoroethylene) to prevent slugs from escaping. Baits were added to the arenas at field rates (Table 1) in a central pile 1 h, 24 h or 48 h prior to the introduction of slugs and covered with a saucer trap. These time intervals were chosen to assess whether the acceptance of baits changes with the length of time they are on the soil. Six slugs were introduced per arena, evenly distributed over the soil surface. The slugs were exposed to baits overnight for a total of 16 h, from 4 p.m. until 8 a.m. The following morning numbers of healthy, moribund and dead slugs were counted. Total slug numbers under the saucer traps were noted. At each of the three time intervals between bait addition and the introduction of slugs (1 h, 24 h and 48 h), all treatments were replicated six times. Slug counts were converted to a proportion and assessed using binomial regression analysis with GenStat, 9th edition (2006).

RESULTS

Mortality was negligible after one night of exposure (only one individual throughout the trial) but all four bait products performed significantly better than controls with respect to morbidity (P<0.001; Table 2), with many slugs exhibiting typical symptoms of poisoning including uncoordinated movement, diminished mucus production and an inability to right themselves when placed on their side.

Excluding controls and comparing only between the four bait products, there were significant differences in slug morbidity where baits were added 48 h prior to slug exposure, when the two methiocarb products performed much better than the two metaldehyde products (P<0.01; Table 2). There was high variability between individuals within a treatment and for baits added 1 h and 24 h before slugs were introduced to arenas. Thus, the differences were not statistically significant, although there were markedly more moribund slugs observed following exposure to Mesuro! Pro than the other three baits.

TABLE 2: The % moribund slugs and % slugs under saucer traps for four slug bait formulations at intervals of 1 h, 24 h and 48 h between the application of bait and the addition of slugs to the arena.

Bait Product	% moribund <i>D. reticulatum</i> ¹			% <i>D. reticulatum</i> under saucer ¹		
	1 h	24 h	48 h	1 h	24 h	48 h
Mesuro! Pro	88.9a	77.8a	91.7a	66.6a	75.0a	88.9a
Mesuro! S/S	52.8a	52.8a	88.9a	72.2a	75.0a	77.8a
Metarex	55.6a	50.0a	33.3b	75.0a	77.8a	88.9a
Slug Out	66.7a	58.3a	44.4b	80.5a	69.4a	86.1a
Control	2.8b	2.8b	2.8c	80.5a	94.4a	91.7a
LSD ²	32.91	27.65	26.80	25.52	33.64	21.18

¹Numbers within a column followed by different letters are significantly different from each other.

²LSD calculations excluded the controls.

There was a significant interaction between bait product and the period of time it was left on the soil surface prior to the introduction of slugs, indicating that slugs respond differently towards the products as time progresses following application. In general, the efficacy of methiocarb products either improved or stayed the same while metaldehyde products experienced reduced efficacy, particularly after 48 h. For the two methiocarb products this interaction effect is most pronounced for the Mesuro! S/S treatment where only 53% slugs were moribund with baits applied 1 h and 24 h prior to slug addition, in contrast to 89% when this period was 48 h.

There were no differences between the four products or control with respect to the numbers of slugs under saucer traps, regardless of whether the baits were added 1 h, 24 h or 48 h prior to exposure. The majority of slugs (mean 80%) were found under saucer traps the morning after exposure.

DISCUSSION

Bait efficacy is the product of a number of factors, including attractance and palatability, and may be defined in a number of ways, for example directional movement of slugs towards pellets, numbers of slugs clearly affected by having ingested bait or numbers of slugs within a certain vicinity of baits. In this study, counts of slugs under baited saucer traps and numbers exhibiting symptoms of bait poisoning were used as a measure of efficacy making results relevant to field situations where the outcome of interest is preventing slugs from feeding on economically valuable crops.

Slugs use olfaction in foraging, but it has been shown that they are only able to detect the presence of food over a relatively short distance, i.e. within 3–4 cm (Howling 1991). In the work described here, slugs were brought appropriately close to baits by covering products with saucer traps, under which they sought shelter.

Whilst molluscicides in themselves are repellent, they are formulated with attractants to ensure they are ingested by slugs. In the work described here, the number of slugs under saucers was similar for bait products and the control, regardless of the length of time baits had been on the soil surface before slugs were introduced. This suggests that the formulations sufficiently overcome any inherent repellency of the active ingredients.

Chemical baits act by paralysing slugs through their effects on the nervous system (Mills et al. 1989). Immobilised slugs then frequently die through dehydration as they are unable to seek shelter and mucus production is disrupted. Morbidity is a good predictor of mortality, although death may take a day or more, and hence slugs are often observed in a moribund state the morning after ingesting molluscicides, as was the case in this trial. Whilst all bait products caused greater morbidity than controls, it wasn't until 48 h post-application that differences in performance between the bait products *per se* became apparent, at which time both methiocarb based products performed better than those

containing metaldehyde as the active ingredient. This suggests that the former may be attractive and palatable to slugs over a longer period of time following application to the soil surface than the latter. It may also be that the time taken to reach peak activity is more prolonged.

Attractance of baits is largely due to the base ingredient (Bailey 2002), whilst palatability is influenced by texture with softer foods eaten in preference to harder items, which are more difficult for the rasping apparatus to manipulate. Baits that absorb moisture become softer, which is likely to increase willingness of slugs to feed (Howlett 2005). This may explain in part the enhanced performance of the methiocarb products after 48 h on the soil surface, especially in the case of Mesurool S/S, which showed a 36% increase in efficacy between assessments 12 and 24 h post application compared to 48 h.

In summary, all four bait products were more effective against *D. reticulatum* than the control. After a period of 48 h between bait application and slug addition, methiocarb products performed significantly better than the metaldehyde products. Further trials to assess the persistence of this effect, especially in relation to rain fastness, would be of value in advising growers as to the application frequency of baits necessary for effective control.

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