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Organic slug control using *Phasmarhabditis hermaphrodita*

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Summary

Phasmarhabditis hermaphrodita is a lethal slug parasitic nematode that has been formulated into an effective biological control agent called Nemaslug®. We investigated the possibility of using different application methods of *P. hermaphrodita* to reduce cost and the number of nematodes applied. We also compared *P. hermaphrodita* with a new slug pellet called Ferramol®, which is available for use on organic farms.

Keywords: *Phasmarhabditis hermaphrodita, Deroceras reticulatum*, metaldehyde, iron phosphate

Introduction

Phasmarhabditis hermaphrodita is a lethal parasite of many slug species (Wilson *et al*., 1993; Speiser *et al*., 2001; Iglesias & Speiser, 2001; Grewal *et al*., 2003) and has been formulated into a biological molluscicide that is produced by Becker Underwood (Littlehampton, UK) and sold under the trade name Nemaslug®. It has been used successfully to protect a range of crops against slug damage including arable crops (Wilson *et al*., 1995), high value crops such as asparagus (Ester *et al*., 2003*a*) and the potential use in floriculture has been demonstrated using Orchids (Ester *et al*., 2003*b*). We investigated using different applications of *P. heramphrodita* to reduce the number of nematodes applied and the cost. To do this we used three split applications of a lower dose compared to one broadcast application of *P. hermaphrodita*. We also examined the effectiveness of combining *P. hermaphrodita* and a new iron phosphate based slug pellet (Ferramol®, Neudorff GmbH, Germany), which has just been released for use in the UK.

Materials and Methods

Mini-plot experiments

Twenty-four boxes (0.7 × 0.5 × 0.2m) were half filled with fresh topsoil. Eight Chinese cabbages (*Brassica rapa var.* pekinensis) were planted in each. The recommended rate of *P. hermaphrodita* (30 cm^{-2}, 150,000 in total) was applied to six boxes. A lower dose of *P. hermaphrodita* (5 cm^{-2}, 25,000 in one application) was applied to another six boxes. This treatment consisted of three low dose applications at two week intervals so that the total number of nematodes applied was exactly half the recommended rate. Nematodes were suspended in two litres of water and applied using a watering can fitted with a rose. Six boxes received only water and acted as the control

and six received the recommended rate of Metarex® green (0.8 g m^{-2}) metaldehyde pellets. Eight Deroceras reticulatum slugs were added to each box. They were supplied with a shelter to provide protection during daylight hours. All sides of the boxes were coated with Fluon® (Sydmonson, 1993) and fitted with a layer of copper fencing to prevent slugs migrating from the boxes. Slug damage was recorded every week for six weeks as percentage damage per leaf.

Effect of combinations of iron phosphate and P. hermaphrodita

Eighteen seed tray propagators were filled with top soil. Five four-week-old Chinese cabbage were planted in each. There were five treatments, which consisted of: no nematodes and no molluscicides, *P. hermaphrodita*, metaldehyde, iron phosphate (5g m^{-2} as Ferramol®), *P. hermaphrodita* and iron phosphate. Each treatment was replicated three times. Five *D. reticulatum* were added to each propagator and were provided with shelter. Propagators were fitted with plastic lids lined with copper tape and fitted with air holes. Once the slugs were added, the propagators were sealed and placed in an incubator at 17°C with a 12-hour light and dark cycle. Percentage damage to each leaf was assessed 1, 2, 4, 8, 12, and 16 days after treatment.

Data analysis

Data were recorded as percentage damage per week and analysed using Kruskal Wallis and Tukey's pairwise comparision to assess differences between treatments.

Results

Mini-plot experiment

All treatments were significantly different from the control from week two onwards ($P \leq 0.05$) (Fig. 1). The recommended rate of nematodes and low dose only differed significantly on weeks 4 and 5 ($P \leq 0.05$). The recommended rate of nematodes and metaldehyde did not differ significantly after week 3 ($P \geq 0.05$). Metaldehyde was significantly more effective than the low dose throughout the experiment ($P \leq 0.05$).

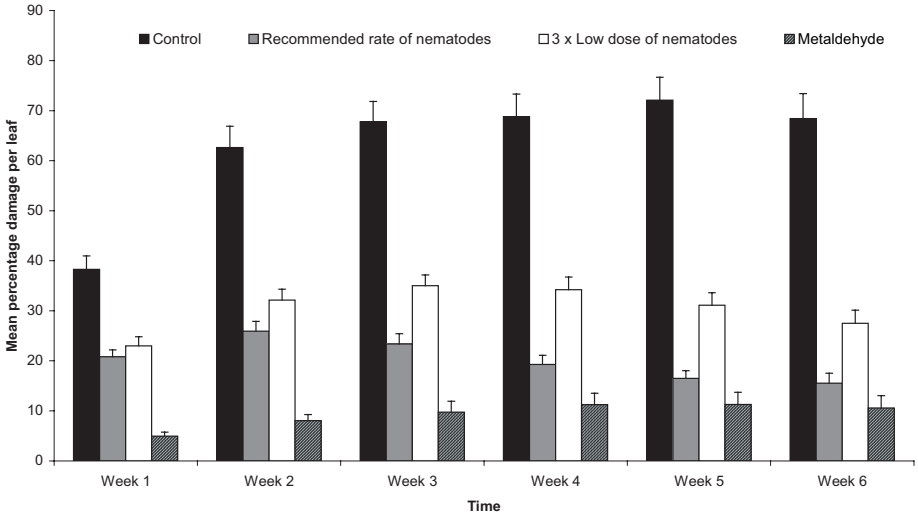

Fig. 1. Mean percentage damage to Chinese cabbage leaves exposed to *Deroceras reticulatum.*

Effect of combinations of iron phosphate and P. hermaphrodita

Metaldehyde, iron phosphate and nematodes and iron phosphate provided significant protection against slug damage after day four ($P \leq 0.05$) (Fig. 2). Nematodes applied at the recommended rate provided poor slug protection and only significantly differed from the control after day 12. Metaldehyde, iron phosphate, and nematodes and iron phosphate did not differ significantly throughout the experiment ($P > 0.05$).

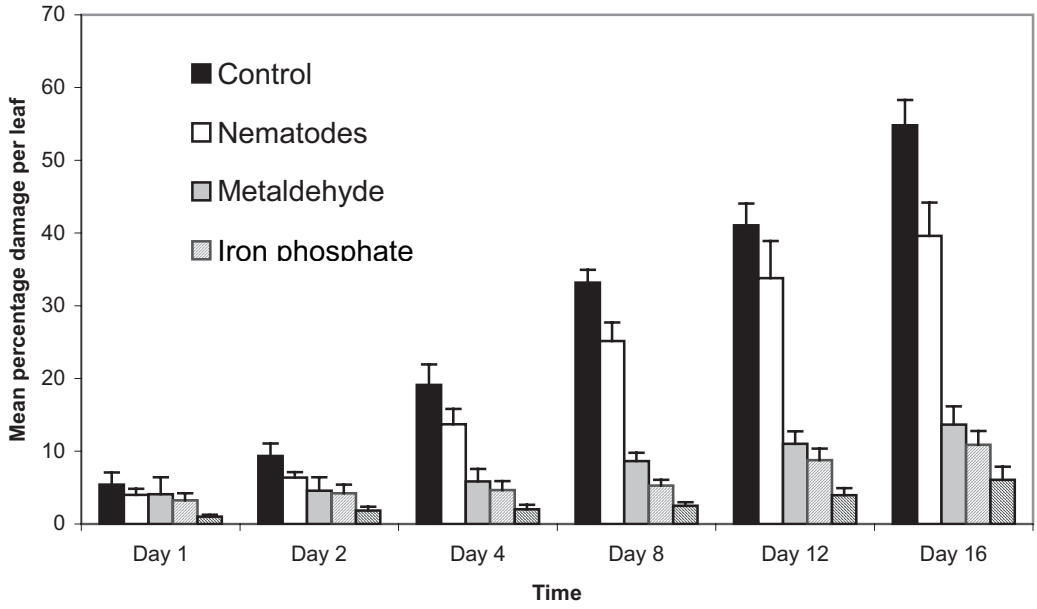

Fig. 2. Mean percentage damage of Chinese cabbage leaves exposed to *Deroceras reticulatum* treated with iron phosphate, metaldehyde, nematodes or nematodes and iron phosphate.

Discussion

P. hermaphrodita applied three times at a lower rate provides significant protection against slug damage. These results are in agreement with Ester *et al*. (2003*a*) who also found that repeated applications at lower doses provided significant protection against slug damage in asparagus. Applying half the recommended rate and achieving slug protection represents a substantial decrease in cost thus making nematode treatments more attractive to growers.

The combination of *P. hermaphrodita* and iron phosphate provided as good protection against slugs as metaldehyde. For organic growers in the UK., who are at a distinct disadvantage as they cannot use molluscicides such as metaldehyde or methiocarb, nematodes and iron phosphate shows massive potential. For example, by using iron phosphate, larger slug species that are resistant to nematodes will be killed and any slugs present in the soil will be killed by the nematodes. In order to confirm these results further research will focus on large-scale field trials.

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