CONTROL OF GARDEN WEEVIL (*PHLYCTINUS CALLOSUS*) LARVAE AND PUPAE WITH A PARASITIC NEMATODE AND A FUNGAL PATHOGEN

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SUMMARY

Adult garden weevil (*Phlyctinus callosus* Boheman (Curculionidae)) is an important pest in asparagus. The parasitic nematode, *Heterorhabditis bacteriophora*, and fungal pathogen *Beauveria bassiana* were evaluated for control of garden weevil larvae and pupae. Topical and soil applications consistently gave mortality levels of 70-100% in pot trials. The results suggest that these biological control agents could be developed as effective controls against the soil dwelling stages of garden weevil and reduce the need for insecticide applications applied against the adult stage during harvesting of asparagus.

INTRODUCTION

Garden weevil, *Phlyctinus callosus* Boheman (Coleoptera: Curculionidae) has rapidly assumed the status of a major pest of asparagus (*Asparagus officinalis*) in localised areas in the North Island since it was first noted in the Manawatu in the early 1980's. Adults are present in the crop from mid-October to March. They feed nocturnally on emerging spears during the peak harvest period which downgrades the quality of the product. Larvae live in the soil and feed on the crown, roots and root hairs of asparagus (Prestidge and Willoughby 1989).

Control procedures have concentrated on the application of insecticides against the adult stage (Prestidge and Willoughby 1989) in an attempt to break the life cycle prior to egg laying. However, the type of chemical that can be successfully used is restricted because of the need for low chemical residues in a crop that is harvested daily. The potential for parasitic nematodes (e.g. Clearwater and Wouts 1980; Bedding and Miller 1981; Jackson *et al* 1981; Barratt *et al* 1989) and fungal pathogens (e.g. Soares *et al* 1983; Barker *et al* 1989; Barratt *et al* 1989) to control a number of weevil species has shown considerable promise. The objective of the trials reported here was to evaluate the potential of the nematode *Heterorhabditis bacteriophora* (Poinar) and the fungus *Beauveria bassiana* (Bals.) as biological control agents against garden weevil larvae and pupae.

METHODS

Garden weevil larvae and pupae were collected from an asparagus crop on Horotiu sandy loam soil in the Waikato. Unless otherwise stated all larvae were in the final instar.

The nematodes *H. bacteriophora* strain V16, were cultured in larvae of the greater wax moth (GWM) (*Galleria mellonella*). The fungus *B. bassiana* isolate F9, was cultured on rice to a conidial concentration of 4.6×10^6 conidia per gram and then stored at 4 °C.

Experiment 1

Ten large (20-30 mg) and small (10-15 mg) garden weevil larvae were topically treated with a 25 µl suspension containing approximately 10-15 nematodes. Larvae were stored at room temperature in petri dishes and assessed for mortality at 48 and 62 hours.

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Experiment 2

Twenty garden weevil larvae were confined individually in 150 ml of Horotiu sandy loam soil in honey pots. Nematodes, at three concentrations (Table 2) were applied as a 12.5 ml suspension, to the soil surface. The soil was then drenched with a further 12.5 ml of distilled water. Control pots received 25 ml of distilled water. All larvae were assessed for parasitism and mortality at 28 days. At this time the soil was bioassayed for live nematodes using GWM larvae. Soil (5 gms), taken from each pot, was placed in a scintillation bottle with 5 gms of artificial diet (Jaycox 1971) and one GWM larvae and maintained at room temperature. After 24 hrs the GWM larvae were transferred to artificial diet for 48 hrs and then dissected for the presence of nematodes.

Experiment 3

(a) Ten garden weevil larvae and pupae were dipped in a suspension of 4.6×10^6 conidial spores of *Beauveria bassiana* and then placed individually in pots containing Horotiu sandy loam soil. Control larvae and pupae were dipped in distilled water. Insect mortality was assessed after 72 hrs.

(b) Twenty garden weevil larvae were individually placed in scintillation bottles containing 2 grains of *B. bassiana* infected rice and maintained at room temperature. Insect mortality was assessed after 48 hrs.

Experiment 4

Twenty larvae and pupae were confined in pairs in pots of Horotiu sandy loam soil treated with 4×10^{10} *B. bassiana* conidia in 12.5 ml of distilled water followed by 12.5 ml distilled water. Controls were treated with 25 ml distilled water. Pots were covered and insect mortality was assessed at 24 hrs and 35 days.

RESULTS AND DISCUSSION

Garden weevil larvae were susceptible to parasitic nematodes when applied topically (Table 1) or as an inundative application to soil (Table 2). Garden weevil pupae exposed to *H. bacteriophora* at 5×10^4 nematodes per pot in Experiment 2, were all dead within 48 hrs. In this experiment mean soil temperature and moisture were 18.5°C (range 16-25.5) and 61% (gravimetric analysis) respectively. The V16 strain of *H. bacteriophora* used is active over a temperature range of 12.5-28°C (M. Garnham pers. comm.). The mean temperature in a Waikato asparagus stand in September 1989 was 14.5°C (range 12.2-19.0°C) at 150 mm soil depth. Because these temperatures are at the lower end of the range for *H. bacteriophora* V16 strain, identification of a more cool active strain would be useful. Clearly, garden weevil larvae and pupae are very

TABLE 1: The percentage mortality of garden weevil larvae exposed to *H. bacteriophora* nematodes applied topically (Experiment 1).

Larval size	No.	Treatment	% Mortality	
			48 hrs	62 hrs
10-15 mg	10	Treated	60	90
	10	Untreated	10	20
20-20 mg	10	Treated	80	100
	10	Untreated	10	10

TABLE 2: The percentage mortality (mean $\pm$ SE) of garden weevil larvae exposed to *H. bacteriophora* nematodes applied to soil (Experiment 2).

Treatment	Rate per pot ($\times 10^3$)	No.	% Mortality at 28 days	% Infection of GWM larvae at 33 days ¹
<i>H. bacteriophora</i>	5	40	55 $\pm$ 8	23 $\pm$ 7
	50	20	70 $\pm$ 10	45 $\pm$ 10
	250	10	80 $\pm$ 13	60 $\pm$ 15
Water only		40	28 $\pm$ 7	0

¹Greater wax moth larvae used as an indicator of nematode viability.

susceptible to attack by parasitic nematodes. The level of mortality obtained in the present studies is similar to that recorded by Barratt *et al* (1989) using *H. bacteriophora* at a rate of 3×10^3 nematodes per pot for control of black vine weevil larvae (*Otiorhynchus sulcatus* (F.)).

The larval and pupal mortality obtained with the fungal pathogen *B. bassiana* was high in Experiment 3 when conidia were applied topically or on grains of rice (Table 3). When *B. bassiana* conidia were applied to the soil surface pupal mortality was similar to that in Experiment 3 but the percentage mortality of larvae was low (Table 4). Mortality of larvae might have been higher if the pathogen had been applied when the garden weevils were at an earlier stage of development. Barratt *et al* (1989) also recorded lower mortality of black vine weevil larvae with *B. bassiana* than with parasitic nematodes.

The level of control of both larvae and pupae with parasitic nematodes and pathogenic fungi is sufficiently encouraging to warrant further work on biological control agents aimed at the soil stages. With the development of a suitable application technique it is hoped to extend the current work to limited field trials.

TABLE 3: The percentage mortality of garden weevil by *Beauveria bassiana* applied topically or attached to rice grains (Experiment 3).

Test	Treatment	Stage	No.	% Mortality ¹
Topical	<i>B. bassiana</i>	larvae	20	85
	Untreated	larvae	20	0
	<i>B. bassiana</i>	pupae	20	85
	Untreated	pupae	20	5
Rice	<i>B. bassiana</i>	larvae	20	75
	Untreated	larvae	20	5

¹Mortality assessed at 72 hrs (topical tests), 48 hrs (rice test).

TABLE 4: The percentage mortality of garden weevil larvae exposed to *Beauveria bassiana* applied to the soil surface (Experiment 4).

Treatment	Stage	No.	% Mortality	
			48 hrs	35 days
<i>B. bassiana</i>	larvae	20	0	35
Untreated	larvae	20	6	16
<i>B. bassiana</i>	pupae	20	70	100
Untreated	pupae	20	0	20

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