Efficacy of the nematode, *Heterorhabditis heliothidis* (Rhabditida: Heterorhabditidae) against the peachtree borer, *Synanthedon exitiosa* (Lepidoptera: Sesiidae) in peach trees

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ABSTRACT

A suspension of *Heterorhabditis heliothidis* Khan, Brooks and Kirschmann, sprayed in mid-June onto the trunks of peach trees infested with peachtree borer (PTB) *Synanthedon exitiosa* (Say) larvae significantly ($P < .05$) reduced the numbers of PTB adults that eclosed from the feeding tunnels. Injections of nematode suspensions into and on the outside of active PTB tunnels did not reduce the number of emerging PTB adults to a level significantly ($P < .05$) lower than those emerging in the control cages. The study also confirms that the larvae of the peachtree borer require up to 2 years to complete development in stone fruit trees in the southern interior of British Columbia.

INTRODUCTION

The peachtree borer (PTB), *Synanthedon exitiosa* (Say) attacks most stone fruit trees and is a particularly serious problem on peaches, nectarines, apricots, prunes and plums in the southern interior of British Columbia. King and Morris (1956), as well as Madsen and Procter (1982), reported this species to have one generation per year in western North America in which adults are active through the summer. Female moths oviposit several hundred eggs on the trunks of stone fruit trees near the soil line (Anthon, 1949) and on the trunk bark up to a height of 60 cm above the soil line as well as on adjacent grass and weed foliage in stone fruit blocks with dense, deep cover crops (F.L. Banham, pers. commun.). The PTB larvae bore into the tree bark and feed by tunnelling in the cambium layer at or below the soil line. The tender bark and sapwood of nursery seedlings and young transplants makes them particularly vulnerable to larval attack. Young trees are frequently killed by the girdling injury. Severe feeding damage, even in older trees causes loss of vigor and increased vulnerability to secondary pests (Madsen and Procter, 1982). Chemical control of PTB is required to protect the trunks of stone fruit trees from larval feeding injury throughout the growing season. Once larvae have bored into the tree trunks they are protected from contact with conventional commercial control chemicals by the brown sawdust frass and sap gummosis exudate that plugs the feeding tunnels. Entomogenous nematodes have been shown to control boring insects in the family Sesiidae under field conditions (Simons 1978; Bedding and Miller 1981). The efficacy of the nematode, *Heterorhabditis heliothidis* Khan, Brooks and Hirschmann, was investigated as a possible biological alternative to chemical control of PTB larvae within their protected tunnels.

MATERIALS AND METHODS

A 0.12 ha block of Early Redhaven and Redhaven peach trees, located in an orchard in Osoyoos, British Columbia, was chosen for investigation. Grass, weeds and soil, to a depth of 5 cm, were pulled away from the bases of 40 PTB-infested trees 15 June, 1987. Frass at the entrance to PTB tunnels was scraped away and the number of active tunnels per tree assessed. The trees were irrigated at the trunk base by sprinklers on the day and evening prior to treatment.

Heterorhabditis heliothidis nematodes, provided by Phero Tech Inc. (Vancouver, B.C.), were applied to trees in the following treatments: a 200 ml spray of 200 nematodes per ml water around the base of the tree using a calibrated backpack sprayer; 2 ml

TABLE 1
Percentages of peach tree borer adults emerging from active feeding tunnels up to 90 days post-nematode treatment. 1987.

Treatment	% adults eclosing[1](n)
Control	20.14 a (52)
Syringed inside tunnel	7.19 ab (55)
Syringed outside tunnel	7.14 ab (51)
Sprayed at base of tree	3.97 b (43)

1. Percentages transformed before analysis using an arcsin transformation. Means followed by by the same letter are not significantly different ($P > .05$) as determined by Duncan's multiple range test.

injections of 500 nematodes per ml with a syringe into each active peachtree borer tunnel; and, applications of 2 ml of 500 nematodes per ml to the outside of each active tunnel. Each treatment was applied to 10 trees in a completely randomized design which included 10 control trees. On the day of treatment the humidity was 58% and the temperature 28°C.

Saran screen (32 mesh) trunk cages were fitted around the base of each of the 40 trees immediately after the numbers of active tunnels were determined and the treatments applied. Each cage formed a cone approximately 70 cm in diameter and 60 cm high with an 8 cm wide sponge rubber collar wrapped and tied tightly around the tree trunk. The edges of the screen were folded twice and stapled from the collar to below the soil. The bottom of each cage was buried in soil to a depth of at least 5 cm. Ten, fourth- and fifth-instar PTB larvae were removed from untreated peach trees and were exposed to *H. heterorhabditis* in the laboratory to establish survival.

From early July, after the first PTB adults were caught in Zoecon R PTB pheromone-baited traps within the test orchard, until the end of September, the trunk cages were lifted 4 times at 3-week intervals and the numbers of emerged PTB adults counted. Ten of the trunk cages were left on control trees and inspected at 6-week intervals the following year in late July and August. No evidence of rodents was found under the tents.

RESULTS AND DISCUSSION

Lower percentages of PTB emerged from *H. heliothidis* treated than from untreated trees (Table 1). The nematode spray around the base of the peach tree significantly ($P < .05$) reduced the percentage of emerging adults when compared to the emergence level from the control trees. Percentage PTB adult emergence was calculated based on the number of infested tunnels observed before treatment. Percentages were transformed using an arcsin transformation before analysis.

The soil-inhabiting entomogenous nematode *H. heliothidis* is capable of parasitizing a wide range of insects (Khan et al. 1976) including PTB larvae under laboratory conditions (pers. communication, T.A. Rutherford, Research Associate, Simon Fraser University, Burnaby, B.C.). All PTB larvae exposed to the nematode in the laboratory the day of the field release died in 7 to 14 days and nematodes were found within those sampled. In the second larval stage *H. heliothidis* penetrates host larvae through the mouth, spiracles and anus (Wouts 1979). Once inside a host the nematode releases a symbiont bacterium, *Xenorhabdus luminescens* Thomas and Poinar (Thomas and Poinar, 1979). Within 24 hours the bacterium multiplies and causes damage to all major internal host organs (Wouts, 1984). This restricts host feeding and movement and ultimately kills the insect while the nematode multiplies within. Nematodes are susceptible to ultra violet radiation and low humidity (Finney, 1981). Promising results in nematode field tests have followed nematode releases in damp environments and complete host control has been obtained with nematode application within the dark and

moist environment of wood-borers in the family Sesiidae (Bedding and Miller 1981; Simons 1978; Wouts 1984). The plugged, moist PTB tunnels located beneath the bark would theoretically provide a parasitic nematode with an ideal humid environment in which to move and multiply. Infective juvenile *H. heliothidis* are believed to find hosts by following host chemical attractants (Bedding and Akhurst 1975).

Suppression of PTB by *H. heliothidis* within infested peach trees shows promise as a potential control treatment that could decrease the need for routine protective chemical sprays. The importance of time, number and rate of application(s) of the nematode should be examined in future studies. Nematode treatment may be practical in an orchard setting as the trunk spray was equally successful as the more laborious and hence more expensive injections. Also, the tree trunk and surrounding soil can be easily moistened in most commercial orchards with irrigation systems. Peachtree borer survival and emergence within the control trees was only 20.1% by the end of the first summer test period (1987). When cages were removed from the 10 control trees the following summer (1988) they were found to contain 4 PTB moths and 15 uneclosed pupae. Three of the adult PTB found in the second year were alive indicating that they had emerged during the summer of 1988. Eclosed male and female PTB moths were not found co-existing in any of the control tents during the 1987 summer trials, eliminating the possibility of the second year PTB being a result of oviposition within the tents. The emergence of these adults substantiates previous observations that some PTB larvae require two growing seasons to complete development within stone fruit trees in British Columbia.

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