USE OF ENTOMOGENOUS NEMATODES OF THE FAMILIES HETERORHABDITIDAE AND STEINERNEMATIDAE TO CONTROL BANANA MOTH (*OPOGONA SACHARI*)†

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ABSTRACT

Peña, J. E., W. J. Schroeder, and L. S. Osborne. 1990. Use of entomogenous nematodes of the families Heterorhabditidae and Steinernematidae to control banana moth (*Opogona sachari*). Nematrópica 20:51–55.

The entomogenous nematodes *Steinernema feltiae, Heterorhabditis bacteriophora,* and *H. heliothidis* were applied to larvae of *Opogona sachari* infesting potato (*Solanum tuberosum*) and bamboo palms (*Chamaedorea elegans*). The applications resulted in successful establishment of the nematodes and a 58–100% reduction of larval numbers in infested potatoes and bamboo palms.

Key words: bamboo palms, biological control, *Chamaedorea elegans,* entomopathogenic nematodes, *Heterorhabditis bacteriophora, H. heliothidis,* microbial control, *Opogona sachari,* potato, *Solanum tuberosum, Steinernema feltiae.*

RESUMEN

Peña, J. E., W. J. Schroeder y L. S. Osborne. 1990. Uso de los nematodos entomogenos de las familias Heterorhabditidae y Steinernematidae para controlar la polilla del banano (*Opogona sachari*). Nematrópica 20:51–55.

Los nematodos entomogenos *Steinernema feltiae, Heterorhabditis bacteriophora* y *H. heliothidis* fueron aplicados a porciones de papa (*Solanum tuberosum*) y palmas (*Chamaedorea elegans*) los cuales habían sido infestados previamente con larvas de *Opogona sachari.* Las applicaciones resultaron en el establecimiento exitoso de los nematodos y estos redujeron la poblacion larval en un 58–100%.

Palabras claves: *Chamaedorea elegans* control biologico, control microbial, *Heterorhabditis bacteriophora, H. heliothidis,* nematodos entomopatogenicos, *Opogona sachari,* palmas bambu, papa, *Solanum tuberosum, Steinernema feltiae.*

INTRODUCTION

The banana moth, *Opogona sachari* Bojer, is a pest of ornamentals (e.g. *Arecastrum* sp., *Dracaena* sp., *Cycas revoluta* Thungberg, and

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Chamaedorea sp., fruit crops (e.g. *Musa paradisiaca* L.) and row crops (e.g. *Sacharum officinarum* L. and *Solanum tuberosum* L.) in tropical areas (1,4,6,10,11). This pest has become established in ornamental nurseries in Florida (3) and has damaged corn plant (*Dracaena fragrans* (L.) Ker-Gaus 'Massangeana'), bamboo palms (*Chamaedorea elegans* Mart.), Hawiian good luck plant (*Cordyline terminalis* (L.) Kunth), and aralias (*Polyscias* spp.). Damage is caused by larvae of *O. sachari* feeding on the stem and on the roots of the host plant. On corn plant, the bark and phloem are damaged, whereas on palms the roots are infested, resulting in death within 2–3 weeks after infestation. Infestation can be reduced by application of chemical insecticides (3,5,6). However, possible phytotoxic effects on ornamental plants and environmental concerns motivated the need for alternative methods of control.

The entomogenous nematodes *Steinernema feltiae* Filipjev (=*Neoaplectana carpocapsae* Weiser) (12), *Heterorhabditis bacteriophora* Poinar and *H. heliothidis* (Kahn, Brooks, & Hirchmann) Poinar, Thomas, & Hess are promising biological control agents for a broad range of insects (7,11). These entomogenous nematodes possess specific bacteria of the family Enterobacteriaceae (*Xenorhabdus* spp.) that cause septicemia and death of the insect when released from the nematode into the hemolymph of the insect (9).

In this paper we report on research to investigate the potential of entomogenous nematodes of the families Steinernematidae and Heterorhabditidae as control agents for the banana moth attacking a greenhouse-grown ornamental crop (*C. elegans*) and potato.

MATERIALS AND METHODS

Opogona sachari colonies were established by using larvae collected from *Dracaena* plants in Homestead, Florida. Larvae were fed *Dracaena* stems until pupation. Upon emergence, adults were placed in 14-cm-high × 12-cm-diam cylindrical cages. The cages were maintained at 24 ± 2 C and 65–70% RH with ca. 12 hour photoperiod. A folded filter paper was introduced into the cage to serve as an oviposition substrate. Moths were provided with a 10% honey-water solution. Eggs were removed daily and allowed to hatch on the filter paper. Larvae were reared on velvet bean caterpillar diet (2). Groups of six neonate larvae were placed in 30-ml plastic cups containing 12 ml of the medium covered with paper lids. Third-instar larvae were used in all experiments.

Nematodes used were *S. feltiae* All strain, *H. bacteriophora* Hp-88 strain, *H. heliothidis* NC strain, and a strain (FL) of *H. heliothidis* common to Florida soils. Stock cultures of nematodes were obtained from Biosys (Palo Alto, California, 94303, U.S.A.) and were maintained on water-soaked sponges at 10 C. Nematodes were propagated in *Galleria mellonella* (L.) and were checked for viability before application.

Laboratory experiment: Rearing cups (30 ml) were filled with moist sand (9% wt/wt) and ca. 2 g of potato to provide food for the larvae. Each container was infested with six third-instar *O. sachari* larvae collected from the laboratory colony. Five treatments replicated 20 times were established at 27 ± 2 C, in which each container was infested with 1 000 nematodes. The treatments were: infective juveniles of *S. feltiae, H. heliothidis* (NC), *H. bacteriophora, H. heliothidis* (FL), and a control. Larval mortality was recorded 72 hours after treatment.

Greenhouse experiments: Sixty bamboo palms, each planted in 3.8-L pots, were infested with six third-instar banana moth larvae at the base of each plant. Holes were made into the soil (24 ± 4 C) within a 5 cm radius of the plant stem with a punch or finger before infesting with the larvae. A Tanglefoot (The Tanglefoot Company, Grand Rapids, Michigan, U.S.A.) barrier around the pots prevented escape of the larvae. There were three treatments consisting of 20 palms each. Treatments consisted of an infested control, infested plus *S. feltiae*, and infested plus *H. heliothidis* (Florida strain). Inoculations with the nematodes were made 8 days after larval infestation. Five hundred ml of water containing 1×10^5 nematodes per ml were poured evenly over the soil surface. Larval mortality was recorded 4 days later.

A second experiment was conducted to determine survival and infectivity of infective *H. heliothidis* and *S. feltiae* nematodes over time. Bamboo palms were infested with six banana moth larvae and treated with nematodes following the same procedure as described for the first greenhouse experiment. After 72 hours, larval mortality was recorded and larvae were removed. The palms were reinfested with six live banana moth larvae. These procedures were repeated during 5 consecutive weeks.

Data from laboratory and greenhouse experiments were subjected to analysis of variance and means were separated using Duncan's multiple-range test.

Table 1. Effect of *Steinernema feltiae* strain All, *Heterorhabditis bacteriophora* strain Hp88, and *H. heliothidis* strains NC and FL on mortality of third-instar larvae of the banana moth, *Opogona sachari*, under laboratory conditions 72 hours after adding 1 000 nematodes to six larvae in a rearing cup.

Nematode	No. dead larvae	% mortality
S. feltiae strain All	6.0 a	99
H. heliothidis strain Hp88	6.0 a	100
H. bacteriophora strain NC	3.4 c	58
H. heliothidis strain FL	5.0 b	84
Control	0 d	0

Means followed by a different letter are significantly different according to Duncan's multiple-range test ($P = 0.05$).

Table 2. Effect of *Steinernema feltiae* strain All, *Heterorhabditis heliothidis* strain NC on mortality of the banana moth, *Opogona sachari*, 4 days after adding 1×10^5 nematodes to soil which had been infested 8 days earlier with six third-instar larvae in pots containing 20 *Chamaedorea elegans* plants.

Nematode	Mean dead larvae/pot	% mortality
S. feltiae	6.0 a	100
H. heliothidis	6.0 a	100
Control	1.2 b	20

Means followed by a different letter are significantly different according to Duncan's multiple-range test ($P = 0.0001$).

RESULTS AND DISCUSSION

Laboratory: All four nematode strains were effective in killing *O. sachari* larvae. More larvae died when *H. heliothidis* strain NC and *S. feltiae* strain All were applied than when *H. heliothidis* (FL) and *H. bacteriophora* strain Hp88 were applied (Table 1).

Greenhouse: All larvae died when exposed to *H. heliothidis* strain F1 and *S. feltiae* strain All whereas mortality of control moths was 20% (Table 2). Plants were not stressed by larval attack in any of the treated plots when compared to the control plots.

Residual *H. heliothidis* strain NC were more effective in reducing new infestations of banana moth larvae than residual *S. feltiae* (Table 3). Apparently, *S. feltiae* had a lower survival rate than *H. heliothidis* strain NC. Average temperature during the study was 24 ± 4 C. Nevertheless, banana moth larval control by nematode applications appears feasible and further greenhouse research is warranted. Whether *H. heliothidis* persists in the soil 6 weeks after application remains to be shown. These tests suggest that parasitic nematodes would have potential in controlling banana moth larvae under greenhouse conditions.

Table 3. Effect of *Heterorhabditis heliothidis* strain NC and *Steinernema feltiae* strain All, on mortality of *Opogona sachari* larvae up to 5 weeks after adding 1×10^5 nematodes to soil which had been infested 8 days earlier with six third-instar larvae in pots containing 20 *Chamaedorea elegans* plants.

	No. dead larvae/plant					Total %
Treatment	72 hours	2 weeks	3 weeks	4 weeks	5 weeks	mortality
H. heliothidis	0.7 a	1.0 a	2.2 a	1.8 a	1.4 a	23.3 a
S. feltiae	1.0 a	0.9 a	0.9 b	0.6 b	1.3 a	15.7 a
Control	0.2 a	0.2 b	0.3 b	0.2 b	0.4 a	4.3 b

Means in columns followed by a different letter are significantly different according to Duncan's multiple-range test ($P = 0.05$).

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