Potential for Pink Bollworm Control with Entomopathogenic Nematodes

J. E. Lindegren, USDA, ARS, HCRL, Fresno, CA
T. J. Henneberry, USDA, ARS, WCRL, Phoenix, AZ
J. R. Raulston, USDA, ARS, Weslaco, TX
L. J. Forlow Jech, USDA, ARS, WCRL, Phoenix, AZ
K. A. Valero, USDA, ARS, HCRL, Fresno, CA

Abstract

The susceptibility of late instar pink bollworm (PBW), Pectinophora gossypiella (Saunders), larvae to two species of Steinernema was evaluated in small scale field tests in spring and summer of 1993. In the spring, PBW mortality at 15 infective juveniles/cm² for S. carpocapsae and S. riobravis was 87 and 89%, respectively. In midsummer, mortalities with S. riobravis were significantly greater than with S. carpocapsae at the four concentrations tested. A simple method was developed for small scale field testing and efficacy monitoring for PBW and other soil associated insects.

Introduction

Pink bollworm (PBW), *Pectinophora gossypiella* (Saunders), larvae were reported susceptible to the Kapow selection of *Steinernema carpocapsae* (Weiser) under both field and laboratory conditions (Lindegren *et al.* 1992, 1993c). Using a substitute host, wax moth, *Galleria mellonella*, *Steinernema riobravis*, Poinar, Cabanillas and Raulston, was the most virulent of six entomopathogenic nematode species tested (Lindegren, *et al.* 1993a). In the present study, comparative PBW larval field mortality responses were evaluated in spring and summer studies using *S. carpocapsae* Kapow selection as a standard and *S. riobravis* as the more virulent candidate nematode.

Materials and Methods

The tests were conducted in Phoenix, AZ cotton plantings in the spring (May) and summer (July) of 1993. PBW larvae used were obtained from the Western Cotton Research Laboratory colony, reared on diet using the procedures described by Bartlett and Wolf (1985).

The Kapow selection of *S. carpocapsae* infective juveniles (IJs) (Agudelo-Silva *et al.* 1987 and Lindegren *et al.* 1993b) and *S. riobravis* (Raulston *et al.* 1992), were produced at the USDA-ARS, Horticultural Crops Research Laboratory, Fresno, California using the *in vivo* method described by Lindegren *et al.* (1993b). Soil temperatures were monitored in each test using three OMNIDATA® data loggers with probes placed at approximately 5 cm depths.

In the spring test, *Steinernema riobravis* IJs were applied as a water suspension to soil in which host PBW larvae had been introduced. Larvae were placed into bottomless buckets with screened lids (Lindegren *et al.* 1990) either directly onto the soil surface (experiment 1) or buried in the soil at a depth of approximately 1.5 cm (experiment 2). Both experiments, set up 3 days after irrigation, consisted of five replications of five treatments,

0.0, 0.5, 1.5, 5.0 and 15 nematodes/cm^2 of soil surface. Buckets were inserted into the soil 2 cm or more and at 1 m intervals. In experiment 1, 50 PBW larvae were introduced into each bucket. Also, an additional treatment, S. carpocapsae at the rate of 15 nematodes/cm^2 as a standard was included. Experiment 1 was arranged in a Randomized Complete Block Design. In experiment 2, single PBW larvae were enclosed inside each of 20 plastic biopsy containers. Biopsy containers (20 with larvae) were placed inside each bucket and covered with approximately 2.5 cm soil. Buckets were arranged in a Latin Square Design. Nematodes were applied to the soil 3 h following the introduction of PBW larvae in both experiments. Twenty PBW larvae were collected from each bucket in each experiment after 36 h exposure and held in petri dishes with moist filter paper at 27°C for an additional 24 h. Mortality was then determined with all dead larvae dissected to verify nematode parasitism.

In the summer test, the effects of IJ concentrations of 10, 15, 20 and 25/cm^2 of soil surface on PBW larval mortality were determined for both S. carpocapsae and S. riobravis nematodes at all treatment levels. Efficacy of both nematode species was evaluated over time (Day 0, 7, 14 and 21) in daily irrigated plots at the 25 IJ/cm^2 concentration. Sevin dust (5%) was applied around the outside of each bucket to prevent ant predation. The PBW biopsy container bioassay as described was used for both nematode species. PBW larvae in biopsy containers were retreived from the buckets 48 h after treatment. PBW larval mortality was determined at 48 and 72 h later. All dead larvae from each treatment were dissected to verify the presence or absence of nematodes.

Results and Discussion

In experiment 1, PBW mortality ranged from 32.3 to 88% for larvae released on the soil surface and treated with 0.5 to 15.0 S. riobravis IJ/cm^2 as compared to 12.6 to 75.3% for larvae contained and buried in plastic biopsy containers (Fig. 1). Mortality of PBW larvae released on the soil surface and treated with 15.0 IJ/cm^2 S. carpocapsae Kapow selection, was 88.9%. Soil temperatures, irrigated and non-irrigated, ranged from 26.5 to 30.0 and 26.0 to 32.5°C, respectively, over the 36-h field experimental period. The LD50 values of 5.26 IJs S. riobravis/cm^2 for PBW larvae confined in biopsy containers was significantly greater that the LD50 of 1.27 S. riobravis/cm^2 for PBW larvae released on the soil surface (Fig. 2). The regression coefficients were not significantly different and the comparative rates highly correlated.

At the higher soil (26.5 to 34°C within the buckets and 26.5 to 40°C outside the buckets) and ambient temperature conditions during the summer (July), PBW mortalities at all rates of S. riobravis were significantly greater than those of S. carpocapsae Kapow selection (Fig. 3).

Percentages of PBW larval mortality on the day of treatment were not significantly different for S. riobravis and S. carpocapsae Kapow selection nematodes (Fig. 4). However, higher PBW mortality occurred for S. riobravis treatments on sampling dates 7, 14 and 21 days following treatment as compared to S. carpocapsae Kapow selection nematodes. These results suggest an advantage for the more temperature tolerant S. riobravis nematode as previously reported (unpublished data, T. J. Henneberry and L. J. F. Jech)

The experimental design in the spring test in 1993 was compromised by ant predation. Data for these replications were deleted from the data base. Statistical analyses and comparisons were subsequently accomplished with regression analysis and paired t tests. Ant predation was prevented in the summer test by treating soil outside the test containers with an insecticide. The PBW bioassay using larvae contained in biopsy containers has several advantages. Easier, more dependable and rapid recovery of test insects, no control mortality and good correlations of results to other more timely and costly bioassays are important considerations. Lower mortality response of contained vs uncontained PBW larvae (Fig. 1) may be caused by limited access and additional time required for the nematodes to negotiate the inner container space. The technique should be useful in large scale field evaluations. S. riobravis nematode, with its higher tolerance to soil temperatures, may have potential use for in season applications under hot, desert conditions as well as spring and fall applications under lower temperatures for diapausing PBW larvae. Our results suggest that the soil associated period of the

PBW larval population cycle can be significantly reduced with the parasitic nematodes tested. The nematodes used are EPA exempt, commercially available and can be applied using conventional ground sprayer, aircraft or irrigation systems.

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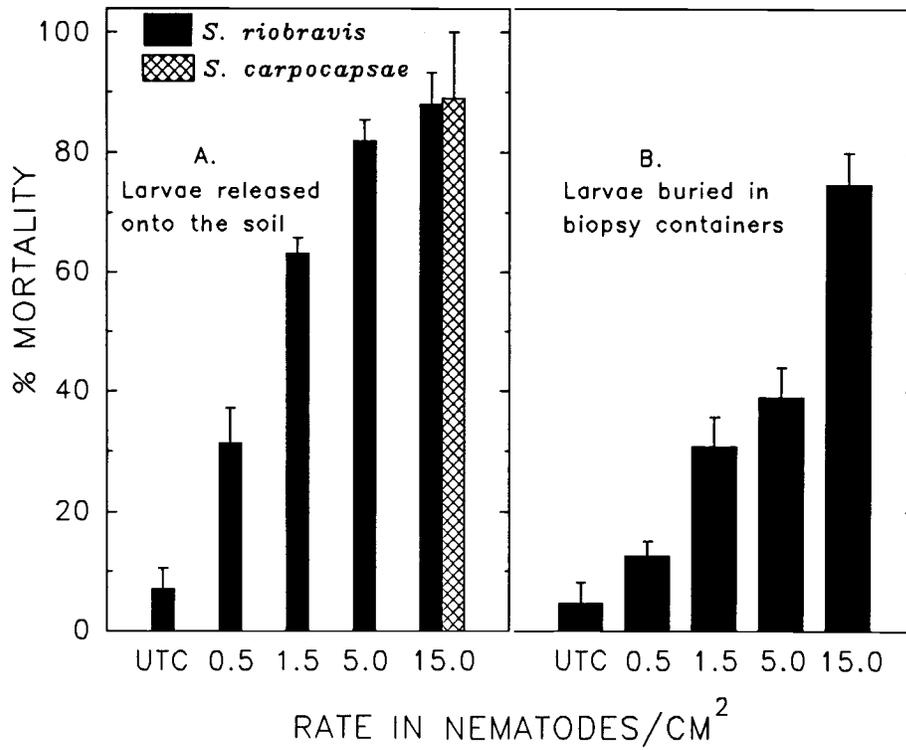
Figure 1. Mean percent pink bollworm larval mortalities following release on soil surface (A, spring, experiment 1) or buried in soil in plastic biopsy containers (B, spring, experiment 2) followed by treatment with *S. riobravis* or *S. carpocapsae* nematodes. Controls were untreated.
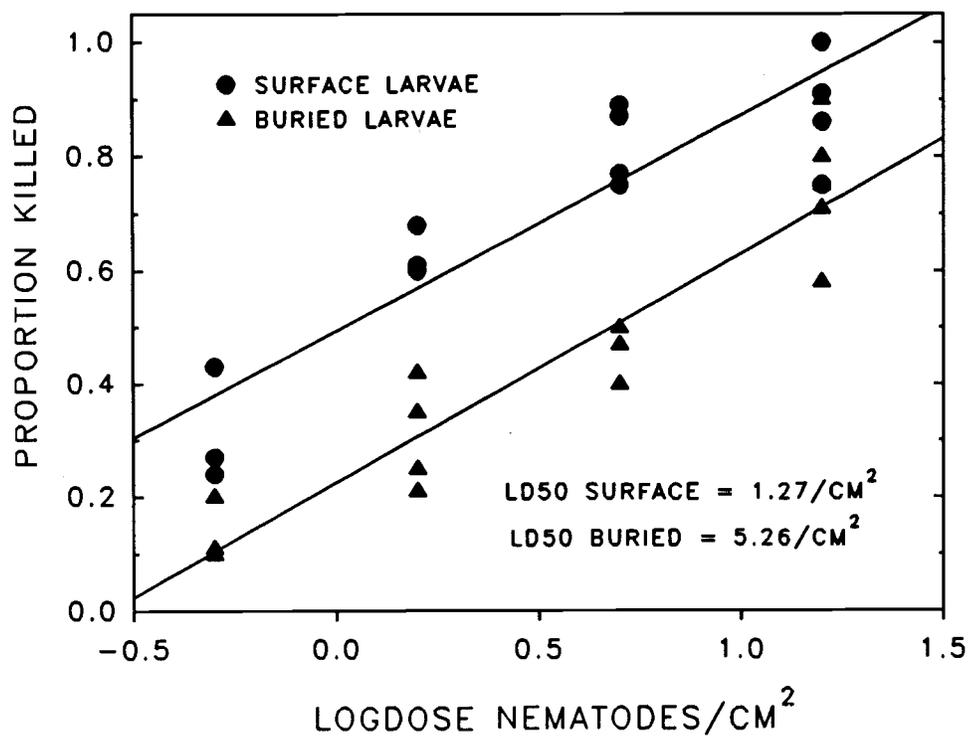
Figure 2. LD50's for pink bollworm larvae released free on the soil surface (spring, experiment 1) or buried in plastic biopsy containers (spring, experiment 2).
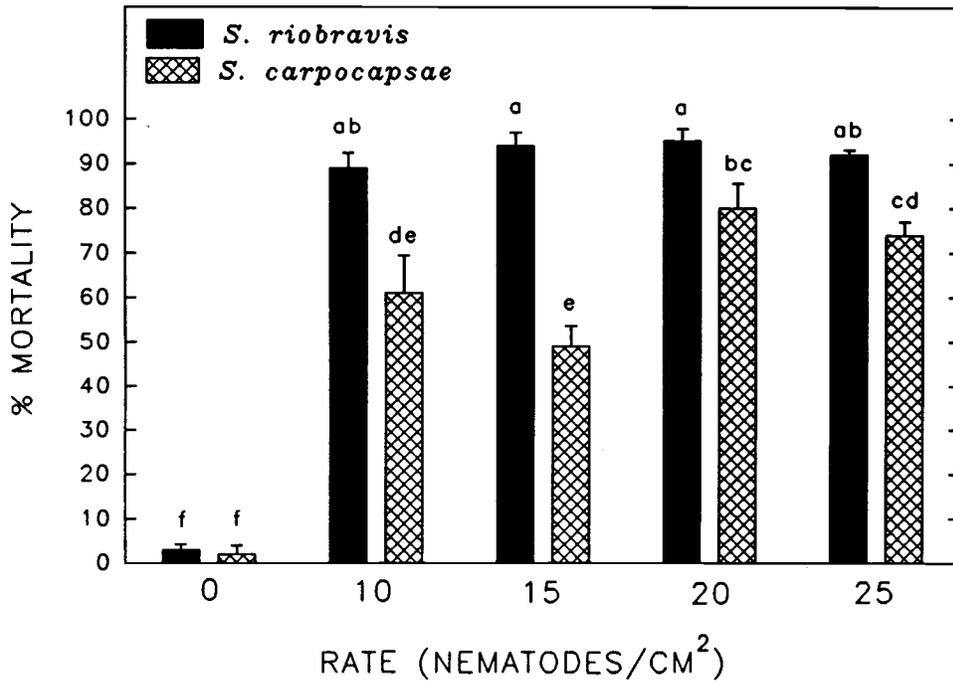
Figure 3. Percent mortalities of pink bollworm larvae (summer experiment) buried in the soil followed by treatment with *S. riobravis* or *S. carpocapsae* nematodes. Controls were untreated.
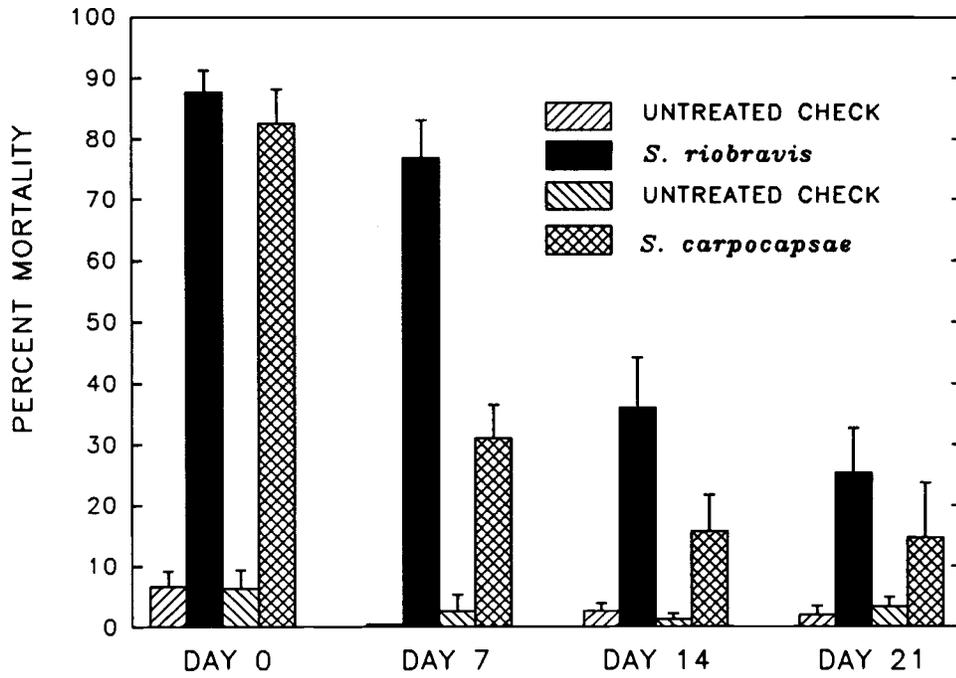
Figure 4. Percent mortalities of pink bollworm larvae in plastic biopsy containers buried in nematode-treated and untreated soil samples taken on days 0, 7, 14 and 21 following nematode application.