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FIELD EVALUATION OF ENTOMOPATHOGENIC NEMATODES AGAINST CITRUS ROOT WEEVILS (COLEOPTERA: CURCULIONIDAE) IN FLORIDA CITRUS

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Several species of weevil, including *Diaprepes abbreviatus* (L.), *Pachnaeus litus* (Germar), *Pachnaeus opalus* (Oliver) and *Artipus floridanus* Horn, are known to infest citrus in Florida. These species are similar in their biology. The adults feed on young, tender foliage and lay eggs in masses on the leaves. Newly hatched larvae burrow into soil and begin feeding on roots of citrus trees, resulting in a weakened, stressed tree (Schroeder & Beavers 1977). Feeding of the larvae on roots also opens wounds for entrance of fungi and other pathogens.

The potential for entomopathogenic nematodes to serve as biological control agents of insects has been explored for several decades (Poinar 1971). Diaz & Hernandez (1978) and Montes et al. (1981) reported on the successful use of *Steinernema carpocapsae* (=*S. feltiae* = *Neoaplectana carpocapsae*) for control of *P. litus* in potted citrus trees in South America. Beavers et al. (1983) found both *S. carpocapsae* and *Heterorhabditis* spp. to be pathogenic to *D. abbreviatus* larvae in laboratory evaluations. Research by Schroeder (1987, 1990a, 1990b) confirmed this activity in additional laboratory and field trials.

The purpose of this research was to compare the efficacy of two species of entomopathogenic nematodes, *S. carpocapsae* All strain (BioVector™ - Biosys, Palo Alto, CA)

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and *H. bacteriophora* (Otinem™ - Bioenterprises Pty. Ltd., Roseville, NSW, Australia), for control of *D. abbreviatus* and *P. opalus* in citrus groves in Florida.

The research for this note was conducted during the spring of 1990 in three citrus groves in central Florida. One grove, near Holopaw, FL, had an endemic population of *P. opalus* while the other two (Lake Jem, FL) had known populations of *D. abbreviatus*. Application of the entomopathogenic nematodes was made in late March, 1990 and used the existing irrigation system of each grove. All were equipped with microjet irrigation emitters. The irrigation line was spliced and the nematodes were pumped into the water using a metered pesticide injection system (Chemical Containers Co., Lake Wales, FL). Plots were irrigated before (ca. 0.50 cm), during, and after (ca. 0.50 cm) application. The nematodes were applied at rates of 1, 2 and 5 million infective juveniles (IJs) per tree for Otinem™ and 5 million IJs per tree (labelled rate) for BioVecter.™ Microjet emitters dispersed irrigation water and entomopathogenic nematodes in an area of approximately 1 m in diameter at the base of each tree. Trees in the untreated checks received irrigation water only.

Adult weevil emergence traps were used to evaluate nematode efficacy by catching adult weevils as they emerged from soil. Each trap was an inverted cone-shaped basket (1 m diameter x 45 cm high) made of wire cloth (Wirecloth Manufacturers, Randolph, NJ). A 1-liter plastic cup was placed on top of the cone to contain the emerging weevils. Traps were placed over major roots as close to the trunk as possible. Each test tree received 1 trap.

The treatments were arranged in a randomized complete block design with 10 trees per replicate and 3 replicates per treatment. A total of 450 traps were monitored weekly for 12 weeks. Data were analyzed by analysis of variance and Duncan's multiple range test using Pesticide Research Manager (Version 4.0 Grylling Data Management, Inc. Brookings, SD).

A total of 706 weevils were collected over the course of the experiment. The majority were trapped at the Holopaw (364) and Lake Jem I (243) groves. Less than 100 were trapped at the Lake Jem II site. Although there were reductions in the number of weevils trapped from treated trees as compared to untreated trees, no statistically significant differences were discernible among the treatments in Lake Jem II (Table 1.).

In the grove near Holopaw, 30% of *P. opalus* were collected in the untreated plots (Table 1). Otinem™ at 5 million IJs/tree resulted in significant reduction of *P. opalus* adults (76%) as compared to controls. Reduced adult emergence was also noted with the lower rates of Otinem™ and with the 5 million IJs/tree rate of BioVector™ but these were not statistically significant.

Two hundred forty three *D. abbreviatus* adults were trapped in the Lake Jem I grove. All three rates of Otinem™ resulted in a statistically significant reduction in the

TABLE 1. Total number of adult citrus root weevils trapped per grove.

Treatment	*Rate* (IJs/tree)	Total # Adults (% Reduction)		
		Holopaw	*Lake Jem I*	*Lake Jem II*
Otinem™	1M	92^{ab}(17)	18^{b}(83)	10^{a}(72)
Otinem™	2M	59^{ab}(53)	24^{b}(78)	19^{a}(47)
Otinem™	5M	27^{b}(76)	34^{b}(69)	16^{a}(56)
BioVector™	5M	75^{ab}(32)	59^{ab}(45)	18^{a}(50)
Untreated Check	–	111^{a}	108^{a}	36^{a}

[1]Totals followed by the same letter are not significantly different.

number of adults trapped as compared to the untreated trees (Table 1). The low rate (1 million IJs/tree) appeared to provide the best control (83%). BioVector™ also reduced adult emergence (by 45%) but was not statistically different from either the untreated control or the Otinem™ treatments.

This study demonstrates that entomopathogenic nematodes applied through the irrigation system can provide significant protection to citrus trees from attack by *P. opalus* and *D. abbreviatus*. At least one rate of Otinem™ applied at the Lake Jem I grove and the Holopaw grove resulted in statistically significant reductions in the number of weevils per trap as compared to untreated populations. Although Otinem™ resulted in a greater reduction of weevil numbers than did BioVector™ when applied at equivalent rates (Table 1), these differences were not statistically significant. Recent research (Schroeder 1990b) reported that there was no difference in *D. abbreviatus* control between *H. bacteriophora* (HP-88 strain) and *H. bacteriophora* (Florida strain). The reduction in weevil numbers for both treatments applied at 5 million IJs/tree was 58% (Schroeder 1990b). Where there were significant treatment effects in our experiment, *H. bacteriophora* CI strain (Otinem™) at 5 million IJs/tree resulted in greater than 58% reduction in weevil numbers, suggesting that there may be differences between various *H. bacteriophora* strains for control of citrus root weevils. However, there was no clear rate response for Otinem™ in this study. Thus, although it has been demonstrated that treatment with entomopathogenic nematodes can provide significant reductions in citrus root weevil numbers, further research to determine the most efficacious species and/or rate is needed.

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