

RESEARCH NOTES

Journal of Nematology 19(4):503-504. 1987.
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Comparative Small-scale Field Application of *Steinernema feltiae* for Navel Orangeworm Control

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Key words: almond, *Amyelois transitella*, entomogenous nematode, field application, Kapow selection, Mexican strain, *Neoplectana carpocapsae*, orchard.

The infective stage of the entomogenous nematode, *Steinernema feltiae* Filipjev (= *Neoplectana carpocapsae* Weiser) Mexican strain, remains viable and infective inside almond hulls for at least 8 (4) to 10 days or more (1). Nematodes can be applied effectively from the ground or air (2) and appear promising for the management of navel orangeworm (NOW), *Amyelois transitella* (Walker), populations in almond orchards (4).

A new, simplified monitoring method that measures nematode numbers on the almond itself was evaluated as a substitute for the more difficult baited almond monitoring methods described by Lindegren et al. (1). In addition, the comparative application efficacy of two hand-held sprayers was assessed for use in small scale NOW mortality evaluations.

Infective juvenile nematodes selected for increased production and pathogenicity (Kapow selection) (4) were produced in vivo substituting wax moth larvae as a host (3). Harvested juveniles were stored on wet polyurethane foam at 7 C in a plastic bag for 6 days before field application.

Experimental units at Ballico, California, consisted of individual almond trees, five replicates per treatment, four treatments per test. The test was applied at day-break, 0600 hours, 28 August 1985. Temperatures and relative humidities were 16.7 C and 56% and 14.5 C and 70% at 0530 and 0645 hours, respectively. Nematodes were applied with a backpack Echo duster-mister (Echo, Inc., Lake Zurich, IL) or a pick-up mounted hand-gun sprayer with a diaphragm pump (Farmtec, Oakland, CA). Comparative applications consisted of 3×10^6 juveniles in 5 liters of water per tree with a water only control. Ten open hulled almonds (aperture ≤ 1 cm) randomly chosen around the periphery of each tree (height 1.8 m) were baited with two sixth-instar insectary-reared NOW larvae 24 hours before application. Three days after the application, the infested almonds were collected and examined for surviving and dead NOW larvae. Dead larvae were dissected to ascertain nematode infection. Data were analyzed by ANOVA and means were compared by Duncan's multiple-range test. ANOVA was used for analysis of the total number of alive, dead, and infected larvae per tree (10 nuts).

Immediately after application, 10 almonds randomly chosen from the periphery of each treated tree (same location as artificially infested nuts) were collected, placed in a plastic bag, and transported at 4 C to the laboratory for nematode extraction. Each almond was placed in a 118-ml specimen container and agitated for 10

Received for publication 17 February 1987.

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seconds with 70 ml deionized water. Nematodes were allowed to settle to the bottom of the container for 24 hours and then counted.

Both types of application equipment were successful in delivering nematodes, although the sprayer delivered 3.5 times more nematodes to almonds. The mister treatment averaged 17 ± 25 (range 0–123), and the sprayed treatment averaged 59 ± 64 (range 1–287) nematodes per nut. Sprayer treatments resulted in a 2.8 times greater larval mortality with significantly more of the cadavers harboring nematodes (Table 1). The percentage of nuts with nematode verified NOW mortality was 78 (SD = 16) for the sprayer and 30 (SD = 20) for the mister.

Of the two applications evaluated, the hand-held diaphragm truck-mounted sprayer was easier to handle and delivered more than three times the nematodes to the split almonds with an equivalent increase in total baited NOW mortality. It allowed for application of the nematodes from outside the tree canopy minimizing applicator contamination. This sprayer would be the equipment of choice for small-scale nematode evaluations of NOW in almonds.

TABLE 1. Effect of application of *Steinernema feltiae* Kapow selection infectives on survival of *Amyelois transitella* larvae placed in almonds.

Treatment	\bar{x} Number (SD) of dead larvae per tree	
	Total	Harboring nematodes
Nematode-mister	4.8 a (3.1)	2.4 a (2.1)
Nematode-sprayer	13.6 c (2.1)	9.2 b (3.0)
Water-mister	0.4 b (0.5)	0
Water-sprayer	0.4 b (0.8)	0

Means within each column followed by the same letter are not significantly different (Duncan's multiple-range test $P \leq 0.05$).

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