Project No. 80-C
(Continuation of Project No. 79-C6)

Cooperator:
USDA/SEA/AR
Stored-Product Insects Research Laboratory
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Project: Navel Orangeworm Research
Insect Parasitic Nematode

Objectives: To determine the biological control potential of insect parasitic nematodes for the control of n.o.w. in almond orchards.

Progress: The invasive stage nematodes can be effectively applied by helicopter and commercial ground application. Both 2% emulsifiable Volk oil and semi-concentrate nematode applications increased nematode distribution and n.o.w. mortality in baited almonds. A California exemption from tolerance was obtained for test almonds. A nematode rearing procedure is being developed that may reduce the nematode rearing costs to less than $.10 per million.

Plans: (1) Further nematode rearing evaluations

(2) Nematode rearing for lab and field applications

(3) Lab evaluation of:

(a) Early n.o.w. instar susceptibility to Neoaplectana carpocapsae

(b) Long term effects of 2% emulsifiable oil of N. carpocapsae viability

(c) Long term effects of concentrate spray application of N. carpocapsae viability

(d) Research and Development concerning storage of N. carpocapsae

(e) Temperature requirements of N. glaseri towards possible mummy application

(f) N.o.w. susceptibility to newly isolated unidentified nematode from Yakima, Washington

(g) Susceptibility of n.o.w. larvae to a nematode associated with Baccillus thuringiensis

(4) Field evaluation of internal almond temperatures at hull crack and their correlation with air temperature and nematode survival

(5) Evaluate biological control potential of N. carpocapsae and/or N. glaseri for the control of plum borer and Pacific peach tree borer attacking almond trees.

Almond Industry Participation $11,040

Title: Project 80B5B - Insect Parasitic Nematodes
Prepared by: James E. Lindegren

I. Objectives: To determine the biological control potential of the insect parasitic nematode, Neoaplectana carpocapsae for the control of navel orangeworm, American plum borer and peach tree borer.

II. Interpretive Summary: Late instar larvae of the fellow wood boring insects that attack almond trees were found susceptible to the insect parasitic nematode N. carpocapsae under both laboratory and field conditions. The American plum borer Euzophora semifuneralis and the peach tree borer Synanthedon exitiosa.

The larva of the carpenter worm Prionoxystus robiniae peck, which may be readily controlled in fig orchards with this nematode, have also been found infesting almond trees in the Merced area.

Undiluted Volck supreme oil, used as a carrier in nematode applications to American plum borer larvae infesting almonds in the Merced area, was found to provide a control even without the nematodes. Table (1)

The invasive stage of the insect parasitic nematode Neoaplectana carpocapsae Weiser which reportedly dies at temperatures above 32°C, remained viable and infective to navel orangeworm larvae in newly split almonds for the duration of a four day test. The average daily maximum temperature in the almonds ranged from 42.0°C (morning sun) to 49.2°C (afternoon sun) (Table 2). All monitored almonds reached a maximum of at least 44°C over the four day period.

Drying almonds remained a favorable habit for nematodes as long as the hull remained partially green. Nematodes sprayed on individual almonds were able to successfully parasitize NOW larvae during process as long as the almond hull remained partially green.

III and IV. Experimental Procedure and Results: See Table 1 and 2.

V. Discussion:

Insects that inhabit cryptic habitats such as the previously mentioned wood borers, in my opinion, offer the most economical and effective use of this insect parasitic nematode. The need and efficacy have already been established for the control of carpenter worm in figs. This information is available and will probably suffice for the control of this insect in almond trees as well. American plum borer can probably be controlled with small amounts of oil applied to the active galleries. Further studies are needed concerning possible oil phytotoxicity, oil formulations and the use of alternate oils including vegetable oils. The American plum borer is susceptible to the insect parasitic nematode under field conditions and further efficacy studies are needed. The nematode offers potential for nonphytoxic summer applications.

The peach tree borer which attacks the crown of almond, apricot, cherry and peach is causing a problem in the Manteca area. Larvae of this borer are susceptible to the nematode. Further testing is needed to verify the best technique.

Two techniques for rearing the nematode are currently being investigated. One of the techniques utilizes a monoxenic artifical media--the other uses commercial bait crickets as a nematode host. Of the two techniques the use of bait crickets

appears to offer the most promise for grower or pest management operator use. The development and encouragement of commercial production of this nematode is necessary to determine production costs and to ultimately pursue EPA approval of this nematode.

The 1980 test applications determined that the insect parasitic nematode N. carpocapsae could successfully survive average daily maximum temperatures in field almonds that ranged from 42°C (morning sun) to 49.2°C (afternoon sun). The nematodes also can effectively parasitize NOW larvae in partially dryed almonds. Based on this data, future test applications could be applied later in the drying process, instead of at the initation of hull crack as previously suggested.

VI. Publication:

1. Lindegren, J. E., Dibble, J. E., Curtis, C. E., Yamashita, T. T. and Romero, E., 1981. Compatibility of Entomogenous Nematode with some Commercial Sprayers. California Agriculture (in press)

2. Lindegren, J. E., Yamashita, T. T. and Barnett, W. W. 1981. Potential Carpenter worm Control in Fig Orchards with an Entomogenous Nematode California Agriculture (in press)

3. Hara, A. H., Lindegren, J. E. and Kaya, H. L. 1981, Monoxenic Mass Production of Entomogenous Nematode, USDA, SEA, AR AAT series (in press)

4. Lindegren, J. E., Yamashita, T. T. and Henricks, L. C. 1981, Control of American Plum Borer on Almonds. Insecticide and Acaricide Tests (in press)

5. Lindegren, J. E. and Curtis, C. E. 1981 untitled (temperature studies) Abstracts of the 55th Annual Pacific Conference Meeting Portland, Oregon.

Table 1 American Plum Borer Control with a Dormant Oil

Control of American plum borer on Almonds - Feb. 1980: A Volck Supreme oil (2E) was applied to frass in American plum borer gallery openings. Galleries showing recent activity were selected and 1.8 ml oil was applied with a 500 ml "oil can" to the frass protruding from 10 treatment galleries. Ten like galleries were selected for the untreated control. The oil rapidly penetrated the gallery through the accumulated frass. Three days after exposure, all larvae, test and control, were excavated from the galleries to determine larval mortality.

Volck Supreme oil (2E) was originally used as a carrier for insect parastitic nematode tests for American plum borer control on almonds. The oil by itself may offer an effective control for the American plum borer larvae. Oil application resulted in 100% larval mortality in the test compared to no mortality in the untreated control. Though no phytotoxicity was observed in this limited test, further studies are needed concerning application methods and possibly phytotoxicity under large scale applications.

Treatment and ml/gallery	Mean Mortality 3 days after treatment
2E Volck Supreme Oil--- 1.5 ml.....	10.0
Untreated check.....	0.0

Table 2. Nematode Response to High Field Temperatures in Newly Split Almonds

Four day average maximum and minimum temperatures recorded from newly split almonds[1/] exposed to morning or afternoon sun.

	MAXIMUM TEMPERATURES (°C)			MINIMUM TEMPERATURES (°C)		
Date	Morning sun	Afternoon sun	air	Morning sun	Afternoon sun	air
7-19-80	42.4	48.4	44.0	19.6	19.0	22.0
7-20-80	43.4	49.2	48.6	19.0	18.6	22.0
7-21-80	43.2	48.4	45.6	20.0	20.0	23.6
7-22-80	42.0	46.6	43.0	20.2	20.6	23.6

1/ Temperatures recorded from 5 almonds/side, 10 almonds total.

2/ Air temperature recorded inside shaded weather station.

INSECT PARASITIC NEMATODE PROJECT

NAVEL ORANGEWORM

Invasive stages of the insect parasitic nematodes, which reportedly die at temperatures above 32°C , remained viable in newly split almonds for four days. The average daily maximum temperatures (Table 1) ranged from 42.0°C (morning sun) to 49.2°C (afternoon sun). All monitored almonds reached a maximum at least 44°C over a four day period.

TABLE 1

Four day average maximum and minimum temperatures recorded from newly split almonds[1/] exposed to morning or afternoon sun.

	MAXIMUM TEMPERATURES			MINIMUM TEMPERATURES		
Date	Morning sun	Afternoon sun	Air[2/]	Morning sun	Afternoon sun	Air
7-19-80	42.4[3/]	48.4	44.0	19.6	19.0	22.0
7-20-80	43.4	49.2	48.6	19.0	18.6	22.0
7-21-80	43.2	48.4	45.6	20.0	20.0	23.6
7-22-80	42.0	46.6	43.0	20.2	20.6	23.6

1/ Temperatures recorded from 5 almonds/side, 10 almonds total.

2/ Air temperature recorded inside shaded weather station.

3/ Degrees centigrade.

AMERICAN PLUM BORER

WOOD BORING INSECT PESTS OF ALMONDS TREES

The Pacific Peach tree borer, American Plum borer and Carpenter Worm larvae are susceptible to the insect parasitic nematode N. carpocapsae under field conditions. Further efficacy studies are planned for next year.