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## BIOLOGICAL CONTROL OF INSECTS WITH INSECT-PATHOGENIC NEMATODES - A BRIEF STATUS REPORT[1]

Plant industry inspectors have recently received a number of inquiries from the nursery industry and homeowners about nematodes as biological control agents of insect pests. With the increasing concern about health and environmental effects of chemical pesticides, scientists are looking more seriously at non-chemical methods of insect management.

Entomogenous nematodes, those that kill insects, have been known for many years. Testing of these beneficial nematodes as tools for insect management has accelerated in the past 10 years with the development of economical methods for mass producing the nematodes. Exemption of insect parasitic nematodes from federal and state registration (Vol. 47, Fed. Reg., 23928, 1982) has spurred the commercial development of products for control of dozens of agricultural insects pests; some of these products are beginning to enter the market. The nematode *Neoaplectana carpocapsae* (Weiser), also referred to as Nc, DD-136, or *Steinernema feltiae*, has been most extensively studied and tested. Another useful nematode receiving attention *is Heterorhabditis heliothidis* (Khan, Brooks, and Hirschmann). *N. carpocapsae* and *H. heliothidis* should not be confused with damaging plant parasitic nematodes: Insects are the only hosts of *H. heliothidis* and *N. carpocapsae* - they do not damage plants.

Infective juveniles of *N. carpocapsae* are capable of finding their host (i.e. the larval and pupal stages of the black vine weevil) in response to chemical stimuli from the insect. They enter body openings and penetrate the body cavity where the mutualistic bacterium *Xenorhabdus nematophilus* is released from within the nematode. The bacteria multiply within the body cavity of the infected host insect and cause rapid death of the insect. The nematodes feed on the bacteria within the insect cadaver and reproduce several times before emerging to find new insect hosts. *H. heliothidis* acts in the same manner. That the nematode and the bacterium cannot survive independently of one another played a part in the EPA decision to exempt this microbial pesticide (9).

*N. carpocapsae* has a broad host range of nearly 250 insect species in laboratory tests. Results from field trials have been variable (10) as nematode effectiveness is critically affected by environmental conditions, especially moisture. Decreased field populations in the presence of *N. carpocapsae* have been reported for soil-inhabiting wireworms, root maggots, and root weevils as noted by Gaugler (4), although the population reductions have not always resulted in satisfactory control.

Control of black vine weevil, *Otiorhynchus sulcatus*, in greenhouse tests with potted plants has recently been reported (1, 12). Research in California has shown that *H. heliothidis* and *N. carpocapsae* (15,000 or 30,000/gal. pot in 200 ml drench), when used to control **late-stage larvae** and **pupae**, provided up to 90 and 78% mortality, respectively (12). When tested against acephate (Orthene), isofenphos (Oftanol), and chlordane*, bendiocarb (Ficam) at 1 lb. ai/100 gal. gave the best control (84% mortality). Against **younger weevil larvae**, nematodes were not as effective as bendiocarb (Ficam) and isofenphos (Oftanol). **Though nematodes appear useful as a soil treatment, adulticides remain the most recommended control for black vine weevil**.

Insects found in protective, cryptic habitats, such as moist, frass-filled galleries of tree heartwood, have been suppressed by nematodes (6, 7, 8). Testing of *N. carpocapsae* and *H. heliothidis* in PA, Ohio, and NY in commercial turf has resulted in population reductions of Japanese beetle and masked chafer (P. Heller, Extension Entomologist, Pennsylvania State University; D. Shetlar, Research Scientist, ChemLawn Services, pers. comm.; 3). In Canada, *H. heliothidis* has shown promise for controlling housefly maggots in poultry barns (11).

**Overcoming nematode environmental sensitivity appears to be the most critical factor restricting wide use of insect-pathogenic nematodes as nonchemical insecticides.** Nematode effectiveness will be greatest where moisture and temperature conditions can be optimized, for example in greenhouses. Suppression of soil-inhabiting insects has been most consistent when nematodes have been applied as a drench to potted plants and containerized nursery stock (1) under conditions where insects and nematodes are confined, where the soil surface is moist and shaded from sunlight, and where competition with other organisms is minimized. Nematodes remain effective in conjunction with most insecticides such as pyrethrins and methoxychlor (5) and with rotenone and diatomaceous earth (A. Pye, unpubl.). However, some organophosphate and carbamate insecticides, such as phenamiphos, carbofuran, and oxamyl, adversely affect nematode development and reproduction (5), and this incompatibility must be considered when using nematodes in an integrated pest management program.

The broad host range and unique characteristics of *Neoaplectana* and *Heterorhabditis* spp. demonstrate their potential as biological control agents of insects. Active research continues at universities and in private industry to increase the effectiveness of insect-pathogenic nematodes and to make them a cost-effective tool of insect pest management. For a list of sources of beneficial nematodes, see Rodale's Organic Gardening magazine, Aug. 1986, p. 54(2).

*Chlordane is not registered for use on ornamentals and cannot legally be used for black vine weevil control.

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FOR ADDITIONAL INFORMATION ON ROOT WEEVILS, locate articles previously published in the Ornamentals Northwest Newsletter by looking at "Root Weevil", page 14 of INDEX IV.

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