THE IMPORTANCE OF ENTOMOPATHOGENIC NEMATODES FOR PEST CONTROL

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ABSTRACT

In biological control initiatives, entomopathogenic nematodes (EPNs) have been used in both traditional and conservation efforts. Applied research has overwhelmingly focused on their potential as inundatively applied augmentations of biological control agents (ABC). During the past three decades, extensive study has shown both their achievements and failures in controlling insect pests of crops, ornamental plants, trees, and grass. Their advancements in insect pest management, both above and below ground, are summarized in this study. Bugs from foliar and subterranean habitats are on the list of insects to be targeted. EPNs have seen a spike in commercial use and development due to improvements in mass manufacturing and formulation technology, the identification of several effective isolates and strains, and the need to reduce pesticide consumption. It is now being used to manage scarab larvae in lawns and turf, fungus gnats in mushroom production, the invasive mole cricket, the black vine weevil in nursery plants and Diaprepes root weevil in citrus, among other pest insects, with commercially made EPNs. While some pesticides have been shown to be effective in controlling a number of different insects, this has not always led to a considerable market share for these pesticides.

INTRODUCTION

Entomopathogenic Nematodes: A Field Guide

Nematoda from the Phylum Nematoda, the families Steinernematidae and Heterorhabditidae, are soil-inhabiting, fatal insect parasites that have shown to be the most efficient biological control organisms of soil and above-ground pests.[2] However, nematodes have been used for pest management only since the 1930s, despite the fact that they have been known about since the seventeenth century.

SteinernemaTravassos, 1927 and Neosteinernema are the only two genera in the family Steinernematidae. One species of termite, Neosteinernemalongicurvicauda, is all that Neosteinernema has to offer. It was found in Neosteinernemaflavipes. One species of HeterorhabditisPoinar, 1976 is found in the Heterorhabditidae family, the only one in existence.

Steinernematidae and Heterorhabditidae both carry Xenorhabdus and Photorhabdus bacteria as EPNs, and these two genera are often found together in the family Enterobacteriaceae. The "infective juvenile" (IJ) or "dauer" stage is the third juvenile stage of EPNs. Adults and fourth-stage juveniles of both IJ genera emerge from the insect host body with their bacterial symbiont. Septicemia is the most common cause of death for the insects in this experiment. Septicemia may be preceded by a bacterial toxaemia.

The sole free-living stage is the infective juvenile, which may survive in the soil for several months until it encounters a susceptible insect. By entering the insect host through the mouth, anus, spiracles or thin sections of the host cuticle, IJs are able to seek and infect appropriate insect hosts.[3] The symbiotic bacteria are discharged into the insect's hemocoel after infection, resulting in septicaemia and death for the insect. A corpse infected with an EPN might take anywhere from one to three weeks to mature and reproduce.

Entomopathogenic Nematodes for the Control of Insect Pests

The host range, host finding or foraging strategy, tolerance of environmental factors and their effects on survival and efficacy,moisture, soil type, temperature, salinity and organic content of soil, exposure to ultraviolet light,means of application, agrochemicals, and others are all factors that influence the selection of an EPN for a particular pest insect.[6] Insect pathogens, temperature, moisture, and foraging strategy are the four most important parameters in determining the success of an insecticide application. Those EPNs with a mobile foraging approach might be evaluated for application in subterranean and some aboveground ecosystems if the temperature, moisture, and host vulnerability are appropriate. In cryptic and dirt surface settings, those with a wait-and-see approach to foraging will be most successful.

Numerous studies have established the impact of environmental variables as temperature, moisture, aeration, soil type, and biotic parameters of EPN species, targeted insects, insect age, soil fauna.[1] According to the EPN species, the temperature range in which it may survive and transmit disease will vary depending on its original environment and the location of its birthplace. Some Steinernemafeltiae can be infective from 2 to 30°C, although some heterorhabditids can infect host insects from 7 to 35°C and Steinernemacarpocapsae is essentially inert at 10°C.

Habitats in the ground. It is not unexpected, however, that numerous subterranean insects have been targeted for control using EPNs, including white grubs of the Scarabaeidae family and weevils.[2] When it comes to lawns and grass, scarab larvae are the most common pests, although many of the adults feed on a wide variety of plants and flowers. Chemical pesticides and increasingly, EPNs have been employed to manage golf course larvae because of the damage they inflict.

Research and practical usage examples of EPNs for controlling larvae of P. japonica and other scarab species are reviewed. A variety of soils were investigated for the Oriental Beetle, Anomalaorientalis, and P. japonica in order to determine the infectivity of Steinernemascarabaei, S. glaseri, Heterorhabditiszealanddica, and Heterorhabditisbacteriophora. Two Heterorhabditis spp. were most prevalent in potting mix, whereas S. scarabaei was most prevalent in the greenhouse's loamy sand. S. glaseri was shown to be similarly infectious in all soil types in a greenhouse investigation. ' In lab tests, acidic sand reduced the infectivity of all species. Only in clay loam did S. scarabaei recover considerably over time, despite its high persistence in all soil types. Later, in treated field plots, it was shown to persist into the winter.[3]

There is evidence that the combination of EPNs and other control agents is more effective than any agent alone. For example, EPNs and Bacillus thuringiensis interact in an additive and synergistic manner to suppress scarab grubs. Evidence of synergy between imidacloprid, a neonicotinoid pesticide, and the EPNs. Imidacloprid and S. scarabaei, on the other hand, have been shown to be incompatible in the control of the European chafer, Rhizotrogusmajalis.[4] There is still no practical utility for EPNs in controlling scarab larvae despite the fact that their synergistic impact with other control approaches has been established.

Entomopathogenic nematodes' biology and life cycle

There has been an explosion of interest in the familiesSteinernematae and Heterorhabditidae, which regulate insects, via all nematodes investigated. These two families have identical life cycles, with the only variation occurring in the first generation of the life cycle of Heterorhabditis versus Steinernema. Steinernema species are hermaphroditic, but Heterorhabditis species are amphimictic, necessitating the presence of both males and females for reproduction.

In the second generation, the reproduction of both nematode taxa is amphimictic. However, a Steinernematid species with hermaphroditic characteristics has been discovered in Indonesia.[6] Sole the free-living, IJ stage, which is the only form outside of the host, is able to target insects. To find their prey, EPNs respond to carbon dioxide, vibrations, and other chemical signals; they also detect the physical structure of an insect's integument and react to chemical stimuli.

The spiracles, mouth, anus, or intersegmental membranes of the cuticle pierce the host insect and enter the haemocoel. IJs expel symbiotic bacterium cells from their digestive tracts into the bloodstream. Within 24–48 hours of infection, the infected host dies from bacterial toxins, while the bacteria proliferate rapidly in the insect hemolymph and feed the nematode with sustenance.

Soft-bodied, nonsegmented roundworms, entomopathogenic nematodes are parasites of insects, obligatory or occasionally permissive. They are naturally found in soil and respond to carbon dioxide, vibration, and other chemical signals in order to identify their prey. biological insecticides have shown successful in pest management programs involving species from two different families. They are non-toxic to people, largely pest-specific, and can be administered using normal pesticide equipment, which makes them an excellent choice for IPM programs. Pesticide registration requirements for entomopathogenic nematodes in the United States have been waived by the EPA. You don't require any kind of protective gear or limits on returning to the area. Insecticide resistance is unlikely to be a concern.

Nematodes continue reproducing until there is no more food available, at which point they become IJs. Progeny nematodes undergo four phases of development before reaching adulthood.[5] There may be one or more generations of IJs in the carcass, and they are discharged into the environment to infect new insects and continue their lives.

If the insects are killed by Heterorhabditids, the corpses will be red; if they are killed by Steinernematids, the corpses will be brown or tan. An insect's color indicates the colors generated by the monoculture of mutualistic bacteria in the insect host.

Entomopathogenic nematodes have only one free-living stage, the infective juvenile (IJ). To reach the hemocoel, the juvenile stage infects the host insect by invading the spiracles, mouth, anus, or intersegmental cuticle membranes. In both Steinernema and Heterorhabditis, the bacteria Photorhabdus and Xenobacter are mutualistically linked. During the juvenile stage, the symbiotic bacteria in their intestines are released into the hemocoel.[3] Insect hemolymph is a breeding ground for bacteria, and infected insects die within 24 to 48 hours. To continue growing and reproducing, worms feed on the dead host's tissue. Each step of the progeny nematode's life cycle may be divided into four distinct phases. An infective juvenile is released from a host corpse after one or more generations have taken place, depending on the host's resources, and these juveniles are then able to infect new hosts.

Different types of nematodes have different methods of reproduction. It's possible that heterorhabditid nematodes are hermaphroditic, but the following generation produces both male and female offspring, unlike steinernematids, which generate both males and female offspring in every generation. When insects are destroyed by heterorhabditids (red) or steinernematids (brown or tan), their corpses turn red. The colors produced by the monoculture of mutualistic bacteria living in the hosts are reflected in the color of the host.[7]

Depending on the species, EPNs utilize either an ambusher or a cruiser strategy for foraging. As an example of an ambusher, Steinernemacarpocapsae waits in the upper soil layer to prey on moving insects (nictitating) with an energy-conserving strategy Examples of cruisers are Heterorhabditisbacteriophora and Steinernemaglaseri.[4] The latter is a very active and mainly subterranean cruiser that uses volatile signals and other means to locate its host under the earth. When it comes to white grubs, they're just as effective, as they're not as mobile. There are also species that employ an intermediate foraging method to reach their host, such as Steinernemafeltie and Steinernemariobrave.[5]

The host range, host seeking or foraging technique, tolerance of environmental conditions, and their impact on survival and efficacy all play a role in the selection of an EPN to manage a certain pest bug. Moisture, temperature, pathogenicity for the targeted pest insect, and foraging behavior are the most important aspects. Through its impacts on moisture retention, oxygenation supply, and texture, soil composition has a significant impact on EPN activity, infection, and survival.

In underground and certain above-ground ecosystems, EPNs with a mobile foraging approach might be considered for usage if the conditions are right, including a temperature range, appropriate moisture, and a sensitive host. Soil-surface dwelling EPNs with a sit-and-wait foraging strategy will be the most successful.[6]

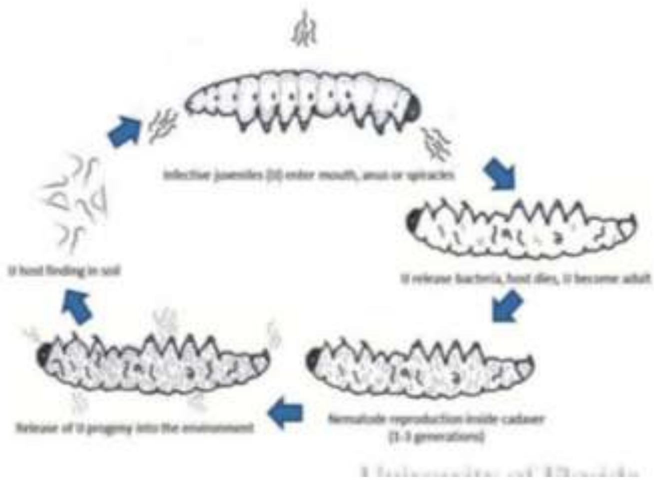

Figure1: Entomopathogenic nematodes have a typical life cycle. Steven Arthurs, University of Florida.

Production Formula

Both in-vivo and in-vitro approaches are presently used to develop nematodes that are harmful to insects. Live wax moth larvae are used as surrogate hosts in the in-vivo manufacturing method, which needs minimum technology and involves the use of trays and shelves for the nematode culture. As the juvenile stage migrates away from the host-cadaver, a White trap is used to capture it. For large-scale operations,[4] this strategy isn't cost-effective, and it may be better suited to niche markets or laboratory investigations instead. In order to cultivate entomopathogenic nematodes in vitro, nematodes are placed in a nutritive medium with a pure culture of their symbiont. Entomopathogenic nematodes may now be produced in enormous quantities using large fermenters because to significant developments in in vitro culture. For example, polyurethane sponges, water-dispersible granules and vermiculite can be used to store and formulate nematodes. Nematodes can be preserved for 2 to 5 months depending on the species and storage material and circumstances. For the first time, entomopathogens have no entirely inactive resting state, and they will consume their limited energy during storage, unlike previous microbial control agents. Nematode virulence and viability tests, age, and the ratio of viable to non-viable nematodes may all be used to gauge the product's quality.[5]

A broad variety of insect species have been examined for the insecticidal properties of EPNs by researchers across the world. Insect pests in different ecosystems have had varying degrees of success with the use of these products. Efforts to combat soil-dwelling pests or pests in cryptic environments, such as inside plant galleries, where IJs thrive, have proved successful. The commercial application of EPNs to combat some pest insects.

Efficacy and Ease of Use

Entomopathogenic nematode handling, shipping, and storage errors are to blame for the unsatisfactory results. Entomopathogenic nematodes are living organisms that can be influenced by both biological and non-biological factors during their lifetime. Entomopathogenic nematodes thrive on sandy soil with a pH of 4–8. Entomopathogenic nematodes are vulnerable to UV exposure, freezing, and desiccation. Steinernemaribrave, Steinernemaglaseri, and Heterorhabditisindica are among among the most heat-tolerant species, whereas Steinernemafeltiae, Heterorhabditismegidis, and Heterorhabditismarelatus are more adapted to milder temperatures. There are several factors that must be taken into consideration before a nematode can be effective: it must be correctly matched to the target pests, applied at the correct dose level, kept moist for at least 8 hours after application, and applied at the right time of day to avoid UV and drying out conditions. Entomopathogens must be checked for viability once they have been obtained and before being applied.

Most successful usage of EPN above ground is the treatment of soil surfaces for insects as they move over or through the soil surface. Using EPNs and other soil-surface insecticides, Diaprepesabbreviatus, a citrus root weevil, was successfully exterminated. Weevils that came in Florida from the Caribbean have been a major concern ever since. Tree roots can be ravaged by subterranean grubs, and a major infestation could lead to the tree's demise. Upon hatching, weevil larvae are deposited on leaves and then fall to the ground, where they dig into the earth.

Considerations for Use

With most horticulture sprayers, mist blowers, and electrostatic sprayers, Entomopathogenic Nematodes can be administered. The cropping system determines the type of application equipment to be used. Bigger diameter nozzles and higher flow rates are often advised. Prevent clogging of spray equipment lines by removing filters, screens and swirl plates.[3] It's also critical to keep the entomopathogenic nematodes agitated during application, as they settle fast in suspension. Add ice packs to the spray mixture if you must use high pressure sprays (more than 300 psi) and to keep entomopathogenic nematodes cold. Bubbles in the aquarium can be utilized as an alternative to the immediate usage of the nematodes. A number of insecticides, fungicides, and herbicides have demonstrated to be compatible with entomopathogenic nematodes. Entomopathogenic nematodes can be harmed by the use of fresh manure or excessive levels of chemical fertilizers. The development of entomopathogenic nematode formulations, particularly for aboveground uses, has made significant progress in recent years. For example, combining entomopathogenic nematodes with certain surfactants and water-dispersible polymers has been used.

REFERENCES

[1] Shapiro-Ilan DI, Han R, Dolinksi C. Entomopathogenic nematode production and application technology. (2012)

[2] Shapiro-Ilan DI, Gough DH, Piggott SJ, Patterson Fife J. Application technology and environmental considerations for use of entomopathogenic nematodes in biological control. (2006)

[3] Kim HG, Alston DG. Potential of two entomopathogenic nematodes for suppression of plum curculio life stages in Northern Climates. Environmental Entomology. (2008)

[4] Bélair G, Fournier Y, Dauphinais N. Efficacy of steinernematid nematodes against three insect pests of crucifers in Quebec. Journal of Nematology. (2003)

[5] Malan A.P., Knoetze R., Tiedt L. Heterorhabditisnoenieputensis n. sp. (Rhabditida: Heterorhabditidae), a new entomopathogenic nematode from South Africa. Journal of Helminthology. (2012)

[6] Grewal P.S., Ehlers R-U., Shapiro-Ilan D.I. Nematodes as Biological Control Agents. Wallingford: CABI Publishing. (2005)

[7] Lacey L.A., Georgis R. Entomopathogenic nematodes for control of insect pests above and below ground with comments on commercial production, Journal of Nematology. (2012)