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RESEARCH ARTICLE

ENTOMOPATHOGENIC NEMATODES: BIO CONTROL POTENTIAL

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ABSTRACT

The rhabditid genera, *Heterorhabditidis*, *Steinernema* and *Oscheius* are used for insect control due to their high and rapid infectivity and easy manipulation. They are safe for non-target vertebrates as well as environment. They are easily applied using standard equipment. All these advantageous characteristics as a bio control agent have triggered the rapid development and commercialization of entomopathogenic nematodes.

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INTRODUCTION

Biological control of insect pests is becoming an integral part of the organic agriculture. The bio control agent should have the desirable characteristics so that it can be able to develop into a viable commercial product. When developing a biological control agent the researchers should have to consider the following points: Parasitism should be lethal, should have host specific, not harmful to environment, can be mass produced and easily manipulated in laboratory, easily disseminated with standard equipment, ability to establishment and recycling, provides control for extended period, shelf - life of at least one year.

Entomopathogenic nematodes as potential Biocontrol agent

Entomopathogenic nematodes (EPNs) are microscopic roundworms. They are termed 'entomopathogenic' as the nematodes kill the insect host from within. Killing the target organism is more desirable than merely altering the behavior or other sub lethal effects from which recovery might be possible. Entomopathogenic nematodes (EPNs), *Steinernema* and *Heterorhabditis* in the family Steinernematidae and Heterorhabditidae of the order Rhabditida are obligate parasites of insect pests and distributed in natural and agricultural soils (Kaya and Gaugler, 1993). The other genus *Oscheius*, of the family Rhabditidae, order Rhabditida, is also recently been isolated and found to be entomopathogenic (Ye *et al*., 2010; Dillman *et al*., 2012; Zhang *et al*., 2012). Only the third juvenile stage is the infective juvenile that is free-living in the soil, non-feeding, encased in a double cuticle with closed mouth and anus and capable of surviving for several weeks in the soil, before infecting a new host individual. Therefore, the only stage used in biological control is the third stage infective juvenile. The infective juveniles actively penetrate through the mid gut wall or tracheae into the insect body cavity (hemocoel) containing insect haemolymph. EPNs have a mutualistic partnership with Gram-negative Gamma-Proteobacteria in the family Enterobacteriaceae. Xenorhabdus bacteria are associated with steinernematids nematodes while Photorhabdus are symbionts of heterorhabditids. *Xenorhabdus* occurs naturally in a special intestinal vesicle of *Steinernema* IJs while *Photorhabdus* is distributed in the foregut and midgut of *Heterorhabditis* IJs .An infective juvenile carries between 0 and 2000 cells of its symbiont bacterium in the anterior part of the intestine *.O. chongmingensis* and *O. carolinensis*, and *Caenorhabditis briggsae* have been found to associate with insect pathogenic bacteria of the genus *Serratia* in their cuticle and intestine while *O. carolinensis* may have additional associates and such bacteria required insect host for their multiplication and as a result they killed the insect. The nematode feed on the insect cadavers, when food is finished they also emerged as dauer juveniles like EPNs into the soil. The EPNs provides protected shelter for the symbiotic bacteria and carries the bacteria into the host. Nematode and bacteria overcome the insect immune system and the host insect is killed within 48 hours post infection .The bacteria break down the host tissues, and provide food sources for the nematode, which feeds and multiplies on bacterial cells and degrading host tissues. The J_4 stage nematodes of *Steinernema* develop into egg laying female or male adults in the insect cadaver and hereby run through four juvenile stages and the adult stage has up to three generations. After reproduction and depletion of all nutrients, a high nematode population density triggers the nematode development into IJs again. The life cycle of heterorhabditid is similar to that of steinernematids except for the fact that the IJs always develop into self-reproducing hermaphrodites (Poinar, 1990). Offspring of the first generation hermaphrodites can either develop into amphimictic adults or into automictic hermaphrodite both can occur simultaneously. The lifecycle is completed in a few days and thousands of new IJs emerge, searching for new hosts. The cycle from entry of IJs into a host until emergence of new IJs is dependent on temperature and varies for different species and strains (Kaya and Gaugler, 1993).

Entomopathogenic nematodes host range

It would be desirable to have a biocontrol agent that is active against specific host. This would reduce the chance of killing non target beneficial organisms. The infectivity of EPNs to Lepidoptera, Hymenoptera and Coleoptera are reported particularly high, but they are very low to Homoptera, Hemiptera and Thysanoptera. The specific nematode currently being used is *Steinernema scapterisci* under the trade name Nematac S ® against pre adult and adult mole crickets.

Entomopathogenic nematodes are safe to environment

EPNs will not harm people or animals, not even earthworms (Akhurst and Smith, 2002). A series of safety tests was made on *Steinernema glaseri* since it has been found to be a potential agent for controlling surgarcane beetles. Rats, rabbits and monkeys were exposed to intranasal, intraperitioneal, and dermally administered nematodes. Detailed analysis by researcher on the blood cells, haemoglobin and glutamic-pyruvic transaminase revealed no symptoms in any of the animals tested.

Entomopathogenic nematodes can be mass produced

In vivo and *in vitro* methods have been developed for culture of entomopathogenic nematodes. Nematodes can be mass produced for commercial purposes using liquid (Friedman, 1990) and solid fermentation (Bedding, 1981). The most common EPN formulation is an aqueous suspension. It has been used mainly for storage, transportation, and application. Storage temperatures between 4 and 15°C have produced survival times of 6-12 months for *Steinernema* spp. and 3-6 months for *Heterorhabditis* spp. Besides aqueous suspension, EPNs are formulated in water dispersible granules, nematode wool, gels, vermiculite, clay, peat, sponge, etc.

Entomopathogenic nematodes can be easily applicable

Entomopathogenic nematodes are always applied as infective juveniles and are mainly used for controlling the larval or pupal stages of insect pests in the soil or cryptic habitats. Under specific conditions, EPNs can successfully suppress also foliar pests. EPNs have been applied in the form of aqueous suspension using sprayers through both automated equipment and manually, mist blowers, or irrigation systems. Insect cadaver application has been proposed as a method enhancing EPN persistence. In this method, EPNs are applied in the infected insect host cadaver directly to the target site, and pest control is achieved by the infective juveniles that emerge from the host cadavers.

Conclusion

Although steady progress has been made, the development of a commercial product that is having a long shelf-life has not yet been achieved. Improvement of the production process by enhancing formulation efficacy, through understanding of nematode biology, ecology and behavior as well as favorable regulation requirements, will help in achieving the stated goal. Further technological advancements are needed to expand the market potential of the nematode-based products.

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