Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 03, Issue: 01 (JAN-FEB, 2023)
Available online at http://www.agriarticles.com
©Agri Articles, ISSN: 2582-9882

Entomopathogenic Nematodes (EPNs) as Potential Biocontrol Agents against Cutworms (*Agrotis* spp.)

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Cutworms are cosmopolitan and polyphagous pests distributed throughout world, which belong to order Lepidoptera family Noctuidae. There are about 26 species of cutworms that are present in India and a few other nations in the world with agriculturally important crops. Generally, agriculturally important cutworms belong to genera Agrotis, and among them, the most damaging species of this genera are like: *A. spinifera*, *A. ipsilon*, *A. plecta*, *A. segetum*, *A. flammatra* and *A. longidentifera* are reported in India. Many agricultural and horticultural crops are severely affected by cutworms, especially at the seedling stage. This insect as a larva feed on the epidermis of leaves and consumes portions of stems, tubers, etc. to cause vitiating symptoms. During night older larvae come out and feed on young plants by cutting their stems cause severe damage and rapid crop loss.

Although, as per biology of cutworms these pests remain hidden in cracks and crevices during most of life cycle so chemical control is often ineffective and uneconomic. Moreover, the harmful effects of the chemical pesticides have led researchers to search for new control strategies. Now-a-day, biological control has become a desirable option for eco-friendly management of numerous insect pests. Among biological control, various bio-agents like fungi (*Trichoderma spp.*, *Paecilomyces lilacinus*, etc.), bacteria (*Bacillus spp.*, *Pseudomonas fluorescens*, etc.), viruses, mites and entomopathogenic nematodes (EPNs) are very effective in pest management techniques. EPNs have broad potential to kill the cutworms in soil itself.

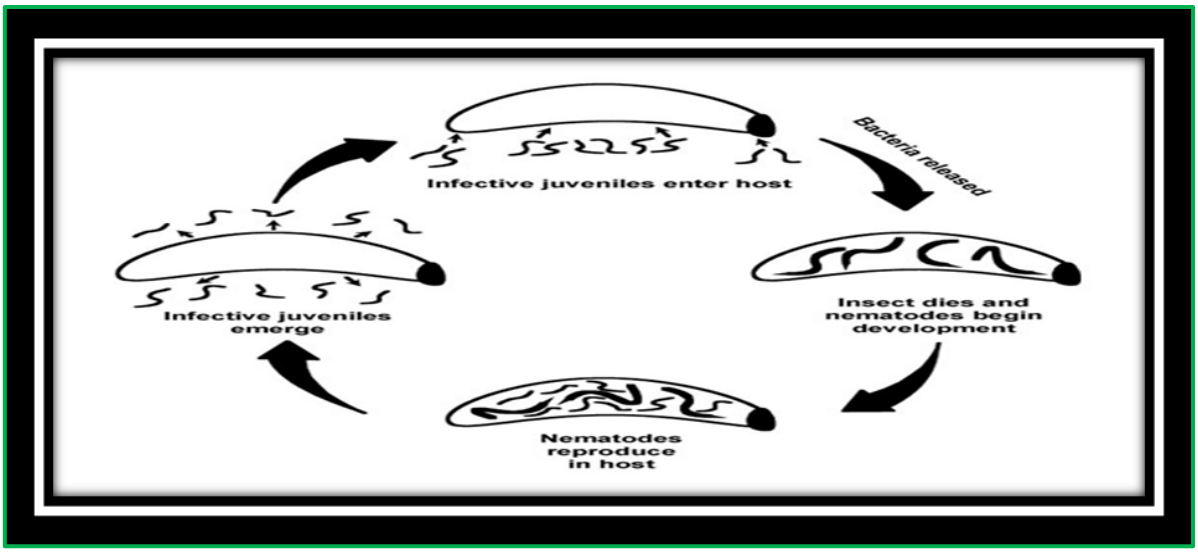
What are EPNs

Nematodes that parasitize insects, commonly known as entomopathogenic nematodes (EPNs), have been described from 23 nematode families. EPNs are obligatory parasites that infect and reproduce within insect larvae, are generally found in the families Steinernematidae and Heterorhabditidae. Various species of EPNs like Steinernema spp. and Heterorhabditis spp. are quite effective which have considerable potential to manage cutworms. So, the use of EPNs for the management of cutworms is a promising good alternate to chemical method. Steinernema and Heterorhabditis are free-living bacterial-feeder nematodes and belong to order Rhabditida (Phylum Nematoda). To date in the literature, hundred species of genus Steinernema and sixteen species of genus Heterorhabditis have been identified, isolated and described.

Life Cycle of EPNs

The life cycle of EPNs includes an egg stage, four juvenile stages, and an adult stage. The third stage juveniles called as infective juvenile (IJs) or "dauer" stage that are non-feeding, developmentally arrested stage and have attributes of both insect parasitoids and predators. The IJs are the only free-living stage and serve three main functions: dispersal, host finding,

and survival under environmental detrimental conditions (Grewal *et al., 2006*). They have good tendency to locate host (insect) and penetrate into the insect body cavity mainly via natural body openings (mouth, anus and spiracles) or areas of thin cuticle. Steinernnema penetrate into the insect larvae primarily through natural body openings and Heterorhbditis penetrate through body openings. Once get enters the host body, the nematodes release symbiotic bacteria (Xenorhabdus for steinernematids, Photorhabdus for heterorhabditids) that kill the host through bacterial septicaemia. In nematode–bacterium complex (EPNs), the bacterium requires nematode for protection from the external environment, penetration into the insect haemocoel and inhibition of the insect antibacterial proteins. After insect death, the cadaver becomes reddish brown if the insects are killed by Heterorhabditids or light greyish or greyish if Steinernematids kill it.



Picture Source-Internet

Host finding strategies

IJs of EPNs locate their hosts in soil by means of two strategies-ambushing and cruising (Gaugler *et al.,* 1989). Ambusher EPNs most effectively control insect pests that are highly mobile at the soil surface, such as cutworms, armyworms and mole crickets. Cruising is EPNs that use the cruising strategy are highly mobile and able to move throughout the soil profile. Cruisers locate their host by sensing CO_2 or other volatiles released by the host.

Examples

Cutworms are greatly susceptible to various species of EPNs. Divya and Sankar (2009) found *A. ipsilon* has been managed effectively with *S. carpocapsae* in golf course. Different formulations of *S. carpocapsae, S. abbasi* and *H. indica* produced upto 80% mortality in *A. ipsilon* after 96 hours of inoculation (Hussaini *et al.,* 2003). *H. bacteriophora* has been reported to cause upto 61.3 per cent *in vitro* mortality of fifth instar of *A. segetum* larvae (Chandel *et al.,* 2009). Various workers have reported the effect of EPNs equivalent to chemical pesticides. Under field conditions *S. feltiae* was equivalent effective to endosulfan in manging the *A. segetum* (Lossbroek and Theunissen, 1985). Lopez and Hague (2003) observed *S. carpocapsae* as affective as cypermethrin in managing the cutworms.

Advantages of EPNs

EPNs fit well into pest management programs for a number of reasons, such as:

- ❖ EPNs are compatible with a number of agrochemicals.
- ❖ They can be applied easily with standard pesticide equipment.

- ❖ They may be applied simultaneously with other bio-control agents, i.e., within a short interval of each other or conveniently by tank mixing with other control agents.
- ❖ When compared to other biological agents, they take less time to kill the insects (24-48 h)
- ❖ There is no maximum residue level or EPNs may account for reduced maximum residue level when used in combination with chemicals.
- ❖ They have broad host range and can affect wide range of insect pests.
- ❖ They are generally safe to labourers, the crop, pollinators and natural enemies.
- ❖ Due to the ease of nematode mass production, many products have been developed and are sold as bio-pesticides.
- ❖ They are considered relatively specific to their target pests and safe to non-target invertebrates and vertebrates as like human being.

Conclusion

EPNs provide the best alternate under the biological control of cutworms that kill insects within a short period (24-48 h). *S. carpocapsae* and H. *bacteriophora* are the effective species of EPNs that killed most soil-dwelling insect pests and attracted commercial interest worldwide. However, these nematodes (EPNs) are an eco-friendly and IPM compatible practice, which is an excellent alternative to chemical pesticides for managing cutworms. In addition to this, for the efficient management of cutworm there is an urgent need to isolate more indigenous EPN species against the target species.

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