Acta Scientific AGRICULTURE (ISSN: 2581-365X)

Volume 6 Issue 7 July 2022

Review Article

Use of Entomopathogenic Nematode for Management of Insect Pests of Mango-An Overview

Gitanjali Devi*

Department of Nematology, Assam Agricultural University, Jorhat, Assam, India

***Corresponding Author:** Gitanjali Devi, Department of Nematology, Assam Agricultural University, Jorhat, Assam, India

DOI: 10.31080/ASAG.2022.06.1158

Received: May 05, 2022

Published: June 20, 2022

Abstract

A number of insect pests and mites are recorded which are the major limitation of yield and quality of mango production. Though chemical insecticides are recommended for control of these pests, other alternative control measures like use of biocontrol agents should be considered. One of the promising biocontrol agents is the entomopathogenic nematodes. This review finds the work done so far on bioefficacy of entomopathogenic nematodes on important insect pests of mango.

Keywords: Mango; Insect Pests; Biocontrol Agents; Entomopathogenic Nematodes (EPNs)

Introduction

Insect pests are the major hurdles for quality and quantity of produced in mango production. A number of insect pests and mites are recorded in mango orchards. Worldwide more than 260 species of insect and mites are known to infest mango [1,2]. Hoppers (*Idioscopus clypealis, I. nitidulus and Amritodus atkintoni*), Mealy Bug (*Drasicha mangiferae*), Inflorescence midge (*Erosomyia indica*), Fruit-fly (*Bactrocera dorsalis*, *B. zonatus* and *B. correctus),* Leaf webber (*Orthaga euadrusalis*), Shoot borer (*Chlumatia transversa*), Bark Eating Caterpillar (*Indarbella quadrinotata)*, Stem borer (*Bactocera rufomaculata*), Shoot gall psylla (*Apsylla cistallata*), Scale insects (*Chloropulvinaria polygonata, Aspidiotus destructor* and *Rastococcus* sp), Stone weevil (*Sternochetus mangiferae) are found to be severe causing considerable loss to the crop.* Chemical pesticides have been recommended as a common method for controlling most of these pests which has generated many problems related to environment and human health. In agroecosystems, pathogens and parasites of arthropods which are present naturally can regulate the population of insect pest populations [3,4]. They may be a good alternative to chemical pesticides. Several biocontrol agents like fungi, bacteria, virus as well as entomopathogenic nematodes may serve as alternative control methods against a number of insect pests [5,6,32]. In this review the work done on efficacy of entomopathogenic nematodes for control of some of the important insect pests of mango has been elaborated.

Entomopathogenic nematodes (EPNS)

Entomopathogenic nematodes (EPNs) from the genera *Steinernema* and *Heterorhabditis* in the families Steinernematidae and Heterorhabditidae respectively have the ability to infect and kill insect pests in all habitats. They are naturally found in all types of soils [7-9]. Symbiotic bacteria (*Xenorhabdus* spp. and *Photorhabdus* spp.) are mutualistically associated with these nematodes. The infective juvenile (IJ), the only free-living stage (dauer stage), present in the soil and forages for an insect host. Upon finding a host insect, IJs enter through the mouth, anus, spiracles or soft cuticles and penetrates into the body cavity. In the body cavity, the IJ releases bacterial cells, which multiply rapidly and cause septicemia in its insect host, within 24-48h. The nematodes degraded host tissues and feed on the bacterial cells. Depending on host size and nutrition, one to three nematode generations may occur in the host cadaver. When food materials are exhausted, the pre-IJs confiscate the bacterial cells. The IJs leave the host and rummage around for new hosts [10]. If host are not found, IJs can persist as dauer stage depending on soil environment. EPNs can be produced *in vivo* on some susceptible host and on synthetic artificial media [11]. Now-a-days, several EPN species are being commercially produced and available for large-scale application under field condition.

Bioefficacy of entomopathogenic nematodes against insect pests of mango

Research on the susceptibility of insect pests of mango has been limited to the laboratory. Some of research findings on major insect pests of mango are highlighted here.

Mealy Bug

Mealy Bug (*Drasicha mangiferae*) is a major pest of mango in India and found to be widely distributed throughout India. Both adults and nymphs suck the plant sap, devastate the inflorescence and cause fruit drop and thereby reduce the plant growth. Mealy bug excretes a sticky substance i.e., honey dew, which cause the development of sooty mould fungi (*Maliola mangiferae* and *Capnodium mangiferae)*. The female insect lays eggs in soil in the month of April/May. The eggs hatch in the month of November/December and crawls up the tree and infest again [12]. Application of a formulation carrying *Photorhabdus luminescens*, symbiotic bacteria isolated from *Heterorhabditis indica*, IARI strain at the rate of 1.4 x 10^6 bacterial cell/ml gave significant control to second stage nymphs under laboratory condition. Formula when applied over bug infested mango twigs resulted in 92.5% application was made one hour prior to release of bugs [13].

Fruit-fly

Mango yield and fruit quality are severely affected by infestations by many tephritid species. The fruit-fly, *Bactrocera dorsalis, B. zonatus* and *B. correctus* are the important pests of mango. Adult female lays eggs in the mesocarp of fruits and develop into larvae and feeds on the pulp that fully complete their development inside the infested pulp. Mature larvae/maggot exit the fruit and fall on the ground where they pupate in the top soil [14]. Soil stages (maggots) of several tephritid species such as *Bactrocera oleae, B. dorsalis, Ceratitis capitata* and *C. rosa* are susceptible to entomopathogenic nematode (EPN) species and can be used as good tool within IPM programs [15-18]. Lindegren, [19] observed that mango fruit fly, *Bactrocera* (*Dacus*) *dorsalis* pre-pupae mortality ranged from 9 to 85% by *S.carpocapsae* at 5000 to 50,000 IJs/cup under laboratory condition. Pupae were not susceptible to infection. Pathogenicity of 12 EPN species and strains to *C. capitata* at a concentration of 100 IJs/one 3rd instar larva in containers was investigated [20]. As for pupae, % mortality of *B.dorsalis* averaged 5.5% and 1% in 3 day old pupae by *H.taysearae* and *S.kandii* respectively [21]. After 14 days insect mortality ranged 7-96% by the 12 tested nematode species and strains (infected pupae were considered larvae). Usman., *et al*. [22] observed susceptibility of *B.dorsalis* larvae and pupae to *H.taysearae* and *Steinernema* sp. The results showed that Per cent mortality in 3rd instar larvae was 94% by *H.taysearae* and 99% by *Steinernema* sp. Although *Anastrepha ludens* is susceptible to a variety of EPN species under laboratory conditions [23-25], extremely high dose is required for control in the field (2.5 X 10^2 IJs of *H. bacteriophora*/cm^2) [26]. Similarly, laboratory and field research conducted on the effectiveness of EPNs against *Ceratitis capitata*, revealed susceptibility of larvae to several nematode species [17,27,28], but high application rates are required for control in the field 5-50 X 10^2 IJs of *S. carpocapsae*/cm^2 [19]. Lindegren and Vail [17] reported on the susceptibility of *B. dorsalis* to *S. carpocapsae* and Beavers and Calkins [29] reported on the evaluation of *A. suspensa* susceptibility to several steinernematids and heterorhabditids. However, field experimentations to investigate such ability of EPNs to control fruit fly population are limited. In China, up to 86.3% mortality of *B. dorsalis* larvae and pupae was achieved with 300 IJs/cm^2 density of *S. carpocapsae* under field conditions [30]. Hominick and Reid [31] suggested the penetration ability of a nematode as an indication of its virulence. The penetration percentages of *H. taysearae* Hessa1, *H. taysearae* Korobororou F4 and *S. kandii* Thui IJs inside *B. dorsalis* larvae increased with time of insect exposure to IJs. *Heterorhabditis taysearae* Hessa1 displays the highest percentage (24.42% ± 2.77) after 24 h exposure time [33].

Conclusion

Incorporation of entomopathogenic nematodes as biocontrol agent in IPM programme with specific species even strain along with proper application technology should be projected for increase yield and quality of fruits in mango orchards.

Acknowledgement

The author acknowledges the encouragement from the Dean, College of Agriculture, AAU, Jorhat, Assam, India.

Bibliography

1. Pena JE., *et al*. "A review of the pest management situation in mango agroecosystems". *Phytoparasitica* 26 (1998): 1-20.

2. Waite GK. Pests and pollinators of mango. In: J.E. Pena, J.L. Sharp and M. Wysoki (eds.). "Tropical fruit pests and pollinators: biology, economic importance, natural enemies and control". Wallingford, UK, CABI Publishing (2002): 440.

3. Ignoffo CM. Manipulating enzootic-epizootic diseases of arthropods. In M.A. Hoy and D.C. Herzog (eds.), "Biological control in agricultural IPM systems". San Diego, Academic Press (1985): 589.

4. Steinkraus DC. Documentation of naturally-occurring pathogens and their impact in agroecosystems. In L.A. Lacey and H.K. Kaya (eds.), "Field manual of techniques in invertebrate pathology: application and evaluation of pathogens for control of insects and other invertebrate pests, 2nd edition". Dordrecht, Springer Scientific Publishers (2007): 267-281.

5. Lacey LA., *et al*. "Insect pathogens as biological control agents: do they have a future?" *Biological Control* 21 (2001): 230-248.

6. Kaya HK and Lacey LA. Introduction to microbial control. In L.A. Lacey and H.K. Kaya (eds.), "Field manual of techniques in invertebrate pathology: application and evaluation of pathogens for control of insects and other invertebrate pests, 2nd edition". Dordrecht, Springer Scientific Publishers (2007): 855.

7. Grewal PS., *et al*. "Lawn, turfgrass, and pasture applications. In: P. S. Grewal, R. U. Ehlers, and D. I. Shapiro-Ilan, eds., Nematodes as biocontrol agents. Wallngford: CABI Publishing (2005): 115-148.

8. Georgis R., *et al*. "Successes and failures of entomopathogenic nematodes". *Biological Control* 38 (2006): 103-123.

9. Shapiro-Ilan DI., *et al*. Orchard applications. In: "Nematodes as Biocontrol Agents". PS. Grewal, R.U. Ehlers and DI. Shapiro-Ilan (editors) (Wallingford: CABI Publishing) (2005): 215-229.

10. Shapiro-Ilan D., *et al*. "Microbial control of arthropod pests of orchards in temperate climates". In: Microbial Control of Insect and Mite Pests, ed L. A. Lacey (Amsterdam: Elsevier) (2017): 253-267.

11. Kaya HK and Stock SP. "Techniques in insect nematology". In: L. A. Lacey, ed. Manual of Techniques in Insect Pathology. San Diego, CA: Academic Press (1997): 281-324.

12. Karar H., *et al*. "Farmers' knowledge, perception and management of mango mealy bug, *Drosicha mangiferae* Green (Hemiptera: Monophlebidae), on Mangifera indica in Punjab, Pakistan". *Saudi Journal of Biological Sciences* 28.7 (2021): 3936-3942.

13. Mohan S., *et al*. "Successful management of mango mealy bug, *Drosicha mangiferae* by *Photorhabdus luminescens*, a symbiotic bacterium from entomopathogenic nematode *Heterorhabditis* indica". *International Journal of Nematology* 14 (2004): 195-198.

14. Hou B., *et al*. "Depth of pupation and survival of the oriental fruit fly, *Bactrocera dorsalis* (Diptera: Tephritidae) pupae at selected soil moistures". *Applied Entomology and Zoology* 41 (2006): 515-520.

15. James M., *et al*. "Surveying and screening South African entomopathogenic nematodes for the control of the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann)". *Crop Protection* 105 (2018): 41-48.

16. Langford EA., *et al*. "Susceptibility of Queensland fruit fly, Bactrocera tryoni (Froggatt) (Diptera: Tephritidae), to entomopathogenic nematodes". *Biological Control* 69 (2014): 34-39.

17. Lindegren JE and Vail PV. "Susceptibility of Mediterranean fruit fly, melon fly, and oriental fruit fly (Diptera:Tephritidae) to the entomogenous nematode Steinernema feltiae in laboratory tests". *Environmental Entomology* 15 (1986): 465-468.

18. Malan AP and Manrakhan A. "Susceptibility of the Mediterranean fruit fly (*Ceratitis capitata*) and the Natal fruit fly (*Ceratitis rosa*) to entomopathogenic nematodes". *Journal of Invertebrate Pathology* 100 (2009): 47-49.

19. Lindegren JE. "Field suppression of three fruit fly species with Steinernema carpocapsae. 5th International Congress of Invertebrate Pathology. and Microbial Control, Adelaide, Australia (1990): 20-24

20. Godjo A., *et al*. "Pathogenicity of indigenous entomopathogenic nematodes from Benin against mango fruit fly (*Bactrocera dorsalis*) under laboratory conditions". *Biological Control* 117.1 (2017).

21. Godjo A., *et al*. "Pathogenicity of indigenous entomopathogenic nematodes from Benin against mango fruit fly (*Bactrocera dorsalis*) under laboratory conditions". *Biological Control* 117 (2018): 68-77.

22. Usman M., *et al*. "Entomopathogenic nematodes as biological control agent against *Bactrocera zonata* and *Bactrocera dorsalis* (Diptera: Tephritidae)". *Biological Control* 163 (2021): 104706.

23. Lezama-Gutierrez R., *et al*. "Larval susceptibility of *Anastrepha ludens* (Diptera: Tephritidae) to *entomopathogenic nematodes* (Steinernematidae y Heterorhabditidae)". *Vedalia Revista Internacional de Control Biologico (Mexico)* 3.1 (1996): 31-33.

24. Toledo J., *et al*. "Parasitismo de larvas y pupas de la mosca mexicana de la fruta, *Anastrepha ludens* (Loew) (Diptera: Tephritidae) por el nemátodo Steinernema feltiae (Filipjev) (Rhabditida: Steinernematotidae). Vedalia 8 (2001): 27-36.

25. Toledo J., *et al*. "Infection of *Anastrepha ludens* (Diptera: Tephritidae) larvae by *Heterorhabditis bacteriophora* (Rhabditida: Heterorhabditidae) under laboratory and field condition". *Biocontrol Science and Technology* 15 (2005): 627-634.

26. Toledo J., *et al*. "Infection of *Anastrepha ludens* following soil applications of *Heterorhabditis bacteriophora* in a mango orchard". *Entomologia Experimentalis et Applicata* 119 (2006): 155-162.

27. Gazit Y., *et al*. "Evaluation of entomopathogenic nematodes for the control of Mediterranean fruit fly (Diptera: Tephritidae)". *Biocontrol Science and Technology* 10 (2000): 157-164.

28. Laborda R., *et al*. "Susceptibility of the Mediterranean fruit fly (Ceratitis capitata) to entomopathogenic nematode *Steinernema* spp. ("Biorend C")". *Bull. OILB/SROP* 26 (2003): 95-97.

29. Beavers JB and Calkins CO. "Susceptibility of *Anastrepha suspensa* (Diptera: Tephritidae) to steinernematid and heterorhabditid nematodes in laboratory studies". *Environmental Entomology* 13.1 (1984): 137-139.

30. Lin J., *et al*. "Effects of entomopathogenic nematodes on the oriental fruit fly, *Bactrocera dorsalis* (Hendel)". *Acta Entomologica Sinica* 48 (2005): 736741.

31. Hominick WM and Reid AP. "Perspectives on entomopathogenic nematology". In: Gaugler R and Kaya HK (editors). Entomopathogenic nematodes in *Biological Control*. Boca Raton, FL, CRC Press (1990): 327-345.

32. Dolinski C and Lacey LA. "Microbial control of arthropod pests of tropical tree fruits". *Neotropical Entomology* 36.2 (2007): 161-179.

33. Godjo A., *et al*. "Evaluation of the ability of indigenous nematode isolates of *Heterorhabditis taysearae* and *Steinernema kandii* to control mango fruit fly *Bactrocera dorsalis* under laboratory, semi-field and field conditions in Northern Benin". *Crop Protection* 149 (2021): 105754.