Available online at http://www.journalijdr.com

IJDR

International Journal of DEVELOPMENT RESEARCH

ISSN: 2230-9926

International Journal of Development Research
Vol. 4, Issue, 5, pp. 1088-1091, May, 2014

Full Length Review Article

ENTOMOPATHOGENIC NEMATODES, FARMERS BEST FRIEND!

Pushpalatha, R.

Department of Bio-control, Genelon Life science Pvt. Ltd., Yelahanka, Bangalore, Karnataka-560 064

ARTICLE INFO

Article History:
Received 01st February, 2014
Received in revised form
30th March, 2014
Accepted 02nd April, 2014
Published online 31st May, 2014

Keywords:
Entomopathogenic nematodes,
Chemical pesticides,
Farmers,
Agriculture practices

ABSTRACT

Agriculture is the keystone of the Indian economy contributing nearly 18 per cent to country's GDP. Our country has achieved a fivefold increase in food grain production of 263.20 million tons in 2013-14 giving food securities for more than 1.27 billion Indian population. Still factors like insect pests, diseases, weeds, rodents etc., take a heavy toll in agriculture production. The losses though cannot be eliminated altogether, these can be reduced. Till now, chemical pesticides were increasingly relied upon to limit the production losses. Toxic and environmentally persistent chemicals are being used as pesticides. Most of the farmers are unaware of pesticide types, level of poisoning, safety precautions and potential hazards on health and environment. Poisoning Incidents are also increasing due to incidental, intentional and occupational exposure. Presently, GAP is formally recognized in the international regulatory framework for reducing risks associated with the use of pesticides, taking into account public and occupational health, environmental and safety considerations. The focus of this paper is to highlight the use and application status of Beneficial nematodes which can be successfully integrated as a part of IPM.

Copyright © 2014 Pushpalatha, R. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Importance of Agriculture

Agriculture is the dominant sector of Indian economy, which determines the growth and sustainability. About 65 per cent of the population still relies on agriculture for employment and livelihood. India is first in the world in the production of milk, pulses, jute and jute-like fibers; second in rice, wheat, sugarcane, groundnut, vegetables, fruits and cotton production; and is a leading producer of spices and plantation crops as well as livestock, fisheries and poultry. Important factors that affect attaining and maintaining the food production are population, land availability, and the devastation of agricultural products by the pests, insects and fungus. It is estimated that 35% of the potential production is lost due to pests, insects and fungus. To achieve increased food production from limited land resources, attention on pest control is very important. Good Agriculture Practices like preparation of soil, sowing seeds, adding fertilizers, irrigation, spraying pesticides, harvesting and storage for crops will promote optimum utilization of resources such as pesticides, fertilizers, water and eco-friendly agriculture and protect the agricultural workers health from improper use of chemicals and pesticides.

****Corresponding author: Pushpalatha, R.***
Department of Bio-control, Genelon Life science Pvt Ltd., Yelahanka, Bangalore, Karnataka-560 064

Chemical pesticide creating wreaking havoc

Our farmers relay mainly on chemical pesticides for their spontaneous result. Pesticides used in our country include Organ chlorides, Organophosphates, Carbamates, Pyrethroids and Triazines.

Of course! Pesticides provide many substantial benefits for farmers by controlling pests and preventing disease, as well as increasing crop yield and keeping costs down; however, these potent chemicals have also put our health in great danger. It may lead to cancer, endocrine complications, infertility and sterility, brain damage, birth defects, respiratory disorders, organ failure and skin irritation. Pesticides cannot discriminate between harmful targets pests and non-pest predators. When pesticides kill the sensitive predators, the resistant pests increase in numbers. As in our country mosquitoes have become resistant to Dichlorodiphenyltrichloroethane (DDT), Benezenehexachloride (BHC), Malathion, Parathion and Fenitrothion. Framers have to use larger share of their capital produce for increasing use of pesticides to control pesticide resistant pests. Natural selection acting on pesticide resistant genes have increased the pesticide resistant pests and decreased the number of their natural predators (*http://entrancepractise.blogspot.com/search/label/PESTICIDES*). The rampant use of these chemicals, under the adage, "if little is good, a lot more will be better" has played havoc with human and other life forms. Farmers worldwide use more than two million tons of chemical pesticides each year. The worldwide deaths and chronic diseases due to pesticide poisoning number about 1 million per year (Environews Forum, 1999). The high-risk groups exposed to pesticides include production workers, formulators, sprayers, mixers, loaders and agricultural farm workers.

The National Institute of Occupational Health (NIOH) (Saiyed *et al*., 1992) assessed the magnitude of the toxicity risk involved in the spraying of methomyl, a carbamate insecticide, in field conditions. Significant changes were noticed in the ECG, the serum LDH levels, and cholinesterase (ChE) activities in the spray men, indicating cardio toxic effects of Methomyl. Also observations confined to health surveillance in male formulators engaged in production of dust and liquid formulations of various pesticides (Malathion, Methyl parathion, DDT and Lindane) in industrial settings of the unorganized sector revealed a high occurrence of generalized symptoms (headache, nausea, vomiting, fatigue, irritation of skin and eyes) besides psychological, neurological, cardio respiratory and gastrointestinal symptoms (Gupta *et al*., 1984). Overuse of chemical fertilizers and pesticides have effects on the soil organisms that are similar to human overuse of antibiotics. Triclopyr inhibits soil bacteria that transform ammonia into nitrite (Pell *et al*., 1998). Glyphosate reduces the growth and activity of free-living nitrogen-fixing bacteria in soil (Santos and Flores, 1995).

Overall user-friendly attributes of beneficial nematodes

Our approach to the use of pesticides should be pragmatic. In other words, all activities concerning pesticides should be based on scientific judgment and not on commercial considerations. Farmer community can depend on Biological control methods like using Predators, Parasitic Insects, Microbial bio pesticides (bacterium, fungus, virus or protozoan), Insect parasitic Nematodes, Plant-Incorporated-Protectants (PIPs), Pheromone traps and Light traps etc., as a part of Integrated Pest Management (IPM) which is programmed to reduces the environmental and public safety hazards of chemicals.

Entomopathogenic Nematode (EPN) is a promising candidate for management of insect pests. Intense interest in EPN for insect pest control has been fueled mainly for their potential efficacy and impressive attributes. These include their wide spectrum of insecticidal activity, ability to kill most hosts within 24 to 48 hours, efficient mass culturing technique, ease of field application and exempted by registration from Environmental Protection Agency (EPA). They act both as predators/parasitoids and pathogens viz., quick kill, presence of chemoreceptors, amenability for *in vitro* production, safety to vertebrates, plants and non-targets, amenability for genetic diversity. EPN can be integrated into standard chemical control practice. Today nematodes are mainly used in the environment where chemical compounds fails, or in cases where resistance to insecticides has developed. Nematodes have been successfully applied to control agricultural and horticultural pests in many countries. Nematodes are amazing animals, being ancient and diverse. They are tiny soil dwelling parasitic round worms, which are simple, soft bodied, un-segmented, colorless, without appendages, usually microscopic in size. Among different types of nematodes EPN belonging to phylum Nematoda, specifically called as beneficial nematodes since they cause diseases within an insect species only and kill them. They attack many different types of soil born insects, including the larval forms of butterflies, moths, beetles, and flies, as well as adult crickets and grasshoppers. Yet are not harmful to humans, animals, plants, or earthworms, and can therefore be used as biological control organisms (Denno *et al*., 2008). Strictly speaking, EPNs are not themselves parasitic because they do not feed on their host directly. Instead, it's the symbiotic bacteria, which the nematodes release that are the true parasites that kill the insect.

They are ubiquitous, that occur naturally in the water film that surrounds soil particles, found in every inhabited continent from a wide range of ecologically diverse soil habitats including cultivated fields, forests, grasslands, deserts, and even ocean beaches (Hominick, 2002). The most commonly studied genera that are useful in the biological control of insect pests are *Steinernema* and *Heterorhabditis* (Gaugler, 2006). EPN attack only insects and their relatives during Infective Juvenile (IJ) stage of their life cycle. Nematode of the family Steinernematidae enter the insect through natural openings such as mouth, anus or spiracles where as those of the family Heterorhabditidae are capable of making holes in the body wall of the insect. Nematodes of both the families exhibit symbiotic associations with bacteria of the genera Xenorhabdus and Photorhabdus, respectively. A broad spectrum of insects are susceptible to the bacteria-nemate symbiotic pairs. Insects belonging to the orders coleopteran and lepidoptera are most susceptible. *Xenorhabdus & Photorhabdus* are known to produce a toxic cocktail of secondary metabolites that are not only lethal to the insect hosts but prevents opportunistic bacteria and fungi from utilizing the nutrient rich cadaver, sequestering the resources for themselves and their nematode partners.

The bacteria always contribute to the virulence of the duo, and usually contribute the lion's share by secreting protein products that degrade and digest host tissues. An unique characteristic in EPN is its foraging strategy used to locate its prey on the basis of which they are classified into the two categories: Ambushers such as *Steinernema carpocapsae* and *S. scapterisci* have adapted "sit and wait" strategy to attack highly mobile insects (billbugs, sod webworms, cutworms, mole-crickets and armyworms) when they come in contact at the surface of the soil. These nematodes do not respond to host released cues but infective juveniles of some *Steinernema spp.* can stand on their tails (nictate) and easily infect passing insect hosts by jumping on them. Since highly mobile insects live in the upper soil or thatch layer, ambushers are generally effective in infecting more insects on the surface than deep in the soil. Cruiser nematodes such as *Heterorhabditis* *bacteriophora*, *H. megidis*, *Steinernema glaseri* and *S. kraussei* generally move actively in search of hosts and therefore, they are distributed throughout the soil profile and more effective against less mobile hosts such as white grubs and black vine weevils. Cruisers never nictate but respond to carbon dioxide released by insects as cues. Some nematode species such as *Steinernema feltiae* and *S. riobrave* have adapted a strategy in between ambush and cruise strategies called an intermediate strategy to attack both the mobile and sedentary/less mobile insects at the surface or deep in the soil. *Steinernema feltiae* is highly effective against fungus gnats and mushroom flies whereas *S. riobrave* is effective against corn earworms, citrus root weevils and mole crickets (Nematode information, 2008).

The life cycle of most nematodes includes an egg stage, four juvenile stages, and an adult stage. The third juvenile stage of EPN is referred to as the "infective juvenile" or "dauer" stage and is the only free-living stage. The infective juvenile is capable of surviving in the soil, where it locates, attacks, and infects a pest insect. Under optimal conditions, it takes 3–7 days for *steinernematids* and *heterorhabditids* to complete one life cycle inside a host from egg to egg. Emergence of infective juveniles from the host requires about 6–11 days for steinernematids and 12–14 days for *heterorhabditids (*Kaya *et al*., 1999). After *Bacillus thuringiensis*, the most widely used bio pesticides in agriculture sector is EPN. First use of the *Steinernema glaseri* against the white grubs *Popillia japonica was* in New Jersey (USA) (Glaser and Farrell, 1935). No inferior damages or hazards caused by the use of EPN to the environment are in records. So the use of EPN is safe for the user. EPN and their associated bacteria cause no detrimental effect to mammals or plants as well (Boemare *et al*., 1996; Bathon, 1996; Akhurst and Smith, 2002; Poinar *et al*., 1982).

In India *Heterorhabditis indica* was detected in sugarcane fields at Coimbatore in 1992. Extensive surveys by Project Directorate for Biological Control (PDBC) since 1996 detected *Steinernema carpocapsae* from Bangalore, Madurai and Rajahmundry, *S. bicornutum* from Delhi, *Heterorhaditis indica* from Bangalore, Coimbatore, Chidambaram, Kanyakumari, and Aligarh. *S. tami* from Jorhat, *S. abbasi* from Delhi and unidentified *Steinernema* sp. SSLW from Aligarh and Coimbatore (Hussaini *et al*., 2001a). Besides, *S. thermophilum* was recorded from, New Delhi (SudershanGanguly *et al*., 2000) and *S. seemae* and *S. massodi* from Kanpur (Ali *et al*., 2005). *As a* current developmental status of India *Steinernema* and *Heterorhabditis* have widely perceived as biological agent (Gaugler and Kaya, 1990). Different workers have studied the use of EPN against cutworms, ragi pink borer, rice leaf folder and stem borers, paddy gall midge, sugarcane borers, white grubs, red hairy caterpillars etc., in lab and field. Immense research work has been carrying out to acknowledge EPN as a potential bioagent by many Research Institutes and Companies such as National Bureau of Agriculturally Important Insect, Bangalore (NBAII), Indian Agricultural Research Institute, Delhi (IARI), Tamil Nadu Agricultural University (TNAU), Directorate of Rice Research, Hyderabad (DRR), Maharana Pratap University of Agriculture and Technology, Udaipur (MPUAT), Sugarcane Breeding Institute, Coimbatore (SBI), Central Plantation Crops Research Institute, Kayangulam (CPCRI), Pest Control India and Genelon Institute of Life Science etc.,. Several issues are being addressed for their commercialization such as mass production, formulation and utilization in field as a component of Integrated Pest Management (IPM). Successful control of insect pests can only be achieved when the nematode material reaches the end user in good condition storage and formulation techniques must provide optimum conditions to guarantee maximum survival and infectivity.

As per the world scenario, major accomplishments are *in vitro* production of nematodes in numbers sufficient for field applications, at a cost competitive with chemical pesticides (Georgis, 1992). Consistent production of high quality nematodes, development of nematode formulation that provide a shelf-life sufficient for storage and transport to the site of use, formulation that make application rapid and simple. Nematode based products that fulfill these requirements are presently available (Georgis and Manweiler, 1994). As for as our Indian farmers are concerned, they will be willing to pay the extra price for an effective alternative like EPN that are safe compared to chemical pesticides. The far most thing is that farming community should be made aware of pest infestation and should be educated for proper utilization of the bioagent and innovative technologies.

REFERENCE

Akhurst, R. and K. Smith. 2002. Regulation and safety. R. Gaugler. (ed.), Entomopathogenic Nematology. CABI Publishing, Oxon, UK. p. 311-332.

Ali, S.S., Shaheen, A., Pervez, R. And Hussain, M.A. 2005 *Steinernemamasoodi* sp. n. and *Steinernema seemai* sp. n. (Rhabditida: Sternernematidae) From Uttar Pradesh, *India International Journal of Nematology.*15 (1): 89– 99.

Bathon, H. 1996. Impact of Entomopathogenic nematodes on non-target Hosts. *Biocontrol. Sci. Technol*. 6: 421-434.

Boemare, N. E., C. Laumond and H. Mauleon. 1996. The Entomopathogenic nematode-bacterium complex: Biology, lifecycle and vertebrate safety. *Biocontr. Sci. Technol.*6: 333-346.

Denno, R.F., D.S. Gruner, and I. Kaplan. 2008. Potential for Entomopathogenic Nematodes in Biological Control: A Meta-Analytical Synthesis and Insights from Trophic Cascade Theory. *Journal of Nematology* 40(2): 61-72.

Environews Forum. Killer environment. Environ Health Perspect. 1999; 107:A62. [PMC free article] [PubMed].

Gaugler 2006.Shapiro-Ilan DI, Gaugler R. 2002. Production technology for Entomopathogenic nematodes and their bacterial symbionts. *Journal of Industrial Microbiology and Biotechnology,* 28: 137-146.

Gaugler, R. and Kaya, H.K. 1990. (eds.). Entomopathogenic nematodes in Biological Control. CRC Press, Boca Raton, FL, USA. Pp.365.

Georgis, R. 1992. Present and future prospects for Entomopathogenic Nematode products. *Bio control Science and Technology*, 2: 83-99.

Georgis, R. and Manweiler, S.A. 1994. Entomopathogenic nematode: a Developing biological control technology. *Agricultural and Zoological Reviews*, 6: 63-94.

Glaser, R.W. and Farrell, C.C. 1935. Field experiments with the Japanese Beetle and its nematode parasite. *Journal of the New York Entomological Society* 43, 345.

Gupta SK, Jani JP, Saiyed HN, Kashyap SK. Health hazards in pesticide formulators exposed to a combination of pesticides. *Indian J Med Res*. 1984; 79:666. [PubMed].

Hominick, W.M., 2002. Biogeography. In: Gaugler, R. (Ed.), Entomo- pathogenic Nematology. CABI Publishing, Wallinford, UK, pp. 115– 143.

http://entrancepractise.blogspot.com/search/label/PESTICIDES

Hussaini, S.S., Ansari, M.A., Ahmed, W., and Subbotin, S.A. 2001a. Identification of some Indian population of Steinernema species (Nematoda) By RFLP analysis of the ITS region of rDNA. *International Journal of Nematology*, 11: 73-76.

Kaya, H.K., and A.M. Koppenhöfer. 1999. Biology and Ecology of Insecticidal Nematodes. In *Workshop Proceedings: Optimal Use of Insecticidal Nematodes in Pest Management,* pp. 1–8. Edited by S. Polavarapu, Rutgers University.

Nematode information, a blog about insect and plant parasitic nematode, November 29th, 2008.

Pell M, Stenberg B, Torstensson L. Potential denitrification and nitrification tests for evaluation of pesticide effects in soil. *Ambio.* 1998; 27:24–28.

Poinar, G. O., Jr., G. M. Thomas, S. B. Presser and J. L. Hardy. 1982. Inoculation of entomogenous nematodes, Neoaplectana and Heterorhabditis andtheir associated bacteria, Xenorhabdus spp., into chicks andmice. *Environ Entomol.* 11: 137-138.

Saiyed HN, Sadhu HG, Bhatnagar VK, Dewan A, Venkaiah K, Kashyap SK. Cardiac toxicity following short term exposure to methomyl in spray men and rabbits. *Hum Exp Toxicol.* 1992; 11:93. [PubMed].

Santos A, Flores M. Effects of glyphosate on nitrogen fixation of free-living heterotrophic bacteria. *Lett Appl Microbiol.* 1995; 20:349–352.

SudershanGanguly, M. Singh and D.L.C. Procter 2000. Two new species Of *Xiphinema* Cobb, 1913 (Nematoda: Dorylaimida) from high altitudes of Bhutan along with a key and compendium to the species of GroupI *sensu* Loof & Luc, 1990. *Indian Journal of Nematology* 30(2):147-156.

****