AgriCos e-Newsletter
ISSN: 2582-7049
AgriCos e-Newsletter
Open Access Multidisciplinary Monthly Online Magazine
Volume: 05 Issue: 01 January 2024 Article No: 12

Importance of Biopesticides in Pest Management

Priyanka P. Patil
Ph.D., Department of Agricultural Entomology, MPKV, Rahuri (M.S.)

SUMMARY

Agricultural crops has had to face the destructive activities of numerous pests like fungi, weeds and insects from time immemorial, leading to radical decrease in yields. For the control of these pests chemicals are highly effective because only they act on a broad host range but there is also a negative impact on the environment and the overall sustainability of the farming systems. Use of synthetic pesticides has severely affected both the abiotic and biotic components of the environment. Managing agricultural production systems on a sustainable basis is one of the most critical challenges for the future of humanity as the world population is increasing exceptionally. Biopesticides is a potential tool considered to be the best alternative to synthetic pesticides that are highly effective, target specific and reduce environmental risks. Biopesticides are derived from animals, plants and other natural materials such as fungi, bacteria, algae, viruses, nematodes and protozoa. The advance research and development in the field of biopesticides applications greatly mitigate environmental pollution. The development of bio-pesticides stimulates modernization of agriculture and will, without doubt, gradually replace chemical pesticides.

INTRODUCTION

Biopesticides are eco-friendly pesticides which are obtained from naturally occurring substances (bio-chemicals), microbes and plants. Some are chemical pesticides if they act on nervous system of the pest. Through the use of biopesticides in a wider way, agriculture and health programmes can be beneficially affected. There are many disadvantages associated with the use of chemical pesticides like genetic variations in plant populations, reduction of beneficial species, damage to the environment or water bodies, poisoning of food and health problems such as cancer.

What are Biopesticides? :

"Biopesticides" are certain types of pesticides derived from such natural materials as animals, plants, bacteria, and certain minerals. For example, canola oil and baking soda have pesticidal applications and are considered bio-pesticides.

Classes of Biopesticides :

Biopesticides fall into three major classes

1. Microbial pesticides
2. Biochemical pesticides
3. Plant Incorporated Protectants (PIPs)
4. Semiochemicals

Microbial pesticides :

Microbe based or microbial originated pesticides are known as microbial pesticides. In other word we can say that active ingredient is microbe. Microbial pesticides consist of a microorganism (e.g., Bacterium, Fungus, Virus or Protozoan) as the active ingredient. Microbial pesticides can control many different kinds of pests, although each separate active ingredient is relatively specific for its target pests. For example, there are fungi that control certain weeds and other fungi that kill specific insects. The most widely used microbial pesticides are subspecies and strains of *Bacillus thuringiensis*, or *Bt.* Each strain of this bacterium produces a different mix of proteins and specifically kills one or a few related species of insect larvae. While some Bt ingredients control moth larvae found on plants, other Bt ingredients are specific for larvae of flies and mosquitoes. The target insect species are determined by whether the particular Bt produces a protein that can bind to a larval gut receptor, thereby causing the insect larvae to starve.

Examples :

- **Fungi :** *Beauveria, Bassiana, Metarhizium anisoplie*
- **Bacteria :** *Bacillus thuriengenesis*
- **Virus :** *Nucleopolyhedrous Virus*
- **Nematodes :** *Steinernema, Heterorhabdis*

Biochemical pesticides :

Biochemical pesticides are naturally occurring substances that control pests by non-toxic mechanisms. Conventional pesticides, by contrast, are generally synthetic materials that directly kill or inactivate the pest. Biochemical pesticides include substances that interfere with mating, such as insect sex pheromones, as well as various scented plant extracts that attract insect pests to traps. Because, it is sometimes difficult to determine whether a substance meets the criteria for classification as a biochemical pesticide.

Examples :

- Plant Growth Regulators
- Insect Growth Regulators
- Organic Acids
- Plant Extracts
- Pheromones
- Minerals

Plant Incorporated Protectants (PIPs) :

Plant Incorporated Protectants are pesticidal substances that plants produce from genetic material that has been added to the plant. For example, scientists can take the gene for the Bt pesticidal protein and introduce the gene into the plant's own genetic material. Then the plant, instead of the Bt. bacterium, manufactures the substance that destroys the pest. The protein and its genetic material, but not the plant itself, are regulated by EPA.

Examples : Bt cotton, Bt corn etc.

Semiochemicals :

A semiochemical by definition is a chemical signal produced by one organism, usually insects which caused a behavioural change in an individual of the same or different species. For crop protection, the most widely used semiochemicals are the insect pheromones which serve as a signal to communicate with others in their species for a number of reasons and synthesized for pest control by mating disruption, Lure-and-Kill systems and mass trapping. Insects produce chemicals called pheromones to stimulate a certain behavioral reaction from other individuals. These pheromones have numerous effects and are named according to their evoked response, for example, sex pheromones, aggregation pheromones, alarm pheromones, etc. A few pheromones function as sex attractants, permitting individuals to detect and locate mates, whereas others induce trail following, oviposition, and aggregation in other congeners. Pheromones have become essential tools for monitoring and controlling agricultural pest populations, and as such, a huge collection of over 1,600 pheromones and sex attractants has been reported. Nowadays, pheromones and other semiochemicals are applied to monitor and control pests in millions of hectares. There are several advantages of utilizing pheromones for monitoring pests, including lower costs, specificity, ease of use, and high sensitivity. Insect pest monitoring by using pheromone lures can profit management conclusions such as insecticide application timing. Pheromones produced by insects are highly species specific. Virgin female insects are developing sex pheromones when expecting for a mate and males along the concentration slope for the female producer. Aggregation pheromones are released by insects such as wood-invading beetles to show to others the presence of a good food source.

Advantages of using Biopesticides :

- Biopesticides are usually inherently less toxic than conventional pesticides.
- Biopesticides generally affect only the target pest and closely related organisms, in contrast to broad spectrum, conventional pesticides that may affect organisms as different as birds, insects and mammals.
- Biopesticides often are effective in very small quantities and often decompose quickly, resulting in lower exposures and largely avoiding the pollution problems caused by conventional pesticides.
- When used as a component of Integrated Pest Management (IPM) programs, bio-pesticides can greatly reduce the use of conventional pesticides, while crop yields remain high.

Sr. No.	Microbial pesticides	Target pests and crops
1	*Beauveria bassiana*	Aphids in chilli and brinjal (*Aphis gossypii*), cabbage (*Brevicoryne brassicae*), cowpea (*Aphis craccivora*) and rice leaf folder (*Cnaphalocrocis medinalis*)
2	*Bacillus thuringiensis* var. kurstaki	Fall armyworm (*Spodoptera frugiperda*) in maize, Legume pod borer (*Helicoverpa armigera, Maruca* sp.), Diamondback moth (*Plutella xylostella*), Spotted stem borer (*Chilo partellus*), Rice leaf folder (*Cnaphalocrocis medinalis*), Brinjal shoot borer (*Leucinodes orbonalis*), Red hairy caterpillar (*Amsacta albistriga*) and *Spodoptera litura* in soybean
3	*Lecanicillium lecanii*	Aphids in chilli and cowpea
4	*Metarhizium anisopliae*	White grubs (*Holotrichia spp.*) in sugarcane, Fall armyworm (*Spodoptera frugiperda*) in maize and Rice leaf folder (*Cnaphalocrocis medinalis*)
5	*Pseudomonas fluorescens*	*Thrips spp.* in capsicum and Fusarium wilt of red gram
6	*Bacillus albus*	Fall armyworm (*Spodoptera frugiperda*) of maize, Tomato pin worm (*Tuta absoluta*) and Fusarium wilt of cucumber (*Fusarium oxysporum* f. sp. *cucumerinum*)
7	*Pseudomonas fluorescens*	Spot blotch of wheat, Sheath blight of rice and Wilt of tomato/ chickpea
8	*Trichoderma harzianum* and *Bacillus amyloliquefaciens*	Wilt of chickpea, lentil, p ea, pigeon pea; damping off/seedling mortality in papaya; *Rhizoctonia, Sclerotium, Sclerotinia, Fusarium, Pythium, Ralstonia, Macrophomina, Bipolaris* and *Phoma* Root knot nematode (*Meloidogyne incognita*)
9	*Trichoderma asperellum*	Phytophthora seedling blight, Macrophomina root rot and Fusarium wilt of safflower

Status of Biopesticides in India :

India Bio-pesticides represent only 4.2% (as on 2021) of the overall pesticide market in India and is expected to increase drastically in coming years. In India, so far only 12 types of bio-pesticides have been registered under the Insecticide Act, 1968. Neem based pesticides, *Bacillus thuringensis*, NPV and *Trichoderma* are the major bio-pesticides produced and used in India. Whereas more than 190 synthetics are registered for use as chemical pesticides.

Role of Biopesticides in IPM :

Crop protection has relied basically on synthetic chemical pesticides in past, but their availability is now declining as a result of new laws and legislations and the evolution in the process of insect resistance. Therefore, it is necessary to replace the pest management strategy. Biopesticide is the best alternative to synthetic chemical pesticides based on living micro-organisms or natural products. Biopesticides include a broad array of microbial pesticides, biochemicals derived from microorganisms and other natural sources, and processes involving the genetic modification of plants to express genes encoding insecticidal toxins. Biopesticides have demonstrated the potential of pest management and used worldwide. In the European Union, there are new opportunities for development of biological pesticides in combination with integrated pest management, ecological science and post genomic technologies. In this regard, the use of biopesticides and bio-agents has assumed significance as an important component of IPM due to their economic viability and eco-friendly nature instead of chemical synthetic pesticide. Biopesticide application as a component of IPM programs can play important role in overcoming disadvantage of chemical insecticides that have some important characteristics such as biodegradable and self-perpetuating, less harmful on beneficial pests, mostly host specific and less shelf life. Baculovirus biopesticides are an alternative to chemical pesticides in integrated pest management; however, they have a wide range of difficulties for commercial uses such as slow killing, short life time, high production costs and current laws and regulations of biological control agents. To overcome many problems of wild-type baculoviruses, many strategies have been developed to improve their killing action by recombinant DNA technology, including the insertion of genes encoding insect hormones or enzymes, or insect-specific toxins.

CONCLUSION

Microbial pesticides / bio-pesticides can be an alternative to the chemical pesticides as indiscriminate pesticide use is detrimental to the environment and human health and also increases insect resistance to pesticides. The bio-pesticides are being used as alternative pest management strategies. Bio-pesticides are more environmentally friendly and do not harm the soil, water supply, or wildlife, including beneficial insects, which is one of the main advantages of introducing them into a sustainable agriculture system. The demand for microbial pesticides is rising steadily in all parts of the world. By combining performance and safety, bio-pesticides perform efficaciously with minimum application restrictions along with human and environmental safety benefits. It is likely that in the future, their role will be more fruitful in agriculture and horticulture.

REFERENCES

Jhala, J., Baloda, A. and Rajput, V. (2020). Role of bio-pesticides in recent trends of insect pest management: A review. *Journal of Pharmacognosy and Phytochemistry*, 9(1): 2237-2240.

Kumar, J., Ramlal, A., Mallick, D. and Mishra, V. (2021). An Overview of Some Biopesticides and Their Importance in Plant Protection for Commercial *Plants (Basel)*. 10(6): 1185.

Ruiu, L. (2018). Microbial Biopesticides in Agroecosystems. *Agronomy*, 8: 235.

Sporleder, M., Lacey, L. A. (2021). Biopesticides. In: Alyokhin A., Vincent C., Giordanengo P., editors. Insect Pests of Potato. Elsevier; Oxford, UK: pp. 463-497.

Thakur, N., Kaur, S., Tomar, P., Thakur, S. and Yadav, A. N. (2020). Microbial biopesticides: Current status and advancement for sustainable agriculture and environment. New and Developments in microbial Biotechnology and Bioengineering. https://doi.org/ 10.1016/B978-0-12-820526-6.00016-6. 243- 282.

Ujváry, I. (2001). Chapter 3-Pest Control Agents from Natural Products. In: Krieger R.I., Krieger W.C., editors. Handbook of Pesticide Toxicology. 2nd ed. Academic Press; San Diego, CA, USA: pp. 109-179.

https://byjus.com/neet/importance-of-biopesticides/