Journal of Advanced Zoology
ISSN: 0253-7214
Volume 44 Issue S5 Year 2023 Page 2484-2487

Nature's Defenders: Microbes as Bio-Pesticide Guardians: A review

Sumana Mondal[1], Srijan Haldar[2*]

. [1] *Swami Vivekanada University, Department of Microbiology, Barrackpore, WB, India*
[2] ** Swami Vivekanada University, Department of Biotechnology, Barrackpore, WB, India*

***Corresponding Author:** Srijan Haldar*
** Swami Vivekanada University, Department of Biotechnology, Barrackpore, WB, India*
haldar.srijan@gmail.com

Article History

Received: 30/09/2023
Revised: 15/10/2023
Accepted:30/10/2023

Abstract

In recent years, the search for safer and more sustainable alternatives has been triggered by the harmful effects of synthetic chemical pesticides on both the environment and human health. Among these alternatives, the use of microbes as bio-pesticides has emerged as a promising solution. Microbes, such as bacteria, fungi, and viruses, have evolved intricate mechanisms to control pests and diseases in nature, making them potential allies in agricultural practices. This paper delves into the various roles microbes play as bio-pesticides and their application in modern agriculture. It highlights the diverse range of microorganisms that exhibit bio-control activities against insect pests, plant pathogens, and nematodes. Moreover, the interactions between beneficial microbes and plants, leading to enhanced disease resistance, are also explored. The mechanisms underlying the bio-pesticidal properties of microbes are elucidated, including the production of secondary metabolites, enzymes, and toxins that target specific pests and pathogens. Furthermore, the paper discusses the advantages of utilizing microbes as bio-pesticides, such as their biodegradability, reduced persistence in the environment, and minimal impact on non-target organisms. The importance of integrating microbial bio-pesticides into integrated pest management (IPM) strategies is highlighted. By incorporating these natural allies into existing agricultural practices, Farmers can reduce their dependence on chemical pesticides, mitigate the development of resistance in pest populations, and encourage the conservation of beneficial insect populations

Key words: Pest, Biopesticide, Biological Control, Current status, Sustainable Environment.

Introduction

The global population is growing exponentially and is projected to reach around 9.7 billion by 2050, particularly in Asia and Africa. Anthropogenic activities, such as cultural development, have significantly impacted the environment and ecosystems. This includes reduced agricultural areas due to construction, increased nutrient mining, and the degradation and contamination of water resources, soil fertility, and soil quality. Plant nutrition are more important to increased demand for food supply. Due to excessive usage of chemical pesticides the soil fertility, agricultural ecosystem and all over animal kingdom and cultivated crops

growth get affected. The use of pesticides contributes to environmental issues (Sepand, M et al, 2020), challenges that microbial inoculants can effectively address, providing a viable alternative and psychostimulants. Beneficial microorganisms play a crucial role in enhancing microflora, soil health, plant growth, and controlling plant diseases, while also offering protection against harmful pests. Various beneficial microbial inoculants, including nitrogen fixers, phosphate and sulfur solubilizers, zinc solubilizers, and plant growth-promoting rhizobacteria, are present in biofertilizers.

The term 'biopesticide' refers to the application of favorable microorganisms for insect monitoring. Biopesticides include specific pesticides derived from natural sources such as plants, animals, and bacteria. Globally, 90% of all biopesticides are in use, with Bacillus thuringiensis standing out as the most commercially successful biopesticide in the market (Bt) (Jouzani, G et l ,2017).

The classification of the microbial biopesticide's contains, Bacteria (*Bacillus thuringiensis*) (Jouzani, G et l ,2017), Fungi (*Zoopthora, Normuroea*) (Weale, A. (2010), Virus (*Homona magnanima GV*) (Hiroshi, A et al, 2022 , Arai, H et al 2019), Protozoa (*Vairimorpha, thelohania*.) (Valles, S et al, 2002), Nematodes (*S.glaseri* , *Heterorhabditis* sp.) (de Oliveira Vasconcelos et al , 2004).

In comparison to conventional pesticides, biopesticides present a lower risk to both humans and the environment, garnering worldwide attention as a novel tool for pest species' destruction and control, including plant diseases, certain insects, and weeds. The primary advantages of most biopesticides lie in their off-target biological safety and high selectivity. These eco-friendly agents are derived from natural substances, utilizing non-toxic processes to control insects. Biopesticides, such as Nucleopolyhedrosis virus and Bacillus thuringiensis from microorganisms, Azadirachta from plants, and Nematodes (S. glaseri) from animals, are produced along with their products and by-products. Consequently, the global use of biopesticides is experiencing a yearly increase of 10%. Biopesticides are intended to be employed similarly to chemical pesticides. Globally, various microbes, including algae, protozoans, fungi, viruses, and bacteria, are widely used for the development of plant growth. (Jouzani, G et l ,2017 ; Weale, A. 2010),). They produce toxin that causes disease. They inhabit the growth of other microorganisms by their contrariety or different non toxic activity. Basically living microorganism, bio insecticide like Bacillus thuringiensis are used as microbial biopesticide. Microbial biopesticide contains bacteria, viruses, protozoans, fungi etc. Generally bacteria are used as instructor of weeds, plant diseases and insects. Pest is inhibit the manner of root growth, giving toxins, out conflicting and harming pathogens.

The bacterial biopesticides are pseudomonas syringae, that protect bacterial strain or Bt (Bacillus thuringiensis) which targets insects larvae. During bacterial sporulation, produces d-endotoxin. To enhanced biopesticides there are used Pseudomonades, including P. fluorescence, P. Syringae, and P. aeruginosa.

BT protein are produced by Bacillus thuringiensis which is spouralated. Spores and protein crystal are involved into the By. Cyt and cry protein also involved into it. In vegetables Bacillus thuringiensis (By) are used to protect insects such as army worm, some types of white fly, velvet bean caterpillar and moth. Inhibiting insect pests of agriculture, mosquito species used different trade product of Bacillus thuringiensis (3).Killing some insects and other harmful fungi, there are used fungal biopesticides. They yield toxin like bacteria that competed the harmful pathogens. They neutralized the insects or pathogens of the plant. Trichoderma harzianum is one type of fungicide which protect the plant from the parasites named Pythium, Fusarium, and *Rhizoctonia*. To protect from the insect there are used some fungal species such as *Verticillium lecani, Nomuraea rileyi* and *Paecilomyces fumosoroseus*(Alizadeh, A et al, 2012 , Perinotto, W et al, 2007). Metarhizium anisopliae and Beauveria bassiana have the molecular techniques by which it allow for the monitorization and characterization of fungi. Colorado Potato beetle were determined to using *Beauveria bassiana* (Mannino, M et al .2012). *M anisopliae* produce a toxin named Destruxins having two virulence properties attacked and destroying the insects and attacked the ticks by a strategy of integument breakdown.

Nematodes are colourless, round shaped parasites. The microscopic worms of the plant cause destruction of crops. Though some specific plants that have essential advantages like root weevils and cutworms. Nematodes are used as biopesticides such as steinernema sp. Heterorhabditis sp. who attack the host organisms as nosogenic kid are widely used. Generally Nematodes are use for protect the plant from insects so that we called that Nematodes are the types of insecticides. Even there are some common entomogenous

nematodes like S.carpocapsae, Heterorhabditis megidis, Steinernema scapterisci, H.bacteriophora, S.riobrave, S.feltiae etc(Hiroshi, A et al ,2022).

Protozoans are single celled eukaryotic microorganisms which lived in both soil and water. Most Protozoans are parasites. They compliance on bacteria while other parasite grow on organic decay. Basically Vairimorpha and Nosema killed lepidopteran and orthopteran. Microsporidia are obligated intracellular parasites(Valles, S et al, 2002).

This virus biopesticides are very important and strong pesticide including Baculoviridae family. This biopesticides have essential advantages for destruction or inhibition of caterpillar pests. Nucleopolyhedro virus (NPVs) and Granulovirus (GVs) are involved into the Baculoviridae family. These viruses are expensive, having less damage, they are compatible for crops. A few species of viruses infected the pests and lepidoptera larvae. Some examples of viral biopesticides are neuclear polyhedrosis virus from corn earworm Helicoverpa sp. and granulosis virus from codling moth of Cydia pomonella. The soybean velvet bean caterpillar controlled by Autographa gemmatalis. The first viral biopesticide are discovered is the Heliothis nuclear polyhedrosis virus (NPV).

Biopesticides as an alternative to synthetic pesticides

Due to the drawbacks of synthetic pesticides, an alternative means of pest control is being encouraged, which is the use of biopesticides (Sepand, M et al ,2020). Biopesticides are effective and safer means of controlling pests, they have a mild effect on the environment compared to their synthetic counterpart, and they are specific in their target, hence preventing bioaccumulation (Sepand, M et al ,2020). Biopesticides are made from natural substances, such as plants, microbes, and nanoparticles of biological origin, thus, making them a sustainable means of pest control (Mostafalou, S, et al 2013).

Future propects of microbial biopesticides:- Persistent organic pollutants were increased the multiplier system. It conducted humans immune system to activated. Due to less expenditure genetically modified crops are used to overcome their problems through RNA interference (RNAi). For cultivation India has the capability to used biopesticide's like microbes.

Biopesticides are attractive through microbial inoculants. Their functions are nitrogen fixation, sulphate, zinc, phosphate which generates the growth of plant by antibiosis. This review discusses the multiple activities of single organisms such as nitrogen fixation, sulfate, phosphate and zinc solubilization through acid and enzyme production. Microbial biopesticides improve the crop healthy and safe. Although biopesticides include a wide range of living organisms, products of their metabolism, and compounds of plant origin, they have completely different characteristics and activities in specific ecosystems. As India totally based on farming country then the procedure of using microbes as biopesticide are developed or incorporated to our country.

Discussion about Microbial Biopesticide's:- Future prosperity of microbial consortia developed to cultivated modified crops through improve of artificial biological tools. The high throughput method like Metaproteomics and Metametabolomics are used to study the microbial ecosystem as well as single cell analysis. In cultivation, there avoid chemicals and used Microbial inoculants. They can remoed from human(Mishra, J et al ,2013). The durability of microbes diverse perfectly into the inoculated seeds. The uses of Microbial Biopesticide's as an undivided aspect of agricultural process,that rapidly sweeping in worldwide. The future expectancy of Microbial inoculants of biopesticide's are pledge to offer many advantages over traditional insecticides or pesticides. The advantages of low pollution, motivated to these Microbial products should be used parallel to harmful chemical pesticides. Easy loans, cheapest investment and locally startups should be launched for financial strength or for marketing the products(Kumar, J et al,2021). If we noticed that about production of biopesticide's then should be seen to having many indian manufacturing companies to produce biopesticide's only single microbial strain. Technological breakthroughs in this segment are urgently needed. In future our agro-eco systems are make sustainable for improved food or food security by Microbial biopesticide's (Hezakiel, H. E., 2023). In future, the research on microbial biopesticide's will provide good, safe, feasible and accessible plant protection.

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