BIOPESTICIDES: ECOFRIENDLY PEST MANAGEMENT

Abstract

In terms of demographics, agriculture is the largest economic sector in India. However, current farming practices are neither economically nor environmentally viable. The pests become a significant problem for both the quality and quantity of fruit and vegetable output. A variety of pests reduce agricultural output. To control them, farmers traditionally used chemical insecticides in varied quantities. Synthetic pesticides shouldn't be used recklessly because they reduce the numbers of natural foes, because environmental contamination, increase insect resistance, and—most importantly—have negative impacts on organisms that aren't their intended targets. In order to control a variety of agricultural pests, biopesticides are organic, naturally occurring compounds that are sprayed to plants in forests, gardens, farms, etc. Botanical pesticides are increasingly acknowledged as an essential component of IPM techniques in all crops because of their efficiency against insect pests. They typically require very low doses to be effective, and they frequently break down quickly, leading to lower exposures and thus avoiding the pollution problems. Additionally, they are made to target a single pest or, in some cases, a limited group of target species.

Keywords: Biopesticides, Microbial pesticides, Plant incorporated protectants, Biochemical pesticides, Integrated pest management

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I. INTRODUCTION

The socioeconomic fabric of India is significantly influenced by agriculture. About 70% of people rely on agriculture for their living. Insecticides, fungicides, and herbicides are frequently used in agriculture to manage pests. However, insecticides make up the majority of pesticides used in India. India uses under 1% of the insecticides produced worldwide. India utilized more than 58160 tons of insecticides in 2018. When a BHC production facility was built close to Calcutta in 1952, India started producing pesticides. India is currently the second-largest producer of pesticides in Asia, behind China, and ranks 12th globally. India's production of technical grade pesticides rose substantially throughout the years, from 5,000 metric tons in 1958 to 102,240 metric tons in 1998. The demand for pesticides in 1996-1997 was projected to be about Rs. 22 billion (USD 0.5 billion), or 2% of the global market. For instance, some chemicals produce pleasing results but have negative long-term repercussions. These toxics build up in the crop, which later has a negative impact on the human population. Chemical pesticides have an indirect or direct impact on the environment and non-target creatures. The majority of chemical pesticides are not biodegradable and have harmful effects on people. Additionally, they spread infections from livestock to humans, leading to major health issues. As a result, environmentally friendly pesticides are required. A need and demand for pest-management systems that maximize naturally occurring suppression mechanisms and employ non-pesticide control treatments has emerged as a result of a better understanding of the negative effects of pesticide use in relation to both the environment and the control of the target species itself. There is considerable proof that the plant kingdom has a vast repository of chemicals that plants produce and utilize to protect themselves against attack by fungi and viruses. A wide range of allelochemicals that plants make are not directly connected to the main metabolic processes of growth and development. Plant secondary metabolites function as antifeedants, oviposition inhibitors, and growth inhibitors, and they play a critical defensive role against insects. In addition to acting as insecticides, botanicals also serve as antifeedants, growth regulators, and oviposition inhibitors. An environmentally friendly and practical answer to pest issues is provided by biopesticides made from plant extracts that are particular to a target pest. By providing various advantages over insecticides, such as host specificity, non-toxicity to mammals and beneficial creatures, reduced susceptibility to insect resistance, easy biodegradability, and lower cost, botanicals become a promising strategy against insect pests. The benefits that come with these products are what fuel interest in biopesticides. The use of biopesticides has significant promise for improving agricultural practices and public health initiatives.

II. TYPES OF BIOPESTICIDES

There are different types of biopesticides that have been developed from various sources.

1. Microbial pesticides
2. Plant-incorporated protectants
3. Biochemical pesticides

- **Microbial pesticides:** Microbial pesticides act as hired guards who keep crops safe. They are microscopic creatures like viruses, bacteria, or fungi that feed on crop-damaging pests. The bacterium *Bacillus thuringiensis* is the most prevalent (Bt).

When pests like caterpillars, moths, and worms consume the crystal protein produced by this bacterium, it is lethal to them.

The fact that these crystal proteins, also known as "Cry poisons," are inactive until they are ingested by the insect is what makes this protein so effective as a pesticide. The protein binds to receptors in the insect's gut after it has been consumed by the insect. It creates a hole in their stomachs once it is coupled to these receptors, effectively killing the target. But don't worry, this protein is safe for people. Since we lack the gut receptors that this protein attaches to, it does not prove poisonous to humans. As a result, it is an inert substance outside of pests that have those receptors.

- **Plant-incorporated protectants:** Plants that have undergone genetic modification create substances called plant-incorporated protectants (PIPs) that are poisonous to pests. For instance, such plants are given the gene for the poisonous protein produced by Bt so that they will likewise manufacture the same protein. Because of this, the plant is poisonous to bugs that attempt to eat it. Again, the absence of compatible receptors shields people from any potential danger from such plants.

- **Biochemical pesticides:** Although the majority of biochemical pesticides have been successfully employed, one issue with this class of biopesticides is that not enough scientific research has been done to determine their toxicity or safety. Many of them do include active substances that, in large doses, might be dangerous.

III. ACTION OF BIOPESTICIDES

1. **Microbial insecticides:** Entomopathogenic fungi, which can operate as pathogenic parasites of insects (and other invertebrates like nematodes), are one type of microbial pesticide. These fungi mainly belong to the divisions Ascomycetes and Zygomycetes. Entomopathogenic fungi can produce fungal poisons in addition to their parasitic behaviour. Insect pests are often controlled by entomopathogenic bacteria like *Bacillus thuringiensis* (BT), which enters their digestive systems. Species-specific viruses that cause disease in insects The codling moth, C. pomonella, a significant pest of fruit plants, is specifically targeted by the *Cydia pomonella* granulovirus, which kills the insect in the larval stage. While not microorganisms, beneficial nematodes (such as Steinernema) are occasionally categorised as such and are utilised in the biological control of insect pests.

2. **Plant-incorporated protectants (PIPs):** A type of biological pesticide known as "plant-incorporated protectants" (PIPs) involves the insertion of foreign DNA into crop genetic material (GM crops). Through the application of genetic engineering, the toxin genes from the *Bacillus thuringiensis* can be directly inserted into plants, giving these plants resistance to Lepidopteran insect pests like caterpillars and beetles. A developing technology called RNA interference (RNAi) allows for the targeting of resistant insects like potato beetles by interfering with the genes that give resistance to insecticides.

3. **Bio-derived (biochemical) insecticides:** Insecticides that are "bio-derived" (or "biochemical") are naturally occurring substances that are primarily created by plants to protect themselves from predators, but they can also contain microbial extracts that kill insects or trigger plant defence mechanisms. Insect pheromones can be used to attract pest

insects to traps or to interfere with the mating process. A bioinsecticide called Spinosad is created by fermenting naturally existing bacteria and is based on natural metabolites (*Saccharpolyspora spinosa*). Chitosan is a polysaccharide generated from fungi or crustacean shells, capable of establishing systemic resistance against insect pests. Surfactin is a biodegradable lipopeptide biosurfactant developed from Bacillus species that is a mosquitocide. Other plant extracts, such as nicotine (isolated from tobacco), pyrethrins (isolated from Chrysanthemum plants), or ryanoids (isolated from, for example, Ryania speciosa), have neural insecticidal activity, causing hyperstimulation—or paralysis—and death. Plant extracts such as garlic extracts or canola oil can repel insects or act as antifeedants.

IV. DISADVANTAGES

In fact, biopesticides were in use long before chemical pesticides were created, therefore they are not a recent discovery. Now, you might be thinking why anyone would bother developing chemical pesticides in the first place if biopesticides are so much superior. There are some aspects that cannot be completely managed because a biopesticide is a natural approach of controlling pests. The microorganisms may be difficult to handle, have a complicated life cycle, or take a long time to kill the intended pest. Biopesticides cost more than synthetic pesticides because of storage and handling restrictions. Researching novel approaches to enhance biopesticides requires a sizable expenditure, and given the likelihood of poor financial benefits and profits, businesses are hesitant to make significant investments in this field. Additionally, because biopesticides are biological agents, there are regulatory restrictions associated with their manufacturing and distribution.

V. CONCLUSION

Due to the world's expanding population, food security is crucial. A steady and sustainable food supply is essential for human welfare as well as for national and international economies. Future threats to food security will only increase as the population continues to increase. Pesticides that are safe for the environment and non-toxic are essential for sustainable farming and maximising soil fertility. As a result, the need for biopesticides appears to be increasing with time. Significant advancements in biopesticides, which are essential for sustainable agriculture, will definitely follow. One strategy to make biopesticides more cost-effective is to optimise manufacturing through reduced costs and higher yields. The need for biopesticides has risen as interest in chemical-free, organic farming increases. In order to gain a deeper scientific knowledge of these tried-and-true practises, efforts are being focused on conducting additional study on traditional biopesticide application techniques. Currently, research is concentrated on enhancing their production, commercialization, delivery, and farmer awareness. Overall, biopesticides are eco-friendly and effective against a variety of pests, including insects, rodents, and microbes. They are organic, safe, and biodegradable (they disappear from the soil and environment). Therefore, using biopesticides is a great way to combat both environmental contamination and insect control.

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