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Current status and impact of bio-pesticides on agricultural commodities

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Abstract
The pests are killed by biopesticides, which do not damage plants and also do not have any negative health impacts on people. As compared to synthetic insecticides, they are more effective, biodegradable, and ecofriendly. The decreased environmental effect of biopesticides is one of their biggest benefits. Aquatic ecosystems are protected by biodegradable biopesticides, which reduce chemical discharge into water bodies. Microbial pesticides are made up of viruses, fungi, and bacteria that naturally insect pests, such as Bacillus thuringiensis. Compounds like pyrethrins (found in chrysanthemums) and neem oil are examples of botanical pesticides, which are made from plants. However, some biopesticides contain compounds called pheromones that prevent pests from mating and reproducing. The environmental impact of biopesticides is lower than that of synthetic pesticides. As they decompose rapidly and don't linger in the environment, they lessen the pollution that synthetic pesticides are known to cause. Biopesticides are less harmful to organisms that are not their intended target. In order to minimize harm to beneficial insects, pollinators, and other species, many biopesticides are designed to particularly target pests. Crop quality can be raised through the use of biopesticides. Biopesticides can improve crop characteristics including colour, size, and nutritional value by fostering a healthier growth environment. Farmers eventually gain from increased yields and better crop quality brought about by effective insect control. The development of pest resistance to chemical pesticides can be postponed or avoided with the use of biopesticides. Programs for integrated pest management (IPM), which encourage a comprehensive approach to pest control, can successfully use biopesticides. Biopesticides support sustainable agriculture practices. With forecasts showing a notable rise in market value and a move towards biopesticides as substitutes for chemical pesticides, the market for biopesticides is expanding quickly due to rising demand for residue free produce and sustainable agriculture.

Keywords: Pests, pesticides, biopesticides, agricultural commodities, IPM

Introduction

Pest & Pesticides

Plant pests are organisms that damage plants, preventing them from growing and reducing agricultural productivity. These pests include insects, mites, nematodes, and other creatures that feed on plant tissues, spread disease, or compete with plants for resources. Pest damage can range from minor cosmetic issues to major production reductions, which eventually affect food security and economic stability. Insects, mites, rats, beetles, aphids, whiteflies, thrips, and caterpillars are examples of plant pests. These pests damage plants by a range of feeding strategies, such as sucking, chewing, and burrowing. Spider mites can result in reduced growth, webbing, and discolored leaves. Small roundworms can damage plant roots, making it more difficult for the plants to take up nutrients and water. Depending on the crop and circumstance, rodents, gastropods, and even some fungi may also be regarded as plant pests.

Pests damage fruits, leaves, stems, and roots, which lowers crop yields. Certain pests carry bacteria, fungus, and viruses that cause plant illnesses. Pest-weakened plants might not grow to their full potential and might even have stunted growth. Pests can lower the value of plants by making them less marketable and appealing.

Costs associated with pest control, such as manpower and insecticides, can drastically raise

production costs and lower farmer earnings. By using techniques like crop rotation, proper fertilization, and adequate sanitation, pest populations can be reduced and infestations can be prevented. Pest populations can be successfully managed by using natural predators and parasites, such as parasitic wasps and ladybugs. Synthetic pesticides can offer immediate relief, but in order to protect beneficial insects and the ecosystem, they should be handled carefully and wisely. Integrated Pest Management (IPM) reduces the need for synthetic pesticides while minimizing pest damage by combining multiple management techniques.

Environmental Impact of Pesticides

The ecosystem and other living things can be harmed by trolling plant pests. They may destroy useful insects, taint water and soil, and disrupt ecosystems. Furthermore, oxidative stress caused by certain herbicides might impair a plant's growth and photosynthetic efficiency. Because pesticides damage beneficial insects, pollinators like bees, and even birds, they can alter food chains and environmental balance.

The U.S. Environmental Protection Agency states that pesticides can contaminate water and soil, putting human and animal health at risk. Pests may become resistant to pesticides over time, decreasing their effectiveness and necessitating the use of more potent or novel compounds. Plants are susceptible to oxidative stress from several pesticides, which damages their cells and reduces their ability to grow and perform photosynthetic functions. The general health and stability of ecosystems are impacted by pesticides, which also lessen the diversity of plant and animal life.

Biopesticides

Biopesticides are pest control chemicals derived from natural sources such microbes, plants, minerals, and animals that can be used in place of synthetic pesticides. These include naturally occurring pesticides, pest-controlling microorganisms, and pesticidal substances produced by genetically modified plants. Biopesticides are used in agriculture to control diseases, pests, and weeds. In comparison to conventional synthetic insecticides, they offer a more environmentally friendly way to control pests. Plant-incorporated protectants (PIPs), which are substances made by plants with pesticidal qualities, biochemical pesticides, which are substances found naturally, and microbial pesticides, which contain microorganisms such as bacteria, viruses, and fungi.

Advantages of Biopesticides

Biopesticides are often less harmful to people and other non-target organisms than synthetic pesticides, and their application can slow the emergence of insect resistance. They support ecologically friendly pest management techniques and are an essential part of sustainable agriculture. Due to growing environmental consciousness and the demand for sustainable farming methods, the worldwide biopesticide industry is expanding significantly. Biochemical pesticides manage pests by using naturally occurring materials, such as plant extracts or insect pheromones. PIPs are plants that have undergone genetic modification to produce pesticidal proteins in their tissues. *Bacillus thuringiensis* (Bt) is a bacterium used to control certain insect infestations. Fungi known as Trichoderma species are used as biofungicides to control plant diseases. The neem tree provides neem oil, a botanical insecticide that comprises compounds with fungicidal and insecticidal properties. Methoprene is a growth regulator that disrupts the life cycles of insects.

Biopesticides are gaining market share worldwide at a compound annual growth rate of about 10% to 15%. Even though they currently only account for 5% of the global plant protection market, their use is steadily expanding as a result of customer demands for more safe and residue-free food. Microbial biopesticides, especially those derived from *Bacillus thuringiensis*, dominate the market. With an estimated global value of $3 billion and an annual growth rate of 10-15%, the biopesticide business is growing. India has increased its use of biopesticides, consuming 8847 and 8645 metric tons in 2019-20 and 2020-2021, respectively.

The market for biopesticides is expanding due to rising demand for organic food and produce free of residue. The market is also influenced by botanical biopesticides, such as those made from pyrethrins and neem. The Insecticides Act of 1968 registers and regulates biopesticides in India, with specific types of biopesticides being registered. Businesses that are actively participating in the biopesticide sector include BASF and Bayer.

Biopesticides can help crops by reducing insect damage, potentially improving crop quality and yield, and encouraging more ecologically friendly agricultural practices. They have a number of disadvantages over synthetic pesticides, such as a slower rate of control and a shorter permanence.

Impact of Biopesticides

Because they mostly target the targeted pest without endangering beneficial insects or other organisms, biopesticides are frequently quite specific. Biopesticides can promote healthier plants and possibly improve crop quality, including color, size, and nutritional value, by minimizing pest damage. According to studies, biopesticides may have a beneficial effect on plant growth and raise yields. Sustainable agriculture is aided by biopesticides, which provide a greener substitute for synthetic pesticides. Certain biopesticides can cause plant defenses or stop the growth of infections, offering a long-term solution to disease control. A number of biopesticides can boost soil microbial activity and nutrient availability to further encourage plant development. Biopesticides offer several benefits and frequently have a lower environmental impact than synthetic pesticides. They are less likely to harm creatures that are not their intended targets and contaminate soil and water supplies since they are less poisonous. Furthermore, biopesticides can be included into Integrated Pest Management (IPM) systems to aid in the more effective management of pest resistance. Since certain specific biopesticides may have unanticipated effects, including changing the soil microbiota or increasing the resistance of the targeted species, additional research is required.

Environmental Benefits of Biopesticides

Biopesticides often have lower toxicity levels than synthetic chemicals because they originate from natural sources, which lowers the risk of environmental contamination. Over time, the likelihood of soil and water pollution is reduced because of their propensity to decompose more quickly in

the environment. Biopesticides are often more selective since they target specific pests with less damage to beneficial insects, pollinators, and other organisms. They provide a thorough approach to pest management that lessens adverse environmental consequences and is simple to include into IPM practices. The application of biopesticides can promote more sustainable farming practices by promoting ecological balance and long-term soil fertility. However, some biopesticides can harm beneficial insects and parasites, therefore their application and selection must be carefully considered to minimize negative impacts.

Impact on Agricultural Commodities

Biopesticides have a major and mainly favorable effect on agricultural commodities. They improve crop quality, reduce the need for hazardous chemicals, and support a more sustainable agricultural system by offering a natural and environmentally benign alternative to synthetic pesticides. By creating a more healthy growth environment, biopesticides can improve crop attributes including color, size, and nutritional value. The usage of synthetic pesticides and herbicides, which can harm the environment, human health, and non-target animals, is decreased by biopesticides. By reducing the use of chemical pesticides, biopesticides preserve biodiversity, save beneficial organisms, and improve the overall health of the agricultural ecosystem. By helping to control diseases and pests, biopesticides can increase agricultural yields and reduce production losses. On occasion, biopesticides may end up being more cost-effective than synthetic pesticides in the long run, particularly when considering the harm that synthetic pesticides cause to the environment and human health. The International Journal of Advanced Biochemistry Research claims that biopesticides improve the food system, reduce environmental harm, and boost biodiversity. Biopesticides can help prevent the development of pesticide resistance, a significant problem with synthetic pesticides. Compared to synthetic pesticides, biopesticides may require more frequent treatments and have a slower rate of control. The efficiency of biopesticides may be diminished by their increased susceptibility to adverse environmental conditions, including as temperature and humidity. For farmers to successfully apply biopesticides, they might require more education and expertise.

Conclusion

In conclusion, the use of biopesticides in agriculture has a number of benefits, including improved crop quality, a more sustainable food system, and less negative environmental impact. Although applying biopesticides can be challenging at times, they typically improve agricultural output, particularly when used in conjunction with more sustainable farming practices.

References

1. Mawcha M, Malinga M, Muir J, Ge B, Ndolo R. Recent advances in biopesticide research and development with a focus on microbials. F1000Res. 2025 Mar 11; PMC8230470.
2. Senthil-Nathan S. Review of biopesticides and their mode of action against insect pests. In: Biopesticides in Sustainable Agriculture. Springer; 2015. ISBN: 978-81-322-2056-5.
3. Gupta S, Dikshit AK. Biopesticides: an eco-friendly approach for pest control. J Biopestic. 2010;3(1 Special Issue):186-188.
4. Seiber JN, Coats J, Duke SO, Gross AD. Biopesticides: state of the art and future opportunities. ACS Symposium Series; Publication pending.
5. Mawcha M, Malinga M, Muir J, Ge B, Ndolo R. Recent advances in biopesticide research and development with a focus on microbials. [cited 2025 Jul 9]. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC8230470/
6. Das S, Adak A, Bhattacharyya PN. Biopesticides: diversity, applications and mechanisms of action - a review. Front Microbiol. 2023 Feb 16;14:1040901. DOI: 10.3389/fmicb.2023.1040901
7. Mankind Agritech. Importance of biopesticide in modern agriculture. [cited 2025 Jul 9]. Available from: https://mankindag.com/importance-of-biopesticide-in-modern-agriculture/
8. Upadhyay H, Mirza A, Singh J. Impact of biopesticides in sustainable agriculture. In: Plant Microbiome and Sustainable Agriculture. Springer; 2020. p.281-296. DOI: 10.1007/978-981-15-3208-5_11
9. Santhosh RS, Meera MS, Krishnan S, Lekshmi RG, Nisha AR. Biopesticides and bioinoculants: a novel strategy for integrated pest and nutrient management. CABI Agric Biosci. 2024;5:269. DOI: 10.1186/s43170-024-00269-4
10. Prasad R, Gill S, Pal S. Role of biopesticides in sustainable food systems: an agroecological perspective. Front Sustain Food Syst. 2021 Jun 11;5:619058. DOI: 10.3389/fsufs.2021.619058