

Major Types of Biofertilizers

1. Nitrogen-Fixing Biofertilizers:

These microorganisms convert atmospheric nitrogen into forms usable by plants. Important examples include Rhizobium for leguminous crops such as pea, gram, and lentil; Azotobacter for non-leguminous crops like wheat and maize; Azospirillum for cereals and grasses; and Blue Green Algae (BGA) commonly used in paddy fields.

2. Phosphate Solubilizing Microorganisms (PSM):

Bacteria such as Bacillus and Pseudomonas convert insoluble phosphorus present in soil into soluble forms that plants can absorb.

3. Potassium Solubilizing Bacteria (KSB):

These microbes release potassium from soil minerals, improving potassium availability to crops.

4. Mycorrhiza (VAM/AM Fungi):

These fungi form symbiotic associations with plant roots and enhance the uptake of phosphorus, zinc, and water, especially under dry conditions.

Forms Available:

Biofertilizers are available in powder, liquid, and granular formulations for easy and effective field application.

3. BENEFITS & APPLICATION OF BIOFERTILIZERS

Benefits of Biofertilizers

Biofertilizers play an important role in improving soil health and crop productivity in a sustainable manner. They enhance soil fertility by increasing microbial activity, which helps in the natural cycling of nutrients. These microorganisms improve soil structure, increase organic matter decomposition, and promote better aeration and water-holding capacity. Biofertilizers increase nutrient uptake efficiency by converting unavailable forms of nutrients into plant-available forms, thereby improving the overall nutritional status of crops.

They also stimulate root growth and plant vigor by producing growth-promoting substances such as auxins, gibberellins, and vitamins. As a result, crops develop stronger root systems and show improved resistance to drought and other environmental stresses. The use of biofertilizers reduces the requirement of chemical fertilizers, leading to lower production costs and minimizing environmental pollution. Regular use of biofertilizers contributes to sustainable yield improvement without degrading soil quality.

Methods of Application

1. Seed Treatment:

Seeds are coated with a slurry of biofertilizer mixed with water or jaggery solution before sowing. This ensures early colonization of beneficial microbes on seed surfaces.

2. Seedling Root Dip:

Seedlings, especially of rice and vegetables, are dipped in biofertilizer solution before transplanting to enhance root establishment and early growth.

3. Soil Application:

Biofertilizers are mixed with well-decomposed compost or farmyard manure (FYM) and applied to the soil during field preparation.

Recommended Dosage (General)

- Powder formulation: 200–400 g per acre
- Liquid formulation: 250–500 ml per acre

(Always follow product label instructions.)

Storage and Handling

Biofertilizers should be stored in a cool and shaded place, protected from direct sunlight and heat. They must be used before the expiry date and should not be mixed with chemical pesticides or fungicides to maintain microbial viability.

INTRODUCTION

Modern agriculture is facing serious challenges such as declining soil fertility, increasing pest resistance, environmental pollution, and health hazards caused by the excessive and continuous use of chemical fertilizers and pesticides. These problems not only reduce long-term crop productivity but also disturb soil microbial balance and contaminate water resources. To overcome these limitations and promote sustainable farming, eco-friendly alternatives such as biofertilizers and biopesticides are gaining increasing importance in modern agricultural practices.

Biofertilizers are preparations containing living or dormant microorganisms that enhance the availability of essential nutrients to plants through natural biological processes such as nitrogen fixation, phosphorus solubilization, and production of growth-promoting substances. These microorganisms improve soil fertility, stimulate root growth, and increase nutrient uptake efficiency, resulting in healthier plant development.

Biopesticides, on the other hand, are biological agents derived from microorganisms, plants, or other natural sources that are used to control insect pests, plant diseases, and weeds. They act through specific mechanisms such as infection of pests, inhibition of pathogen growth, or repellence, without causing harm to beneficial organisms or the environment.

Together, biofertilizers and biopesticides support sustainable agriculture by improving crop productivity, maintaining ecological balance, and protecting soil, water, and human health, thereby ensuring long-term agricultural sustainability and food security.

Importance in Sustainable Farming

- Reduce dependence on chemical fertilizers and pesticides
- Improve soil health and biodiversity
- Enhance crop yield and quality naturally
- Safe for farmers, consumers, and environment



Source: <https://byjus.com>

2. BIOFERTILIZERS — DEFINITION & TYPES

Definition of Biofertilizers

Biofertilizers are products that contain beneficial living microorganisms which, when applied to seeds, soil, or plant surfaces, promote plant growth by increasing the availability of essential nutrients. These microorganisms improve soil biological activity, stimulate root development, and enhance nutrient uptake efficiency through natural processes such as nitrogen fixation, phosphorus solubilization, and production of plant growth-promoting substances. Unlike chemical fertilizers, biofertilizers do not directly supply nutrients but make the existing nutrients in soil more accessible to plants in an eco-friendly manner.

एग्रीकल्चर फॉरम टेक्निकल एजुकेशन ऑफ़ फार्मिंग सोसायटी

कोटा, राजस्थान



Biofertilizers & Biopesticides

संकलन

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4. BIOPESTICIDES — DEFINITION & TYPES

Definition of Biopesticides

Biopesticides are pest control agents obtained from natural sources such as microorganisms, plants, or certain naturally occurring minerals. They are used to manage insect pests, plant pathogens, and other harmful organisms in an environmentally safe manner. Unlike chemical pesticides, biopesticides are generally target-specific and do not harm beneficial insects, animals, or humans. They degrade quickly in the environment and leave minimal or no toxic residues on crops, making them suitable for sustainable and organic farming systems.



Types of Biopesticides

1. Microbial Biopesticides:

These contain living microorganisms that infect or suppress pests and diseases.

- *Bacillus thuringiensis* (Bt) produces toxins that kill caterpillar pests.
- *Beauveria bassiana* and *Metarhizium anisopliae* are fungal biopesticides that infect and kill insect pests, including soil-dwelling insects.
- *Trichoderma* species are widely used to control soil-borne fungal diseases by competing with plant pathogens and enhancing plant resistance.

2. Botanical Biopesticides:

These are plant-based products extracted from herbs and trees. Neem-based formulations containing azadirachtin are most common and act as repellents, growth inhibitors, and feeding deterrents. Extracts of garlic, chili, and tobacco are also used for controlling soft-bodied insects.

3. Viral Biopesticides:

Viruses such as Nuclear Polyhedrosis Virus (NPV) are highly specific to certain insect pests like *Helicoverpa* and *Spodoptera*, causing disease and death in target insects without affecting other organisms.

Target Pests

Biopesticides are effective against insects, fungal diseases, nematodes, and mites, making them valuable tools in integrated pest management (IPM) programs.

5. BENEFITS & USE OF BIOPESTICIDES

Advantages of Biopesticides

Biopesticides offer several advantages over conventional chemical pesticides and play an important role in sustainable crop protection. They are safe to humans, animals, and farm workers due to their low toxicity and natural origin. Biopesticides do not leave harmful residues on crops, making agricultural produce safer for consumers and suitable for export and organic markets. They help in conserving beneficial insects such as pollinators and natural enemies of pests, thereby maintaining ecological balance.

Another major advantage is the low risk of pest resistance development, as biopesticides often have complex modes of action compared to synthetic chemicals. They are highly compatible with Integrated Pest Management (IPM) programs and can be combined with cultural, mechanical, and biological control methods. Being biodegradable, biopesticides do not accumulate in soil or water and are environmentally friendly.

Application Methods

1. Foliar Spray:

This is the most common method used to control insect pests and foliar diseases. Proper coverage of plant surfaces is essential for effective control.

2. Soil Treatment:

Used to manage soil-borne pests, nematodes, and fungal pathogens. Biopesticides are applied directly to soil or mixed with compost.

3. Seed Treatment:

Seeds are treated before sowing to protect seedlings from early-stage diseases and pests.

Precautions

Biopesticides should be applied during early morning or evening hours to avoid high temperatures and direct sunlight, which may reduce microbial effectiveness. They should not be mixed with chemical pesticides, and clean water must be used for preparation. Recommended doses must be followed, and containers should be shaken well before use.

Shelf Life

The shelf life of most biopesticides ranges from 6 to 12 months depending on the formulation. Always check the expiry date before application.

6. ROLE IN INTEGRATED & CLIMATE-SMART AGRICULTURE

Role in Integrated Nutrient Management (INM)

Biofertilizers play a key role in Integrated Nutrient Management by complementing both chemical and organic fertilizers. They improve nutrient use efficiency by converting unavailable nutrients into plant-available forms and enhancing root absorption capacity. Regular use of biofertilizers can reduce the requirement of chemical fertilizers by about 20–30%, thereby lowering production costs and minimizing soil and water pollution. They also improve long-term soil fertility by maintaining microbial activity and organic matter decomposition.

Role in Integrated Pest Management (IPM)

Biopesticides are essential components of Integrated Pest Management strategies. They help in early-stage pest control, preventing pest population build-up and reducing crop damage. Their use leads to reduced dependence on chemical pesticides and fewer spray applications. Biopesticides provide sustainable pest suppression by preserving natural enemies and preventing pest resurgence, thus maintaining ecological balance in agro-ecosystems.

Contribution to Climate-Smart Agriculture

Biofertilizers and biopesticides contribute significantly to climate-smart agriculture by reducing greenhouse gas emissions associated with chemical fertilizer and pesticide production. They improve soil carbon sequestration and maintain soil microbial diversity, which enhances soil resilience to climate stresses such as drought and flooding. These biological inputs also support organic and natural farming systems, promoting environmentally sustainable crop production.

Government Support in India

In India, the use of biofertilizers and biopesticides is promoted under various organic and natural farming schemes. Government provides subsidies for establishing bio-input production units and offers farmer training programs through Krishi Vigyan Kendras (KVKs) and agricultural extension agencies to encourage adoption of eco-friendly farming practices.

CONCLUSION

Biofertilizers and biopesticides are vital tools for achieving sustainable, profitable, and environmentally safe agriculture. By improving nutrient availability and controlling pests through natural biological processes, they help maintain soil fertility and ecological balance. Their use reduces dependence on chemical fertilizers and pesticides, lowers production costs, and minimizes environmental pollution. In addition, these biological inputs support healthy crop growth, enhance resilience to climate stress, and improve the quality and safety of agricultural produce. Widespread adoption of biofertilizers and biopesticides will play a crucial role in ensuring long-term agricultural sustainability, food security, and farmer livelihoods in the future.

"Healthy Soil + Biological Inputs = Sustainable Future"