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Biofertilizers: Importance, Applications and Implication in India

Supriya Patel[1,2], Pallavi Pandey[2], Kush Shrivastava[2*], Bikash Ranjan Prusty[2], Tripti Jain[2], Mohan Singh Thakur[2]

[1]Government M. H. College of Home Science and Science for Women, Autonomous, Jabalpur, M.P.

[2]Animal Biotechnology Centre, NDVSU, Jabalpur, M.P.

*Corresponding author e mail – kush_vet@yahoo.co.in

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Abstract

Biofertilizers, as an eco-friendly alternative, involve the use of beneficial microorganisms to enhance nutrient availability and improve soil fertility. Their importance lies in promoting plant growth, increasing crop yield, and maintaining sustainable agriculture. Different methods for application, such as seed treatment, soil application, liquid formulation, and foliar spray make their use practical and effective. Harnessing animal waste for the production of biofertilizers further supports nutrients recycling and waste management. In India, the implication of Biofertilizers is gaining significance due to increasing awareness and supportive government initiatives, contributing to improved soil health and long-term agricultural sustainability.

Keywords: Biofertilizers, Importance, Mass production, Harnessing Animal waste.

Introduction

The escalating global population, projected to exceed 10 billion by 2050, necessitates a 60% increase in food production to ensure food security. Historically, this demand has been met through the intensive use of synthetic chemical fertilizers and pesticides. Chemical fertilizers are manufactured in factories with known nutrients compositions such as nitrogen, phosphorous, potassium, sulfur and other elements. Past trends in conventional Indian agriculture, including monoculture without crop rotation, overuse of Inorganic fertilizers and Pesticides, have hindered the activity of naturally occurring microorganism. Onset of Green Revolution and the increasing use of Chemical fertilizers in agriculture achieved food self-sufficiency through hybrid seeds and high-yielding varieties, but the extensive application of chemical fertilizers also has negatively impacted soil health, making the environment uninhabitable for the essential microflora and microfauna responsible for maintaining soil

fertility and nutrient provision to plants and has also increased serious human disorders.

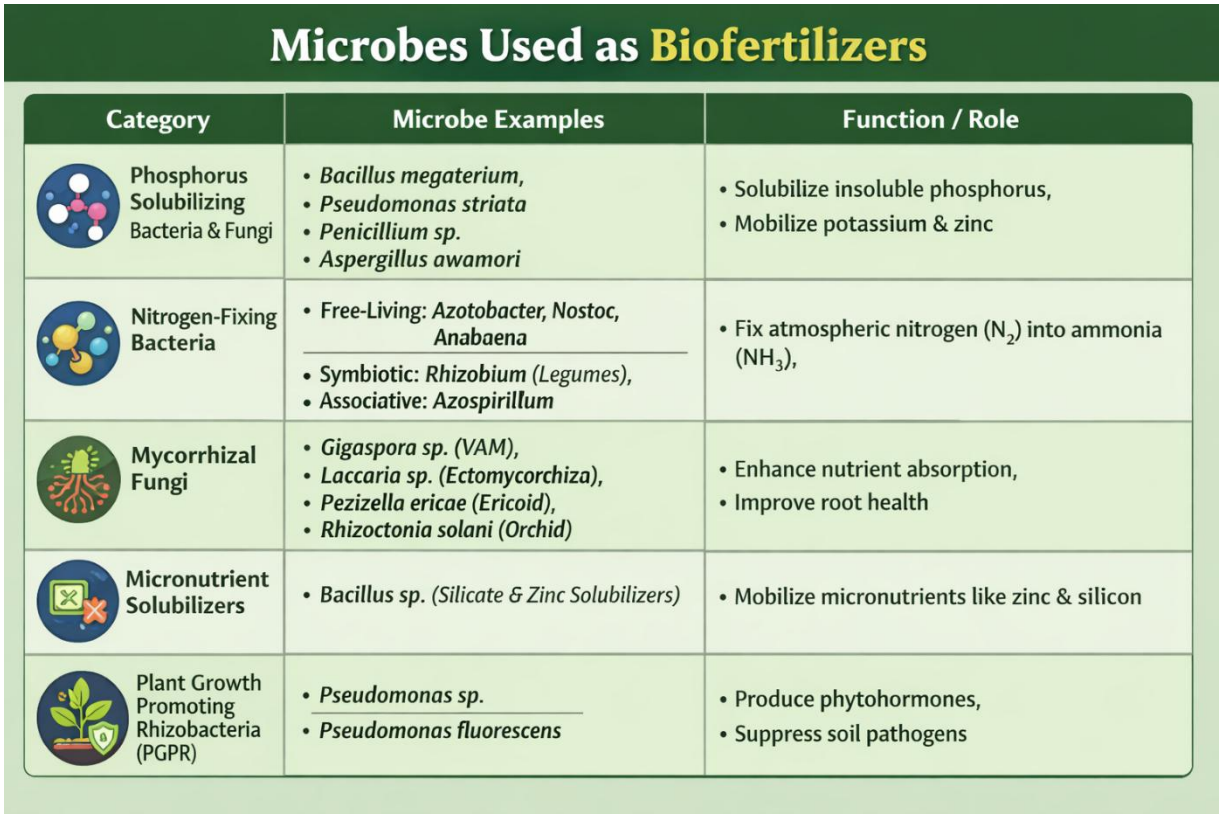
To address these environmental and economic crises and the threat to sustainable agriculture, there is an urgent need for low-cost, eco-friendly, productive fertilizers as alternatives which would work without disturbing the nature. Biofertilizers or Microbial Inoculants are natural fertilizers containing one or more species of microorganisms which have the ability to mobilize nutritionally important elements from non-usable to usable form through biological processes that could serve as a good substitute for Chemical fertilizers.

What are Biofertilizers?

Bio-fertilizers are live formulations of beneficial microorganisms like Bacteria, Fungi and Algae that are used to fertilize farmland and this process is called Biofertilization. They function in several ways, including fixing atmospheric nitrogen, solubilizing and mobilizing phosphorous, increasing organic carbon content, balanced C/N ratio and promoting plant growth. Gazette of India (2006) officially defined Biofertilizers are substance containing living microorganisms that are wrapped in carrier materials such as peat, lignite powder are agriculturally useful for nutrient management and to extend their shelf life. This product are promoted through Integrated Plant Nutrient System (IPNS), which combine various fertilization methods to sustain crop production and maintain soil productivity, health and diversity.

Importance of Biofertilizers

- Biofertilizers improves soil fertility by fixing atmospheric nitrogen.
- Though they do not show immediate results, but the results shown over time are spectacular.
- Solubilize insoluble phosphorous in the soil and mobilize nutrients such as potassium and zinc with the help of Phosphorous solubilizing bacteria.
- They help to enhance nutrient availability and promote root growth by producing plant growth substance (Phytohormones) like auxin, gibberellin, cytokinin by plant-growth-promoting rhizobacteria (PGPB) and antimetabolites
- They are cost effective and sustaining agricultural productivity and healthy environment.
- They help in increasing the crop yield by 10-40%.
- They can also protect plant from soil borne disease to certain degree.



Microbes Used as Biofertilizers

Category	Microbe Examples	Function / Role
Phosphorus Solubilizing Bacteria & Fungi	• *Bacillus megaterium*, • *Pseudomonas striata* • *Penicillium sp.* • *Aspergillus awamori*	• Solubilize insoluble phosphorus, • Mobilize potassium & zinc
Nitrogen-Fixing Bacteria	• Free-Living: *Azotobacter, Nostoc, Anabaena* • Symbiotic: *Rhizobium (Legumes)*, • Associative: *Azospirillum*	• Fix atmospheric nitrogen (N_2) into ammonia (NH_3),
Mycorrhizal Fungi	• *Gigaspora sp. (VAM)*, • *Laccaria sp. (Ectomycorchiza)*, • *Pezizella ericae (Ericoid)*, • *Rhizoctonia solani (Orchid)*	• Enhance nutrient absorption, • Improve root health
Micronutrient Solubilizers	• *Bacillus sp. (Silicate & Zinc Solubilizers)*	• Mobilize micronutrients like zinc & silicon
Plant Growth Promoting Rhizobacteria (PGPR)	• *Pseudomonas sp.* • *Pseudomonas fluorescens*	• Produce phytohormones, • Suppress soil pathogens

Mass Production of Biofertilizers

Stage 1: The production process focuses on culturing efficient strains of microorganisms prepared in suitable medium and mass produced in fermenter with proper aeration, temperature, growth conditions and without any undesired microbial contaminations.

Stage 2: Biofertilizers are formulated usually as carrier-based inoculants. Peat soil, lignite, vermiculite, charcoal, press mud, farmyard manure and soil mixture can be used as carrier material that should be non-toxic, sterile, inexpensive, good aeration, high moisture absorbent and retention capacity. The neutralized carrier material with calcium carbonate powder is best for Biofertilizers production. This process adjust pH of the carrier to a neutral range to ensure the survival and viability of inoculated beneficial microbes.

Stage 3: The microbial culture drawn from the fermenter is added to the sterilized carrier and mixed well by manual by wearing sterile gloves or by mechanical mixer then sealed at room temperature, ready for use.

Storage of Biofertilizer Packets

- The packet should be stored at cool and dry place away from the direct sunlight exposure.

- The population of inoculant in carrier inoculant packet may be determined at 15 days interval. There should be 10^9 viable cells / g of inoculant at the time of preparation.

Table 1. Methods of Application of Biofertilizers

Methods	Application
Seed Treatment	200 g of Biofertilizer is suspended in 300-4000 ml of water and mixed gently with 10 kg of seeds using an adhesive like gum acacia, jiggery solution etc. The seeds are then spread on a clean sheet/cloth under shade to dry and used immediately for sowing.
Seedling Root Dip	This method is used for transplanted crops. For Rice crop, a bed is made in the field and filled with water. Recommended Biofertilizers are mixed in this water and the roots of seedlings are dipped for 8-10 hours and transplanted.
Soil Treatment	4 kg each of the recommended Biofertilizers is mixed in 200 kg of compost and kept overnight. This mixture is incorporated in the soil at the time of sowing or planting.
Liquid Formulation	This can be applied through fertigation (1 L/ha) or by treating seeds (3-5 ml per kg).
Foliar Spray	Liquid bacterial inoculum can be diluted to spray directly onto plants for rapid nutrient uptake.

Harnessing Animal Waste for The Production of Biofertilizers

Animal waste, comprising manure, bedding materials and organic debris represents a massive and historically significant resources for the Biofertilizers production. With livestock populations generating over a billion metric tons of waste annually in regions like India, this biomass is essential for transitioning away from fossil fuel dependent agricultural inputs. As the richest source of organic carbon and indigenous microbes, animal dung from cows, buffaloes and poultry acts as the perfect substrate and carrier for Biofertilizer inoculants. By utilizing specialized processes like the use of earthworms to create Vermicompost- often called "Black Gold" and liquid formulations like Jeevamrut and Panchagavya, which utilize cow dung and urine to culture massive population of beneficial bacteria. Utilizing these materials through processes like anaerobic digestion also yields renewable energy and nutrient-rich digestate.

This processed Biofertilizer is far superior to raw land application as it significantly

reduces environmental hazards, such as the leaching of pathogens into groundwater and the transmission of zoonotic diseases, while contributing to a decrease in greenhouse gas emission compared to conventional treatment methods.

Implication of Biofertilizers in India

- During 1989-1999 National Project on Development and use of Biofertilizers (NPDB) is a central scheme implemented by Government of India to attain the production targets and focusing on "Biotech-derived" microbial inoculants to replace chemicals.
- Liquid fertilizers are also gaining attention nowadays which contains microorganisms, their nutrients, cell protectants for longer shelf life and are tolerant to high temperatures and Ultra-violet radiations.
- Some Government measures like PM-PRANAM (2023); Paramparagat Krishi Vikas Yojana; and the Fertilizer Control Orders are the Government measures which favor the use of Biofertilization. As sustainable agriculture is gaining momentum as a movement all over the globe.
- Biofertilizers are cost effective, eco-friendly, improves soil structure and increase organic matter content.

Constraints in Biofertilizers technology

Unavailability of good quality carrier materials, lack of qualified technical staff in production unit, lack of essential equipment, power supply, storage etc., non-availability of sufficient funds, seasonal demand of Biofertilizers, non-availability of right inoculant at the right place at the right time, unawareness of technology's benefits due to difficulties in farmers adopting it due to various methods of inoculation are some constraints in biofertilizers technology.

Conclusion

As a boon for farmers, Biofertilizers being essential components of organic farming play vital role in maintaining long term soil fertility and sustainability. Biofertilizers would be the viable choice for farmers to increase productivity per unit area in organic farming for an era of flourishing and clean environment. It is important to understand the benefits of Biofertilizers and how to apply them to current agricultural practices.

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