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ORIGINAL ARTICLE

Role of biofertilizers in improving soil fertility

Shilpa*[1], Vindhya Bundela[2] and Charan Singh[3]

[1]Ph.D. Scholar, Division of Soil Science and Agricultural Chemistry, ICAR-IARI, New Delhi.
[2]Ph.D. Scholar, Department of Agricultural Microbiology, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand.
[3]Ph.D. Scholar, Department of Soil Science, Chaudhary Charan Singh Haryana Agricultural University, Hisar.

**Corresponding Author: shilpa9825@gmail.com*

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Abstract

In general, biofertilizers are living microorganisms, unlike chemical fertilizers; they themselves are not the source of nutrients but can help the plants in accessing the nutrient available in its surrounding environment. Healthy plants can be grown through bio-fertilizer along with enhancing soil health and sustainability.This article provides the information about the usage of biofertilizers for agricultural production systems.

Keywords: Biofertilizers, Soil health and Sustainability

Introduction

Biofertilizers are the formulations containing living microorganisms which, on application to seed, plant surfaces, soils, tend to colonize the rhizosphere or the interior of the plant and enhance growth by increasing the availability of primary nutrients to the host plant. Bio-fertilizers provide the nutrients through nitrogen fixation, solubilizing phosphorus, and stimulate plant growth through the synthesis of growth-promoting substances. The microorganism component helps the soils to restore natural nutrient cycle and increase soil organic matter content. Since they play vital roles, they can be called as Plant-Growth Promoting Rhizobacteria (PGPR).

Working Principles of Bio-fertilizer

- Biofertilizers enhances availability of nitrogen to plants by fixing atmospheric nitrogen in soils and root nodules of legume crops.
- They increase the solubility of the insoluble phosphates like tricalcium, Fe and Al phosphates.
- They promote plant root growth by producing hormones and anti-metabolites.
- Biofertilizers aid in internalization process.
- They have potential to improve the yield by 10 to 25% without having adverseeffects on the soil and environment.

Need for Use of Biofertilizers:

- Imbalanced use of chemical fertilizers hascontaminated the soils, polluted water resources, destroyed micro-organisms, eco-friendly insects andmade the crop more susceptible to diseases and reduced soil fertility.
- They can't increase the production levels alone but can help to achieve sustainability when used in conjunction with chemical fertilizers.
- Cost of fertilizations has increased to much higher levels which is becoming quite unaffordable by small and marginal farmers
- Wide gap between nutrient removal and supplies has depletedsoil fertility.
- They are economic to use and eco-friendly.

Different types of bio-fertilizers

Nitrogen fixing microorganisms

Physiological Group	**Types of association**	**Representative**
Heterotrophs	Free living, aerobic nitrogen fixing microorganisms	*Azotobacter*, *Azomonas Azotococcus, Beijerinckia Derxia*, *Pseudomonas; Rhizobium*
	Facultative anaerobic nitrogen fixing microorganisms	*Azospirillum*, *Bacillus*, *Klebsiella*
	Anaerobic nitrogen fixing microorganisms	*Clostridium*, *Desulfovibrio, Desulfotomaculum*, *Methanobacillus*
	Associative nitrogen fixing microorganisms	*Azospirillum, Beijerinckia*
	Facultative anaerobes which fix atmospheric nitrogen	*Enterobacter, Klebsiella*
	Symbiotic nitrogen fixing microorganisms – aerobic	*Rhizobium, Frankia*
Autotrophs (Photosynthetic)	Free-living- unicellular Nitrogen fixing algae	*Gloeocapsa*

	Filamentous, Non-heterocystous Nitrogen fixing blue green algae	*Trichodesmium, Oscillatoria*
	Filamentous, Heterocystous Nitrogen fixing blue green algae	*Anabaena, Calothrix, Nostoc*

Phosphate solubilizing / mobilizing microorganisms

a. Phosphate solubilizers	Examples of Bacteria: *Bacillus spp.* and *Pseudomonassp,* Examples of Fungi: *Aspergillus spp.* and *Penicilliumsp*
b. Phosphate mobilizers	Endomycorrhiza (VAM), Ectomycorrhiza, Ericoid & Orchid Mycorrhiza

Potassium Solubilizing/mobilizing microorganisms

a. Potassium solubilizers	Examples of Bacteria: *Bacillus mucilaginosus*
b. Potassium mobilizers	*Frateuria aurantia*

Biofertilizers for Micronutrients:

Silicate and Zinc solubilizers: *Bacillus spp.*

Plant growth promoting Biofertilizers /Biocontrol agents:

Pseudomonas fluorescens
Trichoderma spp.

Advantages of using Biofertilizers in Agriculture:

1. It is a low cost and easy technique.
2. The biofertilizers increase 15-35% additional yield in most of vegetable crops.
3. Besides fixing atmospheric nitrogen, they synthesize and excrete several growth hormones (auxins and ascorbic acid) and vitamins which stimulate seed germination and growth of crop plants.
4. Some biofertilizers excrete antibiotics and thus act as pesticides.
5. Improvement in physical and chemical properties of soil like water holding capacity, buffer capacity etc.
6. Some of the biofertilizers enhance crop yield even under ill irrigated conditions where chemical fertilizers are of not much advantage.

Types of biofertilizer formulation

Biofertilizers are living and viable microbial cells used to improve soil fertility. They are formulated in such a way that they are both viable and capable of increasing soil fertility, productivity, and plant growth. The biofertilizer formulation is a multistep process that involves combining several strains with each other.The biofertilizers are made in multistep processes that combine multiple strains with certain additives that

protect the cells during storage. In the production of biofertilizers, formulations are extremely important. According to studies, a good formulation increases their number in the soil while also increasing their activity to a great rate in the host plant after inoculation. Improved biofertilizer formulations are needed for developing and commercialising new biofertilizers that are more reliable, durable, and of higher quality. and to meet the needs of farmers.

Some desirable quality of a successful formulation include

I. The ability to incorporate nutrients, an easily adjustable pH, and the use of a suitable low-cost raw material in sufficient supply and availability.
II. It must be environmentally friendly: biofertilizers should be non-toxic, non-polluting, and biodegradable, in line with current environmental concerns about the application of substances that alter soil characteristics.
III. It must allow for the rapid and regulated release of bacteria into the soil, and it must be able to be applied using standard seeding equipment.
IV. Long-term storage facility: biofertilizers should have a long shelf life and be metabolically viable in large quantities even in harsh environments.

Forms of formulations that have been used extensively are

1. Carrier based formulations
2. Liquid formulations
3. Granules
4. Freeze-dried powders.
5. Polymer-based carriers (cell immobilization)

Mode of applying of formulated biofertilizer

- seed treatment with powder formulations
- If dry biofertilizers then mixed with the seeds in the seed hopper
- sprinkle method (seed was mixed with little water before application of powder form of biofertilizer).
- slurry method (The biofertilizer is suspended in water before being applied to the seeds and mixed together).
- seed pelleting
- In the form of slurry both biofertilizer and adhesive can be applied to the seed coated with lime as a ground material.
- peat suspension in water sprayed into the furrow at the time of sowing, (h) seed treatment or seed inoculation
- soil application
- seedling root dip application

Revelation in Biofertilizer Technology

Though the biofertilizer technology is environment friendly, low cost method, many constraints limit the implementation of the biofertilizer technology and affecting at the

time of production, marketing and usage. The contraintsmay include environmental problem, technological issues, infrastructure, economical, resources availability, inattentive, quality, trading, etc.

- Using inefficient, ineffective strains for output.
- In production units, shortage of trained technical staff.
- Availability of laboratory, processing, and storage space, among other things.
- Lack of cold storage facilities for inoculant packets
- Unavailability of required funds and problems in getting bank loans.
- smaller production units low return of profit.
- Demand for biofertilizers according to the season.

Precautions followed while applying Biofertilizers:

1. Keep the packets in cool and dry place and also away from direct heat and sunlight.
2. Combinations of biofertilizers used should be right.
3. The specific biofertilizer like Rhizobium should be applied to a specified crop like *leguminaceae*.
4. Use the packet before its expiry, according to the recommended dose.
5. Biofertilizers are live product and require care in the storage.
6. For getting better result nitrogenous and phosphatic biofertilizers can be used together.
7. It is important to use biofertilizers along with chemical fertilizers and organic manures.

Conclusion

The use of various biofertilizers as an integral part of agricultural practice is the currently gaining importance now a day. Use of these microbes as a biofertilizers are being practiced in the developing world and it will grow with the time. Application of biofertilizers is a potent strategy of supplying nutrients to plants that lead to overall enhancement of agriculture crop production. However, increasing the use of biofertilizers would necessitate paying closer attention to a few issues and taking the appropriate steps to fix them.