

Microbes as Biofertilizers

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Abstract

Biofertilizers are constituents of microbial cells that colonizes rhizosphere of the plants to improve nutrients uptake by increasing the rate of mineralization of insoluble nutrients in the soil through numerous natural process such as nitrogen fixation, phosphorous fixation etc.

Keywords: Arbuscular Mycorrhiza; *Bacillus subtilis*; *Bacillus circulans*; *Azolla*; *Azospirillum*

Introduction

Biofertilizer is a biotic constituent of specific microbial cells which when applied, stimulates plant growth by accelerating the rate of nutrient release through nitrogen fixation, phosphorus cycle etc [1]. *In vitro* cultures of specific microbes are selected for the preparation of biofertilizers to fulfill the specific nutrient requirements of different plants [2]. Biofertilizer is categorized in to different given below

A. Nitrogen fixing

- i. Free-living: *Clostridium*, *Azotobacter*, *Nostoc*, *Anabaena* etc [3]
- ii. Symbiotic: *Rhizobium*, *azollae*, *Anabaena* etc [4]
- iii. Associative Symbiotic: *Azospirillum* [5]

B. Phosphorous solubilizing

- i. Bacteria: *Bacillus subtilis*, *Pseudomonas striata*, *Bacillus circulans* etc [6]
- ii. Fungi: *Aspergillus awamori*, *Penicillium sp* etc [7]

C. Phosphorous mobilizing

- i. Arbuscular mycorrhiza: *Glomus sp.*, *Acaulospora sp.*, *Gigaspora sp* & *Sclerocystis sp* [8].
- ii. Ectomycorrhiza: *Laccaria sp.*, *Boletus sp.*, *Amanita sp* [9].
- iii. Ericoid mycorrhizae: *Pezizella ericae* [10]
- iv. Orchid mycorrhiza: *Rhizoctonia solani* [11]

D. Biofertilizers for Micronutrients

- i. Silicate and Zinc solubilizers: *Bacillus sp* [12]

E. Plant Growth Promoting Rhizobacteria

- i. *Pseudomonas*: *Pseudomonas fluorescens* [13]

Biofertilizers Types

a. Rhizobium: *Rhizobium* is a nitrogen fixing bacteria that colonizes the root nodules of legumous plants and is an effective biofertilizers [14]. They are referred as cross inoculation group for being specific to form root nodules in legumous plants and has seven genera [15, 16]. For all legumous plants it is applied as seed inoculant [17].

b. Azotobacter: Another nitrogen fixing bacteria inoculant that produces ample slime which aids in soil accretion e.g. *A. chroococcum* [18].

c. Azospirillum: Nitrogen fixing bacteria that colonizes the non-leguminous graminaceous plants rhizosphere and intercellular spaces of root cortex e.g. *Azospirillum lipoferum*, *A. brasilense*, *A. amazonense* [19]. Besides these have the ability to reduce nitrate, denitrify etc [20]. *Azospirillum* is inoculated through seed, seedling root dip and soil application methods [21]

d. Cyanobacteria: Free-living /symbiotic cyanobacteria is used as a biofertilizers for rice [22].

e. Azolla: *Azolla* is a free-floating water fern that fixes atmospheric nitrogen in association with cyanobacteria [23]. It is used as a biofertilizer for wetland rice [24].

f. Phosphate solubilizing microorganism: Microorganisms such as *Pseudomonas striata*, *Bacillus polymyxa*, *Penicillium*, *Aspergillus* etc secrete organic acids that cause dissolution of bound phosphates in soil [25].

g. Arbuscular Mycorrhiza: Intracellular obligate fungal endosymbionts that possess vesicles for storage of nutrients and arbuscles for directing phosphorus, zinc and sulphur into the root system [26].

h. Silicate solubilizing bacteria: Some microbes are capable of dissolving silicates by secretion of organic acids like citric, oxalic acid etc [27]. e.g. *Bacillus sp* [28].

i. Plant Growth Promoting Rhizobacteria: Such inoculants are either bioprotectants (suppresses plant disease), biofertilizers (improves nutrient acquisition) or biostimulants (phytohormone production) [29]. e.g. *Pseudomonas* and *Bacillus* species [30].

Benefits of Liquid Biofertilizer

- Long shelf life
- No contamination
- No loss of activity
- Easy documentation
- Cost effective
- Quality control protocols are easy and quick
- Better performance
- Easy to use
- Less dosage required
- High marketable profit
- High distribution potential
- High enzymatic activity [31-36]

Benefits of Biofertilizers

- Fixing nutrient availability in soil
- Improves soil fertility
- Readily converts complex organic compounds into simple soluble forms
- Accelerates mineral uptake by plants
- Increases crop yield

- Stimulates plant growth
- Provide resistance against drought and soil-borne diseases
- Cost-effective [37-40]

Uses of Biofertilizers

- Treatment of seed
- Root dipping of seedling
- Main field use [41]

Limitations in Biofertilizer Technology

Though this technology is cost effective, environmental friendly but still there are numerous limitations that restrict its implementation [42]

Technical limitations

- Use of less effective strains
- Absence of competent technical staff
- Synthesis of poor-quality inoculants
- Short shelf life of inoculants [43-45]

Infrastructural limitations

- Deficiency of appropriate production facilities
- Absence of crucial production equipments
- Availability of space for production or storage, etc.
- Lack of cold storage facility for inoculants [46-48]

Economic limitations

- Insufficient funds
- Low profit generation in smaller scale units [49]

Conservational limitations

- Cyclical demands for biofertilizers
- Instantaneous harvesting
- short duration of sowing/planting
- Soil characteristics [50-54]

Human resources and quality limitations

- Lack of technical expertise
- Lack of appropriate training
- Manufacturer ignorance regarding product quality
- Unapproachability of quality management and control methods
- Lack of strict regulations [55-59]

Awareness limitations

- i. Lack of knowledge about the technology assistances
- ii. Reluctance to practice
- iii. No apparent change in the growth of crop
- iv. Lack of knowledge on the environmental impacts of inorganic fertilizer [60-62]

Marketing limitations

- a. Unavailability of right inoculant
- b. Lack of preserve channels or markets for the producers [63,64]

Conclusion

Thus, biofertilizers proves to be an effective way for supplementing the plants with soluble essential nutrients for the sake of good growth and commercial benefit.

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