

Prospects of Bio-Fertilizers in Minimizing Chemical Fertilizer in Rice

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Introduction

Rice is the world's important cereal crop and source of livelihood security for more than half of the world's population. Among cereals, rice occupies third after maize and wheat in terms of production. In India rice is grown in an area of 46.2 million hectare with a production of 117.32 million tonnes and with average productivity of 2578 kg ha⁻¹ (Anon., 2021). Rice needs the primary nutrients (NPK) for the better plant growth and yield. The availability of these nutrients is one of the major issues due to their fixation in soil or unavailability to the plant after application of chemical fertilizers. Biofertilizer is one of the complement sources for the chemical fertilizers. Use of biofertilizers as supplement of chemical fertilizers, improves the beneficial microbial community particularly biological nitrogen fixing bacteria that fixes atmospheric nitrogen and reduces use of chemical N fertilizer by one fourth and phosphate solubilizing bacteria which can solubilize insoluble phosphate and make them available to the plant.

Biofertilizers have fabulous tendency for decreasing the requirements of synthetic fertilizer without compromising on crop yield. Biofertilizers gives life to the soil by maintaining its health and providing plant growth promoting substances like organic acid, IAA, gibberellins, cytokinins, vitamins, minerals and enzymes. So, these biofertilizers like *Azospirillum*, *Azotobacter*, *Trichoderma*, blue green algae, *Azolla*, *Pseudomonas sp.* and *Bacillus sp.* have huge potential in rice, without causing any harmful effects on soil and aerial environment and helps in food and nutritional security by providing balanced plant nutrition in rice.

What is Biofertilizers...?

- Bio-living and fertilizer-things that nourished the crops

- Biofertilizer is a substance or product which will contain selective strains of microorganisms which can contribute nutrients to plants through microbial activity.
- A product that contains living microorganisms, which exert direct or indirect beneficial effects on plant growth and crop yield through nutrients present in the rhizosphere of the plant.

Importance of Biofertilizer

- Substances that contain microorganisms
- Enrich the nutrient quality of soil
- Fungi, blue green algae and bacteria
- Symbiotic relationship with plant
- Helps to solve increase the salinity of soil
- Renewable source of nutrients
- Sustain soil health
- Supplement chemical fertilizers
- Replace 25-30% chemical fertilizer

Table 1. Reduction of chemical fertilizer use following integration of Biofertilizers

Country	Bio-fertilizer	Reduction of chemical (%)	Crops	References
India	PSB	25	Sugarcane	Sundara, 2002
India (WB)	Azotobacter and PSB	25	Rice	Mondal <i>et al.</i> , 2015
India	Azotobacter and Azospirillum	30	Rice and Maize	Shaheen <i>et al.</i> , 2007
Thailand	<i>Bacillus cereus</i> strain RS87	50	Rice	Bangchang, 2011
Iran	Azotobacter	25	Black cumin	Valadabadi and Farahani, 2010
Pakistan	K solubilizing bacteria <i>Bacillus mucilaginous</i> , Azotobacter, Azospirillum,	50	Maize	Jilani <i>et al.</i> , 2007

Colombia	<i>Azospirillum brasilense</i> , A. <i>amazonense</i> and Azotobacter	20-50	Cotton and rice	Moreno <i>et al.</i> , 2007
Egypt	Azotobacter and Azospirillum	100	Maize	Naseriad <i>et al.</i> , 2011

Important Biofertilizers used in rice crops

1. Blue green algae

- Green feeding both free-living as well as symbiotic cyanobacteria (BGA)
- The benefits due to algalization could be to the extent of 20-30 kg/ha
- Improve the soil's aeration, water holding capacity and add to bio mass when decomposed after life cycle

2. Algae

- A free-floating water fern used as Biofertilizer for wetland rice
- Fixes atmospheric nitrogen in association with nitrogen fixing blue green algae *Anabaena azollae*
- *Azolla* can accumulate 30 to 40 kg K₂O ha⁻¹ from irrigation water in the paddy field and fixes 40-60 kg N/ha in rice crop, supplement nitrogen by 50 % to rice crop.

3. Azospirillum

- Proliferates under both anaerobic and aerobic condition
- Nitrogen fixing ability of 20-40 kg/ha
- PGPRs production (IAA), disease resistance and drought tolerance are some of the additional benefits

4. Azotobacter

- A free living bacteria mostly found in neutral to alkaline soils.
- Fixes the atmospheric nitrogen by converting into ammonia
- Produces abundant slime which helps in soil aggregation
- Fix biologically active PGPRs like IAA and gibberellins

Importance of microorganism in soil

- ✓ Microorganism for improving plant growth promoting activity
- ✓ Microorganism for improving agricultural yield and nutritional quality

- ✓ Microorganism for improving phytoremediation of the degraded land
- ✓ Microorganism for improving stress tolerance and resistance to disease
- ✓ Soil rhizospheric, endophytic, symbiotic, bacteria, fungi and actinomycetes

Application of biofertilizers

1. Seed treatments of Biofertilizer

- ✓ 10-20 kg of biofertilizer / kg of seed
- ✓ Biofertilizer is mixed with water and adhesive material
- ✓ Dried for half an hour before sowing

2. Seedling root dip of Biofertilizer

- ✓ This is mainly done in transplanted crop
- ✓ A slurry of biofertilizer is prepared
- ✓ Seedling are dipped in the slurry for about 15 minutes
- ✓ Then transplanted to the main field

3. Soil application of Biofertilizer

- ✓ 2 kg of biofertilizers are mixed with 40-50kg of decomposed FYM
- ✓ Broadcast at the time of sowing

Difference between chemical fertilizer and biofertilizers

Characters	Chemical fertilizers	Biofertilizers
Pollution	Exists due to indiscriminate use	Pollution free and environment friendly
Residual effect	Nil	+ve
Cost of production	High	Low
Irrigation	More useful to irrigated crops	More useful for both irrigated and rainfed crops
Microbial activity	Low	High
Long term effect	Deteriorates the soil health	Improve the soil health
Shelf life	Long	Short
Accessibility	Affordable section	Small and marginal farmer

Conclusion

Biofertilizers can be an effective approach to minimize chemical fertilizer sources which ultimately improves soil fertility. Use of biofertilizers as supplement of chemical



fertilizers increased leaf chlorophyll and grain protein content and simultaneously increased grain yield. Biofertilizer application increases water uptake and decreases drought susceptibility, act against pathogens as biocontrol agent. Biofertilizers are eco-friendly tools for increasing nutrient availability from sustainable rice production. The innovative agronomic option is one of the ways to apply biofertilizers in combination with chemical fertilizers to reduce the chemical fertilizer usage.

