Bio-fertilizers : Key Inputs for Sustainable Agriculture

Roop Singh[1]*, Rakesh Bairwa[2], Ramraj Meena[3] and Gunjan Sanadhya[4]

Krishi Vigyan Kendra, Kota, Rajasthan

Corresponding Author - roop0008@gmail.com

Introduction

Plant nutrients are essential for the production of crops and healthy food. Soil management strategies are mainly dependent on inorganic chemical based fertilizers, which caused a serious threat to human health and environmental pollution. The exploitation of beneficial microbes as a bio-fertilizer has become paramount importance in agriculture sector for their potential role in sustainable farming systems. Microbial inoculants, term as bio-fertilizers, are a promising technology to reduce the use of conventional inorganic fertilizers. Bio-fertilizers play a key role in productivity and sustainability of soil and also in protecting the environment as eco-friendly and cost effective inputs for the farmers. The use of bio-fertilizers leads to improved nutrients and water uptake, plant growth and plant tolerance to abiotic and biotic factors.

Classification of Bio-fertilizers

Biofertilizers can be categorised in different ways based on their nature as following :

Rhizobium: *Rhizobium* is a soil habitat bacteria, which lives symbiotically the root nodules of leguminous plants and supply atmospheric nitrogen to the plants. The beneficiary crops are groundnut, soybean, greengram, Blackgram, cowpea, chickpea.

Azotobacter: *Azotobacte*r is non-symbiotic nitrogen fixing bacteria recommended for non-leguminous crops like paddy, wheat, millets, mustard, cabbage etc.

Azospirillum: They develop associative symbiotic relationship with graminaceous plants. Apart from nitrogen fixation, growth promoting substance production (IAA), disease resistance and drought tolerance are some of the additional benefits of inoculation with *Azospirillum*.

Cyanobacteria: Both free-living as well as symbiotic cyanobacteria (blue green algae) have been harnessed in rice cultivation in India. Once so much publicized as a biofertilizer for rice crop, it has not presently attracted the attention of rice growers all over India.

***Azolla*:** *Azolla* is a free-floating water fern that floats in water and fixes atmospheric nitrogen in association with nitrogen fixing blue green alga *Anabaena azollae*. *Azolla* is used as biofertilizer for wetland rice and it is known to contribute 40-60 kg N/ha per rice crop.

***Phosphate solubilizing microorganisms* (PSM):** Several soil bacteria and fungi posses the ability to bring insoluble phosphate into soluble form by secreting organic acids and lower the pH in their vicinity to bring about dissolution of bound phosphates in soil.

AM fungi: The transfer of nutrients mainly phosphorus and also zinc and sulphur from the soil *milleu* to the cells of the root cortex is mediated by intracellular obligate fungal endosymbionts of the genera *Glomus, Gigaspora, Acaulospora, Sclerocysts* and *Endogone* which possess vesicles for storage of nutrients and arbuscles for funnelling these

nutrients into the root system. By far, the commonest genus appears to be *Glomus*, which has several species distributed in soil.

Silicate solubilizing bacteria (SSB): Microorganisms are capable of degrading silicates and aluminium silicates. During the metabolism of microbes several organic acids are produced and these have a dual role in silicate weathering. They supply H+ ions to the medium and promote hydrolysis and the organic acids like citric, oxalic acid, Keto acids and hydroxy carbolic acids which form complexes with cations, promote their removal and retention in the medium in a dissolved state.

Plant growth promoting rhizobacteria (PGPR): The group of bacteria that colonize roots or rhizosphere soil and beneficial to crops are referred to as plant growth promoting rhizobacteria (PGPR). The PGPR inoculants promote growth through suppression of plant disease (termed Bioprotectants), improved nutrient acquisition (termed Biofertilizers), or phytohormone production (termed Biostimulants). Species of *Pseudomonas* and *Bacillus* can produce as yet not well characterized phytohormones or growth regulators that cause crops to have greater amounts of fine roots which have the effect of increasing the absorptive surface of plant roots for uptake of water and nutrients. These PGPR are referred to as Biostimulants and the phytohormones they produce include indole-acetic acid, cytokinins, gibberellins and inhibitors of ethylene production.

Methods of Application of Bio-fertilizers

Seed Treatment: 200 g of bio-fertilizer is suspended in 300- 400 ml of water and mixed gently with 10-12 kg of seeds using an adhesive like jaggery solution, gum acacia, 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 bio-fertilizers are mixed in this water and the roots of seedlings are dipped

Types of Biofertilizers

S. No.	Groups	Examples
	N2 Fixing Biofertilizers	
1.	Free-living (non-symbiotic)	*Azotobacter, Beijerinkia, Clostridium, Klebsiella, Anabaena, Nostoc*
2.	Symbiotic	*Rhizobium, Frankia, Anabaena azollae*
3.	Associative Symbiotic	*Azospirillum*
	P Solubilizing Biofertilizers	
4.	Bacteria	*Bacillus megaterium* var. *phosphaticum, Bacillus subtilis*, *Bacillus circulans, Pseudomonas striata*
5.	Fungi	*Penicillium sp., Aspergillus awamori*
	P Mobilizing Biofertilizers	
6.	Arbuscular mycorrhiza	*Glomussp., Gigaspora sp., Acaulospora sp., Scutellospora sp.* & *Sclerocystis sp.*
7.	Ecto-mycorrhiza	*Laccaria sp., Pisolithus sp.*, *Boletus sp.*, *Amanita sp.*

for 8-10 h and transplanted.

Soil Treatment: 4 kg each of the recommended bio-fertilizers is mixed in 200 kg of compost and kept overnight. This mixture is incorporated in the soil at the time of sowing or planting.

Advantages of Using Bio-fertilizers

- They are eco- friendly as well as cost effective
- Leads to soil enrichment and improve the quality of the soil
- These fertilizers harness atmospheric nitrogen and make it directly available to the plants.
- Increase the phosphorous content of the soil by solubilising and releasing unavailable phosphorous.
- Improve root proliferation due to the release of growth promoting hormones.
- Microorganism converts complex nutrients into simple nutrients for the availability of the plants.
- They help in increasing the crop yield by 10-25% also protect plants from soil borne diseases to a certain degree

Liquid Bio-fertilizer (LBF)

The liquid Bio-fertilizers (LBF) are suspensions having useful microorganisms, which fix atmospheric nitrogen and solubilise insoluble phosphates and make it available for the plants.

Benefits of Liquid Bio-fertilizers

The advantages of liquid biofertilizer over conventional carrier-based biofertilizers are listed below:

1. Longer shelf-life- 12 to 24 months
2. No contamination
3. No loss of properties due to storage up to 45º C
4. Greater potential to fight with native population
5. Easy identification by typical fermented smell
6. Better survival on seeds and soil
7. Very easy to use by the farmer
8. High commercial revenues
9. High export potential

Conclusion

Bio-fertilizers being essential components of organic farming play a vital role in maintaining long term soil fertility and sustainability by fixing atmospheric di-nitrogen, mobilizing fixed macro and micro nutrients in the soil into forms available to plants. Currently there is a gap of ten million tons of plant nutrients between removal of crops and supply through chemical fertilizers. In context of both the cost and environmental impact of chemical fertilizers, excessive reliance on chemical fertilizers is not practicable in the long run because of the cost, both in domestic resources and foreign exchange involved in setting up of fertilizer plants and sustaining the production. In this context, bio-fertilizers would be the viable option for farmers to increase productivity per unit area.

❖❖