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## ROLE OF BIOFERTILIZERS IN MODERN AGRICULTURE

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The role of synthetic fertilizers is major in modern agriculture in order to feed the ever increasing population. The synthetic fertilizers dissolve immediately in water and supply nutrients to plants faster than organic manures. These synthetic fertilizers are rich in plant nutrients but are toxic to the environment and cause soil, water and air pollution. On the continuous use of synthetic fertilizers it destroys the soil fertility due to the buildup of chemicals in soil and reduces soil health (Mazid and Khan, 2014). The role of biofertilizers is necessary in modern agricultural practices. They can supplement the necessary plant nutrients for sustainable agriculture. Biofertilizers are the substances which contain living micro organisms which promote the growth and development of crops. They convert the insoluble form of essential nutrients to soluble form making it available to the plants. They can be applied to seeds, seedlings and soil. Biofertilizers involve in the nitrogen fixation, phosphorus solubilization, and nutrient transformation and synthesize plant growth promoting substances (Mahdi *et al.*, 2010). Biofertilizers unlike synthetic fertilizers help in maintaining the soil health without causing contamination and pollution. They improve the soil physical and chemical properties and restrict the activity of harmful pathogens. Therefore the biofertilizers can be used as best supplements to synthetic fertilizers in modern agriculture.

Biofertilizers are cost effective and renewable source of plant nutrients. They are environment friendly and play an important role in maintaining soil health and fertility. Biofertilizers are live formulations of beneficial microorganisms which mobilize the availability of nutrients. The nitrogen fixing bacteria like *Rhizobium* helps in the nitrogen fixation in the root nodules of leguminous crops. *Rhizobium* can fix 15-20 kg/ha nitrogen and increase crop yield upto 20% in pulses. Phosphate solubilizing bacteria like *Bacillus* and *Pseudomonas* and fungi like *Penicillium* and *Aspergillus* have the phosphate solubilizing

capacity and solubilize the inorganic tricalcium and rock phosphate. Phosphate mobilizing biofertilizers like Mycorrhiza mobilize phosphorus and helps in its absorption. The plant growth promoting rhizobacteria colonize in the roots or rhizosphere soil and promote the growth of plants by producing growth regulators.

### **Classification of Biofertilizers**

#### **N<sub>2</sub> Fixing Biofertilizers**

- Free-living: *Beijerinckia*, *Azotobacter*, *Anabaena*, *Nostoc*
- Symbiotic: *Rhizobium*, *Frankia*, *Anabaena azollae*
- Associative Symbiotic: *Azospirillum*

#### **P Solubilizing Biofertilizers**

- Bacteria: *Bacillus megaterium*, *Bacillus subtilis*, *Bacillus circulans*, *Pseudomonas striata*
- Fungi: *Penicillium spp.*, *Aspergillus awamori*

#### **P Mobilizing Biofertilizers**

- Arbuscular mycorrhiza: *Glomus spp.*, *Gigaspora spp.*, *Acaulospora spp.*
- Ecto mycorrhiza: *Laccaria spp.*, *Pisolithus sp.*, *Boletus sp.*, *Amanita spp.*
- Ericoid mycorrhizae: *Pezizellaericae*
- Orchid mycorrhiza: *Rhizoctonia solani*

#### **Biofertilizers for Micronutrients**

- Silicate and Zinc solubilizers: *Bacillus spp.*

#### **Plant Growth Promoting Rhizobacteria**

- *Pseudomonas*: *Pseudomonas fluorescens*

### **Factors Affecting Response of Biofertilizers**

- The efficiency of the inoculant and micro organism is determined by host plant and genotype.
- The quality of inoculant largely influences its results in term of nitrogen fixation and solubilization of particular nutrients.

- Package of practices and management of crop alters the result of biofertilizers.
- Soil physical and chemical properties highly influence impact of different inoculants and micro organisms.
- Climatic conditions like temperature, relative humidity, rainfall and photoperiod affect response of biofertilizers significantly.

### Methods of Application of Biofertilizers

- 1. Seed treatment:** In this method the seeds are treated with the microbial inoculants, dried and sown as early as possible. This method can be followed for cereals (rice, wheat, maize etc.), pulses (soyabean, cowpea, green gram, black gram etc.) and oil seed crops (groundnut, sunflower, safflower etc.).
- 2. Seedling treatment:** In this method the roots of the seedling are dipped in the suspension of biofertilizers and transplanted immediately. This method can be followed in paddy, tomato, chilli, cabbage, cauliflower, onion etc.
- 3. Soil application:** In this method the biofertilizers are mixed with well decomposed organic manure and kept overnight. This mixture is then applied to the soil at the time of sowing or at the time of irrigation in standing crops.
- 4. Foliar application:** Liquid biofertilizers can be applied through fertigation as well as foliar application to the suitable crop.

### Advantages of Biofertilizers

- The microbial formulations are eco friendly and cost effective.
- Improve soil organic matter content and microbial activity.
- Improve soil physical properties like soil structure, soil porosity and water retention.
- Promote plant growth by releasing growth promoting substances.
- Improve the availability of nutrients to crops and supplement the use of synthetic fertilizers.
- Improves soil productivity and the yield of crops by 20 to 30% (Prem Baboo, 2009).
- Reduce the risk of crop failure.
- Protect the environment from pollutants as they are natural fertilizers.
- Reduce the activity of harmful pathogens by restricting their growth and control many diseases (Brahmaprakash and Pramod, 2012).

### Constraints of Biofertilizers

- They are slow releasing and crop specific.
- Lack of good quality of strain which efficiently provide required nutrients in soil.
- Lack of storage facilities makes it difficult to adopt bio-fertilizers.
- Lack of awareness in the farmers (Mahdi *et al.*, 2010).
- Less efficient when compared to synthetic fertilizers.
- Reduction in the population of micro organisms under harsh climate and field conditions like extremely high or low pH and temperature (Mahdi *et al.*, 2010).

### Precautions to Be Taken Before the Application of Biofertilizers

- Biofertilizers need to be stored in a cool and dry place away from direct sunlight and heat as they are live products (Prem Baboo, 2009).
- Usage of right combinations of biofertilizers is necessary.
- Use the microbial inoculants to specific crops as it is crop specific.
- Other chemicals should not be mixed with the biofertilizers (Suryawanshi *et al.*, 2013).
- When purchasing, one should ensure that each packet is provided with all necessary information like name of the product, name of the crop for which it is intended, name and address of the manufacturer, date of manufacture, date of expiry, batch number and instructions for use (Prem Baboo, 2009).
- The packet has to be used before its expiry, only for the specified crop and by the recommended method of application.

### Conclusion

The application of biofertilizers is necessary in the modern agricultural practices because they are renewable and environment friendly. They contain microbes which promote plant growth and crop yield. They produce metabolites making the plant resistant to stress and pathogens. It has great potential in not only influencing the soil quality but also in effective utilization of resources. Therefore biofertilizers play an important role in maintaining soil health and helps in sustainable agriculture.

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