

REVIEW ARTICLE

Organic Agriculture: Biofertilizer - A Review

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ABSTRACT

Fertilizers supply essential plant nutrients, mainly nitrogen (N), potassium (K), phosphorus (P). These fertilizers increase the yield of the crop but they cause several health hazards. Due to these health hazards consumer's preferences are shifting towards organic farming, organic manure and organic fertilizers. In recent years biofertilizers have emerged as a major component of the biological nitrogen fixation. They offer an economically attractive and ecologically sound route of providing nutrients to the plants. Biofertilizers are low cost renewable source of nutrients that supplements the chemical fertilizer. Biofertilizers gained importance due to its low cost amongst small and marginal farmers.

Key words: Biofertilizer, Rhizobium, Mass Production.**INTRODUCTION**

Biofertilizer is a substance which contains living microorganisms which, when applied to the seed, plant surfaces or soil colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant. Bio-fertilizers add nutrients through the natural processes of nitrogen fixation, G.S Naganandha, Arijitdas, Sourav Bhattacharta and T.Kalpana) solubilizing phosphorus, and stimulating plant growth through the synthesis of growth-promoting substances. Bio-fertilizers can be expected to reduce the use of chemical fertilizers and pesticides. Bio-fertilizers provide eco-friendly organic agro-input and are more cost-effective than chemical fertilizers. The microorganisms used for the biofertilizer are bacteria of Bacillus, Pseudomonas, Lactobacillus, photosynthetic bacteria, nitrogen fixing bacteria, fungi of Trichoderma and yeast. Since a bio-fertilizer is technically living, it can symbiotically associate with plant roots. Involved microorganisms could readily and safely convert complex organic material in simple compounds, so that plants are easily taken up. It maintains the natural habitat of the soil. It increases crop yield by 20-30%, replaces chemical nitrogen and phosphorus by 25%, and stimulates plant growth. It can also provide protection against drought and some soil-borne diseases (Nilabja Ghosh, 2007). Biofertilizers are ready to use and used as a live

formulation of beneficial microorganisms, when it amended to seed, root or soil, it mobilizes the availability and utility of the microorganisms and thus improves the soil health. Bio-fertilizers are used in live formulation of beneficial microorganism which on application to seed, root or soil, mobilize the availability of nutrients particularly by their biological activity and help to build up the lost microflora and in turn improve the soil health in general (Ismail *et al.*, 2014). For easy application, biofertilizers are packed in suitable carrier such as lignite or peat. Carrier also plays an important role in maintaining sufficient shelf life (Singh *et al.*, 1999).

Rhizobium is the most studied and important genera of nitrogen fixing bacteria (Odame, 1997). Azospirillum spp. contribute to increased yields of cereal and forage grasses by improving root development in properly colonized roots, increasing the rate of water and mineral uptake from the soil, and by biological nitrogen fixation (Okon, 1985). Biofertilizers have shown great potential as supplementary, renewable and environmental friendly sources of plant nutrients and are an important component of Integrated Nutrient Management and Integrated Plant Nutrition System (Raghuwanshi, 2012). Naturally grown biofertilizers not only give a better yield, but are also harmless to humans and lead to better

sustainable economic development for the farmers and their country (Mishra and Dash, 2014).

ISOLATION TECHNIQUE

Isolation techniques for *Rhizobium* spp. Intact root nodules from a healthy *Sisymbrium* plant were selected. One of the pink juvenile root nodules was selected and transferred to a drop of sterile water in a Petri dish. The nodule in the drop of water was crushed in between two glass slides causing the release of nitrogen fixing *Rhizobium* bacteria into the drop of sterile water. The smear of the crushed root nodule was streaked onto yeast extract mannitol agar (YEMA) plate with 1% Congo red dye. The culture was then incubated at 20 to 25°C for three days (Boraste, 2009).

CARRIERS

Carriers increase the effectiveness of the biofertilizer. It enables easy handling and

increases the storage or shelf life. Carriers which are used for making solid type of biofertilizer products are clay mineral, diatomaceous soil, and white carbon as mineral; rice, wheat bran, peat, lignite, peat soil, humus, wood charcoal and discarded feed as organic matter. However, clay mineral and rice bran are most often used as carriers. To achieve the tight coating of inoculant on seed surface, use of adhesive, such as gum arabic, methylcellulose and vegetable oil is also available.

MASS PRODUCTION OF BIOFERTILIZERS (Figure 1)

Criteria for strain selection

Efficient nitrogen fixing strains is selected and then multiplied on the nutritionally rich artificial medium before inoculating in the seed and soil.

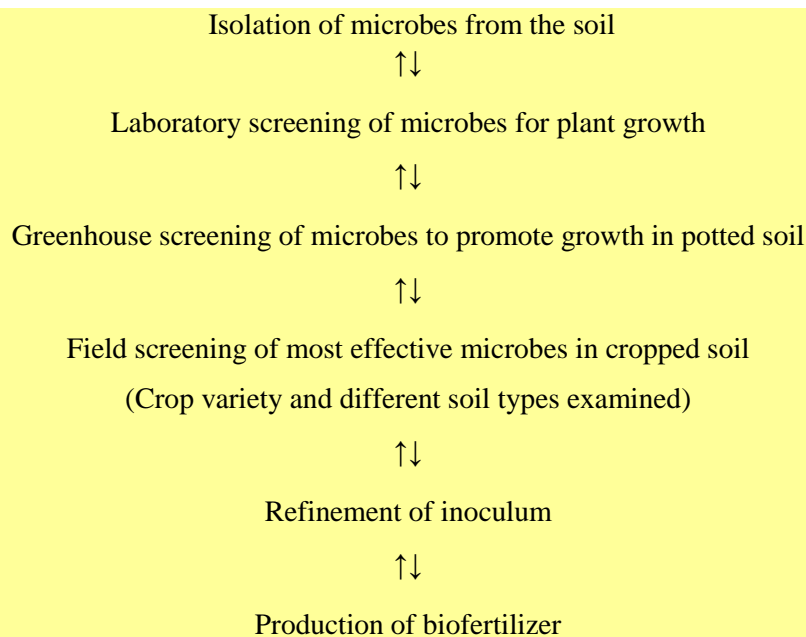


Figure 1: Production of biofertilizers

Culturing in the flask containing broth

The isolated strain is inoculated in the small flasks containing suitable medium for inoculum production. Now, the carrier was autoclaved at 15 psi at 121°C for 20min. The culture broth was mixed with the carrier at 10%, that is, for 1 kg carrier; 100 ml of culture broth was used. The mixture was spread on a plastic sheet in a closed room for air drying. The biofertilizer was packed in sterile plastic air tight bags and stored. For large scale production of inoculums, culture fermenters are used.

QUALITY CONTROL

Like every product, the biofertilizers should also follow some standards. The inoculants should be

carrier based, and it should contain 10⁸ viable cells per gram of carrier on dry mass basis within 15 days of manufacture. The inoculums should have a maximum expiry period of 6-8 month from the date of manufacture. The inoculants should not have any contaminant. The contaminant is one of the biggest problems faced by the biofertilizers industry. The pH of the inoculant should be 6.0-7.5. Each packet containing the biofertilizer should be marked with the information eg. name of the product, leguminous crop for which intended, name and address of the manufacturer, type of carrier, batch or manufacture no, expiry date. Each packet should also be marked with the ISI mark. The biofertilizer should be stored in the cool place and keep away from direct heat.

TYPES OF BIOFERTILIZER AVAILABLE

1. Nitrogen fixing biofertilizer: Rhizobium, Azotobacter, Azospirillum, Bradyrhizobium.
2. Phosphorus solubilising biofertilizer (PSB): Bacillus, Pseudomonas, Aspergillus.
3. Phosphorus mobilizing biofertilizer: Mycorrhiza.
4. Plant growth promoting biofertilizer: Pseudomonas.

MODE OF ACTION OF BIOFERTILIZER

They fix nitrogen in the soil and the root nodules of the legumes crop and make it available to the plant. They solubilise the insoluble form of the phosphate like tricalcium, iron and aluminium phosphate into the available form. They produce hormones and anti metabolites which promote root growth. They also decompose the organic matter. When biofertilizers are applied to the seed and the soil they increase the availability of the nutrient to the plant and increase the yield up to 10-20% without producing any adverse effect to the environment. Therefore, significantly increase the plant growth parameters viz., plant height, number of branches, number of roots, root length, shoot length, dry matter accumulation in plant organs and vigour index etc. (Ezz El-Din and Hendawy, 2010; Ateia *et al.*, 2009; Mahmoud, 2009; Leithy *et al.*, 2009; Gharib *et al.*, 2008; Ismail *et al.*, 2014).

RHIZOBIUM

Rhizobium belongs to family Rhizobiaceae, it is symbiotic in nature, it fixes 50-100 kg/ha nitrogen with legumes only. It includes the following genera: Rhizobium, Bradyrhizobium, Sinorhizobium, Azorhizobium, Mesorhizobium and Allorhizobium (Vance, 2001; Graham and Vance, 2000). It is useful for the pulse legumes like chickpea, red-gram, pea, lentil, black gram, etc., oil-seed legumes like soybean and groundnut and forage legumes like berseem and lucerne. It colonizes the roots of specific legumes to form tumour like growths called root nodules, which acts as factories of ammonia production.

Rhizobium has ability to fix atmospheric nitrogen in symbiotic association with legumes and certain non-legumes like Parasponia. Population of the Rhizobium population in the soil depends on the presence of legume crops in the field. In the absence of legumes, the population decreases.

PLANT GROWTH PROMOTING RHIZOBACTERIA

Various bacteria can promote plant growth (Bashan, 1998). Collectively, such bacteria are

called plant-growth-promoting rhizobacteria (PGPR). These bacteria vary in their mechanism of plant growth promotion but generally influence growth via P solubilization, nutrient uptake enhancement, or plant growth hormone production (Bashan *et al.*, 1990; Okon and Labandera-Gonzalez, 1994; Goldstein *et al.*, 1999; Richardson, 2001). (Bertrand *et al.* 2000) showed that a rhizobacterium belonging to the genus *Achromobacter* could enhance root hair number and length in oilseed rape (*Brassica napus*).

ROLE OF BIOFERTILIZER IN AGRICULTURE

The biofertilizers play an important role in improving the fertility of the soil (Kachroo and Razdan, 2006; Son *et al.*, 2007). In addition, their application in soil improves the structure of the soil minimizes the sole use of chemical fertilizers. Under low land conditions, the application of BGA + *Azospirillum* proved significantly beneficial in improving LAI. Grain yield and harvest index also increase with use of biofertilizers. Inoculation with *Azotobacter* + *Rhizobium* + VAM gave the highest increase in straw and grain yield of wheat plants with rock phosphate as a P fertilizer. *Azolla* is inexpensive, economical, friendly, which provide benefit in terms of carbon and nitrogen enrichment of soil (Kaushik and Prassana, 1989). Some commercially available biofertilizers are also used for the crop. Raj (2007) recorded that microorganisms (*B.subtilis*, *Thiobacillus thiooxidans* and *Saccharomyces* sp.) can be used as bio-fertilizers for solubilization of fixed micronutrients like zinc. Soybean plants, like many other legumes can fix atmospheric nitrogen symbiotically and about 80 to 90% nitrogen demand could be supplied by soybean through symbiosis (Bieranvand *et al.*, 2003). Bio-control, a modern approach of disease management can play a significant role in agriculture (Tverdyuk *et al.*, 1994; Hoffmann-Hergarten *et al.*, 1998; Yang-Xiu Juan *et al.*, 2000; Sharon *et al.*, 2001; Senthilkumar and Rajendran, 2004; Li-Bin *et al.*, 2005; Hossain *et al.*, 2009). Trichoderma based BAU-biofungicide has been found promising to control root knot diseases of French bean (Rahman, 2005). Use of antagonist bacteria like *Rhizobium* and *Bradyrhizobium* also has significant effect in controlling root knot of mungbean (Khan *et al.*, 2006). Growth, yield and quality parameters of certain plants significantly increased with biofertilizers containing bacterial nitrogen fixer, phosphate and potassium

solubilizing bacteria and microbial strains of some bacteria (Youssef and Eissa, 2014).

LIMITATION OF BIOFERTILIZER

1. Biofertilizers never mix with the chemical fertilizers.
2. Biofertilizers are never applied with the fungicides, plant ash at a same time.
3. Biofertilizers are never exposed to direct sunlight.
4. Stored at room temperature not below 0 and 35°C.

CONCLUSION

Biofertilizers are becoming increasingly popular in many countries and for many crops. Biofertilizers are fertilizers containing living microorganisms, which increase microbial activity in the soil. Often, organic food is included to help the microbes get established. In India soil fertility is diminishing gradually due to soil erosions, loss of nutrition, accumulation of toxic elements, water logging and unbalanced nutrient compensation. Organic manure and bio fertilizers are the alternate sources to meet the nutrient requirement of crops. The role of bio-fertilizer in agricultural production is of great importance. Inoculation of nitrogen fixing bacteria with biofertilizer increases the phosphorus level that influences the sunflower seed oil content and the proportion of fatty acids.

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