



Bio-fertilizers in Organic Farming for Sustainable Agriculture

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Bio-fertilizer in Organic Farming is a nature friendly approach which operates for the environmental sustainability as well as for enhancement of crop yield which leads to the socio-economic development of India. Bio-fertilizer contains micro-organisms which helps for crop growth and development with their specific function like nitrogen fixation or may be solubilization or help for mobilization of specific type of nutrients. Bio-fertilizers are getting popularity in agricultural sector due to its capacity of activating the soil biologically for boosting the productivity of crop yield in low cost. The micro-organisms present in some bio-fertilizers helps in decomposition of plant waste which improves the C/N ratio of soil, soil texture, water holding capacity of the soil, availability of nutrient content etc. and so, improve the soil health and yield of plants. The production of bio-fertilizer in India is increasing day by day by considering its demand in Indian market. But regulations should be there from the Government side for the production agencies for restrict the use of poor quality of inoculant with low self-life, low population count and avoid the supply of contaminated product.

Introduction

Bio-fertilizer is a natural organic fertilizer which contains a specific type of micro-organism and has specific functions for nourishment of soil for proper growth and development of the host plant by adequate supply of nutrients (Singh et al., 2021, Sanjay-Swami, 2022). It is an important component of Organic Farming. Organic Farming is a holistic approach for protecting the environment, primarily the soil and water quality while boosting up the crop productivity by avoiding hazards to environment (Bordoloi, 2021 a, Bhuyan, 2021, Kumar et al., 2020, Rajkhowa et al., 2019). Bio-fertilizers are less expensive and eco-friendly. It proliferates quickly and mobilize nutrients through biological processes. When it is applied to the crop field it usually acts on rhizosphere by colonization and some of them are take their shelter in the interior of the plant and create a symbiotic relationship with the plant. Some bio-fertilizers lives individually and helps directly to the crop plant by providing the essential nutrients. It can be successfully utilized for maintenance of the long-term soil fertility and can be effectively used for increased the productivity of crops which directly helps in socio-economic development of India (Bordoloi, 2021 b). Bio-fertilizer is an important component of present-day agriculture in nature friendly cultivation with reduce rate of chemical fertilizers (Babu et al., 2015; Bordoloi et al., 2020; Sanjay-Swami, 2020).

Different Types of Bio-Fertilizers

Generally, the bio-fertilizers contains bacteria, fungi and cyanobacteria which performs different activities linked to nourishment of crop. It can be applied to the seeds as seed treatment, roots as seedling root dip treatment or in soil by soil treatment. There are different types of bio-fertilizers available in the market which can be utilized successfully for

improvement of soil health with enrichment of soil nutrients leads to crop growth and development.

Free Living Nitrogen Fixing Bio-fertilizers

These bio-fertilizers are free-living soil bacteria having the capacity to fixing the atmospheric nitrogen directly. It includes mainly *Azotobacter*, *Clostridium* and *Bacillus polymyxin*. The most common free living nitrogen fixing bio-fertilizer used in agriculture is *Azotobacter*, which is aerobic, free living and heterotrophic in nature. *Azotobacter* can be used in all types of crops and trees like rice, maize, sugarcane, vegetables, plantation crops etc. as nitrogen fertilizer. Moreover, it has the capacity of synthesize biologically active growth promoting substances such as vitamins of B-group, indole acetic acid (IAA) and gibberellins.



Figure: Bio-fertilizer application in different crops

Symbiotic Nitrogen-Fixing Bacteria

The symbiotic nitrogen-fixing bacteria makes symbiotic association with the host plant and have the capacity of fix atmospheric nitrogen, which may be available for nourishment of the host plant. The most common symbiotic nitrogen-fixing bacteria used in agriculture is *Rhizobium*. It traps the atmospheric nitrogen and converts it into ammonia. It creates symbiotic association with legume plans by taking their shelter in roots by forming root nodules and takes their food from it and in return the accumulated nitrogen is absorbed by the host plant. This is a good source of nitrogen fertilizer for leguminous plants.

Loose Association of Nitrogen-Fixing Bacteria

Some bacteria lives around the roots of plant and takes nutrient from the plant and it return they provide nitrogen to the crop plant which they accumulated through biological nitrogen fixation. They also have the capacity of producing some growth regulating substances, which may be useful for growth and development of the host plan. *Azospirillum* is a good example of it, which is mostly used in present day agriculture. The association between the plant and the *Azospirillum* is known as associative mutualism. *Azospirillum* is mainly used in maize, sugarcane, sorghum, pearl millet etc. The improved yield of crop and soil nutrient status were

recorded in many experiments conducted in India with application of *Azospirillum* (Bordoloi, 2022; Bordoloi, 2021 c).

Symbiotic Nitrogen-Fixing Cyanobacteria

The Cyanobacteria or Blue Green Algae have the capacity of biological nitrogen fixation and it creates symbiotic association with the host for its survival. In tropical condition different types of BGA are available like *Tolypothrix*, *Calothrix*, *Schizothrix*, *Anoboenosis*, *Plectonema*, *Nostic* etc. BGA creates symbiotic association with various types of fungi, liverworts, ferns etc. They are mainly found in the rice field naturally. *Azolla pinnate* is a floating fern suitable for wetland rice crop cultivation, which gives shelter to the *Anabaena* at their leaf cavities. It fixes the atmospheric nitrogen in the form of NH_4^+ and make it available for the rice crop. *Azolla* can be used very successfully in the wet land rice crop cultivation for its capacity of sheltering *Anabaena* at their leaf cavities and moreover it decomposed very fast so, it can provide different types of nutrients to the standing crop as well as for the succeeding crop in the same plot. Increased yield of rice with the application of *Azolla* is recorded by Sanjay-Swami and Singh, 2020.

Phosphorous Solubilizing Bio-fertilizers

Some micro-organisms can be utilized successfully as phosphorous solubilizing bio-fertilizers as because of its capacity to hydrolysed insoluble and bound phosphates to the soluble form which are fix in clay minerals of soil. So, the bound phosphate converted to the form suitable to the plant which helps for crop growth and development. Some species of fungi and bacteria like *Bacillus*, *Pseudomonas*, *Aspergillus*, *Penicillium* are suitable for used in crop cultivation as phosphate solubilizing biofertilizers. These types of micro-organisms generally secrete organic acids and helps for lowering the pH of the soil and bound phosphates are dissolved and make it available for the crop plant. Various studied were conducted in PSB and recorded the beneficial effect on crop growth and soil nutrient status (Bordoloi and Islam, 2020; Bordoloi, 2021 d).

Phosphorus Mobilizing Bio-fertilizers

A group of fungi called as arbuscular mycorrhizal fungi creates symbiotic association between the root system of certain plants where the fungus absorbed the photosynthetic products mostly the carbon requirements from the host plant and in return the plant gets the essential nutrients from the fungus along with water, which is absorb by the fine absorbing hyphae of the fungus. This fungus penetrates the cortical cells of the roots and increase the surface area of roots which increases the transfer of P ions and stimulate metabolic processes. This association is seen in majority of agricultural crops and it is found in all types of environments starting from aquatic to desert environments.

Potassium Solubilizing Bacteria

Although the soil contains large amount of potassium, the plant can absorb very less amount of it because of its bound form. Some bacteria have the capacity of solubilize insoluble potassium to soluble forms which makes the potassium available to plant uptake. These groups of micro-organisms are considered as potassium solubilizing bacteria (KSB). Some potassium solubilizing bacteria are *Acidithiobacillus ferrooxidans*, *Paenibacillus* spp., *Bacillus mucilaginosus*, *B. edaphicus*, *B. circulans* etc. KSB have the capacity of dissolve silicate minerals and release potassium through the production of organic and inorganic acids, acidolysis, polysaccharides, complexolysis, chelation and exchange reactions. This is a very important group of bio-fertilizer suitable for crop cultivation.

Benefits of Bio-Fertilizers

- Bio-fertilizers are eco-friendly and cost-effective.

- Bio-fertilizers is a very good source of nutrients for crop cultivation. It improves the yield of crop. It can replace a distinct amount of chemical fertilizer used in agricultural sector.
- Bio-fertilizers improve the soil texture. It activates the soil biologically and improves the C/N ratio of soil.
- Some bio-fertilizers helps in decomposition of plant waste and improves the water and nutrient holding capacity of soil, Moreover, it improves the tolerance towards drought and moisture stress.
- Some micro-organisms used in bio-fertilizers do secretion of various growth hormones, vitamins, fungistatic and antibiotic like substances which induce pest and disease resistance of crop plant.

Contains of Bio-Fertilizers

- The demand of bio-fertilizer in agriculture sector of India is more than its production.
- Poor quality of inoculant with low self-life, low population count and contaminations are the major constrains for success of bio-fertilizer application in crop field.
- Unavailability of bio-fertilizer in proper time and proper place.
- Lack of awareness among the farmers and inadequate and inexperienced staff working in bio-fertilizer industries.

Conclusion

Bio-fertilizers contain agriculturally useful micro-organisms which performs as nutrient supplier of crops. This is an important component of Organic Farming and very much accepted by the farmers of India due to its proper response to the crop growth and for its low cost. For achieving success in bio-fertilizers proper storage facility and transportation should be there while transferring to farmers' level. From the Governmental side strict regulation should be there for production and use of bio-fertilizers. The prime objectives should be use of high-quality inoculant with high self-life, high population count and less contaminations while preparing the bio-fertilizers to avoid low quality bio-fertilizers in the market. The success of bio-fertilizer based organic farming depends in its proper applicability in the farmer's field, so haphazard field work and more research work are required in success of bio-fertilizer in farmers' field.

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