Ecofarming
e-Magazine for Agriculture and Allied Sciences
http://www.rdagriculture.in
e-ISSN: 2583-0791
Ecofarming Vol. 02(01): 10-14, 2022

Bio-fertilizers

Future of farming in India

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Received: **Nov 27, 2021; *Revised:* Dec 03, 2021 *Accepted:* Dec 10, 2021**

e-ISSN: 2583-0791

Introduction

Bio-fertilizers are the substances which contain living microorganisms which, when applied to soil and plant colonize the rhizosphere and cause promotion of growth by enhancing the supply of primary plant nutrition (Vessey, 2003). Bio-fertilizers supplement nutrition through the nitrogen fixation, solubilizing phosphorus and encouraging growth of plantby synthesizing growth-promoting substances. Bio-fertilizers can be relied upon to decrease the utilization of synthetic fertilizers and pesticides. The microorganisms in bio-fertilizers rejuvenate the soil nutrient cycle and enhance organic matter in the soil. Healthy plants can be grown through use of bio-fertilizers. Consequently, they are invaluable in improving soil fertility and satisfying the plant supplement necessities by providing the natural supplements through microorganism.

On the basis of type of microorganism, bio-fertilizers can be classified as-

1. **Bacterial Bio-fertilizers** (e.g. Azotobacter, Phosphate Solublizing bacteria, Rhizobium and Azospirilium)
2. **Algal Bio-fertilizers** (e.g. Azolla and Blue Green Algae)
3. **Fungal Bio-fertilizers** (e.g. Mycorhiza)
4. **Actinimycetes Bio-fertilizer**: (e.g. Frankia)

Commonly used Bio-fertilizers in Agriculture

Rhizobium

This bio-fertilizer is comparatively more efficient and used extensively. The symbiotic association of legumes and with the rhizobium bacterium brings about the development of root nodules which cause atmospheric nitrogen fixation. The population of Rhizobium in the soil is reliant on the presence of leguminous crop. In the absence of leguminous crop the population of rhizobium populationdeclines in the soil.

Azotobacter

It is also used as bio-fertilizer. Among the various species of Azotobacter *A. chrococcum* is extensively present in Indian soil. Soil organic matter acts as vital factor that determines the bacterial growth.

PSB (Phosphate Solublizing bacteria)

The use of Phosphate Solubilizing Bacteria (PSB) as inoculant simultaneously increases posphorus uptake by the plant and hence improves the crop yield. These bacteria have capability to solubilize insoluble compounds into inorganic phosphorus. Mahamuni and Patil (2012) isolated 4 strains of PSB from sugarcane (VIMP01 and VIMP02) and rhizosphere of sugar beet (VIMP03 and VIMP 04). PSB has attracted the agriculturists as a better soil inoculums option to enhance the crop growth and yield. When PSB is employed with rock phosphate, it saves about 50 per cent need of phosphatic fertilizer by the crop.

Mycorrhizae

The distribution of Arbuscular Mycorrhizae spores in rhizosphere soil is governed by

edaphic and certain climatic factors. Soil based pot culture is applied as a common method for production of Arbuscular Mycorrhizae fungal inoculum. Dual inoculation of such fungi with a Rhizobium and other bacterium on plant enhanced the growth and other beneficial effect (Sadhana, 2014).

Azospirillum

It is well known for its close associative symbiosis with higher plants. Azospirillum have a close association with various cereal crops like; sorghum, maize, pearl millet and some other minor millets as well as fodder grasses.

Blue Green Algae (BGA)

Blue green algae are also known as rice organisms sincethey are found in abundance in rice field. Mostly nitrogen fixingBlue Green Algaeare filamentous which consists of chain of vegetative cell called heterocyst that functions as a micro nodule for synthesis of nitrogen as well as nitrogen fixing tool.

Beneficial effects of bio-fertilizers:

1. Bio-fertilizers have ability to fix atmospheric nitrogen into the soil and root nodules of leguminous crops and make it readily useable by the plant.
2. When bio-fertilizers are employed to seed or soil they enhance the availability of nutrients and boost the crop yield by 10 to 25 per cent without adversely affecting the soil and environment.
3. Microorganisms can convert complex organic material into simple compounds, so that they can be easilyused by the plants. Microorganism function results in improvement of the soil fertility. It also preservesthe natural soil habitat. It alsoenhances crop yield by 20 to 30 per cent, substitute chemical nitrogen and phosphorus by 30 per cent. It can also bring protection against soil-borne diseases and drought.
4. They cansolubilize the insoluble phosphates forms like tricalcium, iron and aluminium phosphates into readily available forms.
5. They help in decomposition of organic matter and mineralization in the soil.They alsoacts as scavenger towards phosphate present in the soil layers.
6. They develop hormones as well as anti metabolites that enhances root growth.

Bio-fertilizer application to crops

Seed treatment

Bio-fertilizer inoculants (200g) are mixed with 200 ml jaggery solution. The seeds required for one hectare are mixed well in the slurry to make uniform coating of inoculants over the surface of seeds which is kept for 30 minutes in shade for drying. After seed treatmentit should be used within 24 hours. One packet of inoculants is enough for treating 10 kg seeds. Bio-fertilizers which are used for seed treatment are Rhizobium, Azospirillum, Azotobacter and Phosphobacteria.

e-ISSN: 2583-0791

Seedling root dip

Seedling root dip method is used in case of transplanted crops. Five packets or 1 kg of the inoculants are needed for 1hectare and mixed in 40 liters of water. The roots of seedlings are dipped in the solutions for at least 5 to 10 minutes and thereafter transplanting is done. The bio-fertilizer Azospirillum is used as seedling root dip especially in case of rice.

Soil treatment

Four kg each of the recommended bio-fertilizers are mixed thoroughly in 200 kg compost and then kept overnight. The mixture formed is then incorporated into the soil.

Role of Bio-fertilizers in Agriculture

Nitrogen-fixing bacteria and Phosphate solubilizing bacteria

The incorporation of bio-fertilizers plays a vital role inenhancing fertility of soil and hence crop yield. Due to application of bio-fertilizers in soilthere is improvement in soil biota and it also minimizes the use of chemical fertilizers (Subashini *et al*., 2007). It is well knownfact that efficiency of phosphatic fertilizers is very low (15 to 20 per cent) due to its fixation in acidic and alkaline soils. Hence, the inoculation with PSB and other microbial inoculants in acidic and alkaline soils become mandatory to retain and maintain effective population of microorganisms for solublization of chemically fixed phosphorusas well as to make availability of other macro and micronutrients to achieve sustainable crop yield.

Mycorrhizae

The fungi which are most abundant present in soil are Arbuscular Mycorrhizae (AM) fungi. They account for 5to 50 per cent of biomass of soil microorganisms. Potential Role of AM in Agriculture is improvement of Phosphorous nutrition in plants. The AM-fungi also improves the uptake of potassium and enhances the efficiency of micronutrients like Zn, Cu, Fe etc. Through enzyme and organic acid secretion it makes the fixed macro and micronutrients mobile which hence become readily available to the plants. This fungus also plays a vital role in improving the water economy of plants.

Mycorrhizae significantly contribute towards soil structurethrough growth of external hyphae into soil tocreate a skeletal structure which grasps soilparticles conjointly.

The action of phytohormones like cytokinin and IAA (Indole acetic acid) is significantly higher in plants inoculated with Arbuscular Mycorrhizae. There is better growth anddevelopment of the plant as a consequence of higher hormone production.

An Arbuscular Mycorrhizae inoculation result in increased production and activity of phenolic and phyto alexien compounds which strengthens the defense mechanism of plant by imparting resistance in plants.

e-ISSN: 2583-0791

Conclusion

Application of bio-fertilizers is the only option to improve thesoil organic carbon to sustain soilquality and enhance crop productivity. Bio-fertilizer plays animportant role in improving supplementing nutritionas well as ensuring availability of crop in future. Bio-fertilizers are eco-friendly, non-bulky and also low cost agricultural input. Abio-fertilizer is an organic in nature and contains aspecific micro-organism in concentrated form which may be derived either from the rhizozsphere of plant or from the soil near the root zone. Among the various available bio-fertilizer inoculants Azotobacter, Azospirillum and Acetobacter are the key nitrogen fixers. Also, *Bacillus sp*. and *Aspergillus sp*. are important bio-fertilizer inoculants for phosphate solubilisation.

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