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Biofertilizers: A Modern Approach for Organic Farming

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ARTICLE ID: 005

Introduction:

Bio-fertilizer is a material which contains living microorganisms. When applied to plant surfaces, they promotes plant growth by increasing the supply of primary nutrients to the host plant. Bio-fertilizers add nutrients through natural processes like nitrogen fixation, phosphorus solubilisation and stimulating plant growth along with the synthesis of growth-promoting substances. Some PGPR promote the growth by acting as bio-fertilizer. Microorganisms mainly nitrogen fixers, phosphate solubilizers and mycorrhizae are the main sources of bio-fertilizers. The microorganisms used for the biofertilizer are bacteria like *Bacillus*, *Pseudomonas*, *Lactobacillus*, photosynthetic bacteria, nitrogen fixing bacteria and fungi like Trichoderma and yeast. Bio-fertilizers have shown great potential as a renewable and environmental friendly source of plant nutrients. Foregoing researches have reported positive, rarely negative and the lack of any significant influence of biofertilizers on soil physical, chemical and biological properties. In view of the growing demand for safer and healthier food and concerns for environmental sustainability, organic farming has emerged as an important priority area globally.

History of Bio-fertilizers:

Bio-fertilizers differ from chemical and organic fertilizers in the sense that they do not directly supply any nutrients to crops and are cultures of special bacteria and fungi. Historically, the bio-fertilizers were initially identified by a Dutch scientist in 1888, thereafter bio-fertilizers use started with the launch of Nitragin by Nobe and Hiltner with a laboratory culture of Rhizobia in 1895 (Ghosh, 2004). In India the first commercial production of bio-fertilizer started in 1956 under the supervision of N.V Joshi. The NIKU Bio Research Laboratory was established in the year 1997 at Pune. The initial name signifies N=Natural, I=Input, K=Complete and U=Utilization.

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Classification of Bio-fertilizers:

- **N Fixing bio-fertilizers:** *Rhizobium, Azotobacter, Azospirillum, Clostridium* and *Acetobacter.*
- **P solubilising/mobilising bio-fertilizers:** Phosphate solubilising bacteria (PSB) and Phosphate solibilising microorganism (PSMs); e.g. *Bacillus, Pseudomonas* and *Aspergillus.*
- **K solubilising/mobilising bifrtilizers:** *Bacillus mucilaginosus, Bacillus edaphicus, Bacillus circulans, Paenibacillus etc.*

Important Bio-fertilizers

Some of the important bio-fertilizers are mentioned below with a concise explanation of the main features.

- ***Rhizobium***

In legume-rhizobium symbiosis, rhizobia induce nodules formation on the roots of leguminous plants. In this process, N_2 which is chemically inert and makes up approximately 80% of the volume present in the Earth's atmosphere is reduced to ammonia by the bacterial enzyme nitrogenase. The annual N-value of legume symbioses is about 70 million tons.

Rhizobium species that can form nodules and fix N with specific leguminous plants are:

Rhizobium ciceri	Chickpea
Rhizobium etli	Beans
Bradyrhizobium japonicum	Soybean
Rhizobium leguminosorum	Peas, broad beans, lentils etc.
Rhizobium lupine	*Lupinous sp.* and *Ornithopus sp.*
Rhizobium meliloti	Sweet clover, alfalfa, fenugreek
Rhizobium phaseoli	*Phaseolus*
Rhizobium trifoli	*Trifolium sp.*

Source- (Principles of Agronomy, SR Reddy 2019)

- ***Azotobacter***

Azotobacter is a free living and aerobic chemo-heterotrophic N_2 fixing bacterium; it can successfully grow in the rhizospheric zone of wheat, maize, rice, cotton, tomato, okra and

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many others crops and fix 10-20 kg N ha^{-1} cropping $season^{-1}$ (Jadhav *et al*., 1987). Azotobacter synthesizes and secretes considerable amounts of biologically active substances like vitamin B, nicotinic acid, pentothenic acid, biotin, heteroauxins, and gibberellins etc., which enhance root growth of plants. Azotobacter sp. has the ability to produce antifungal antibiotics and fungi static compounds against pathogens like *Fusarium* sp., *Alternaria* sp. and *Trichoderma* sp. (Witter *et al*., 1996). All these factors combined together produce positive effects on crop yield.

- ***Azospirillum***

Azospirillum is chemo-heterotrophic bacteria associated with the roots of sorghum, pearl millet, rice, maize, wheat and sugarcane crops (Eetela sathyanaryana, 2020). *Azospirillum* genomes, as previously suggested for various strains are larger and are comprised of multiple replicas indicating a potential for genome plasticity. Most studies on the Azospirillum inoculation have suggested that nitrogen fixation was the major mechanism of plant growth. Lima *et al*. noted that up to 50 per cent of the N content of crops such as sugarcane, *Panicum maximum* and *Paspalum notatum* could be supplied by associated nitrogen fixers mainly Azospirillum.

Importance of Bio-Fertilizers

From the literature survey, the following conclusions can be drawn regarding the impact of bio-fertilizers:

- Reduce over dependence on chemical fertilizers and pesticides that has created problems in agriculture (Chaturvedi, 2006)
- Nutritional quality significantly higher in the bio-fertilizers produced product (Pascale, S. De. *et al*,1995)
- Bio-fertilizer works as a vegetative and yield growth promoters .
- It is beneficial always in terms of soil fertility, ecological health etc.

Conclusion

There is no doubt that bio-fertilizers are the potential tools for sustainable agriculture not only in India but also globally. Our dependence on chemical fertilizers and pesticides has encouraged the thriving of industries that are producing life threatening chemicals which are

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not only hazardous for human consumption but can also disturb the ecological balance. Bio-fertilizers being essential components of organic farming play vital role in maintaining long term soil fertility and sustainability by fixing atmospheric di-nitrogen (N=N), mobilizing fixed macro and micro nutrients or convert insoluble P in the soil into forms available to plants, thereby increases their efficiency and availability. The application of bio-fertilizers can minimize the use of chemical fertilizers, decrease environmental hazards, enhance soil structure and promote agriculture. Bio-fertilizers are cheaper and remarkable in affecting the yield of cereal crops. Bio-fertilizers being important components of organic farming play a key role in maintaining long term soil fertility and sustainability by fixing insoluble P in the soil into forms available to plants, thus increasing their effectiveness and availability. In context of both the cost and environmental impact of chemical fertilizers, excessive reliance on the chemical fertilizers is not a useful strategy in the long run.

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