**ROLE OF BIOFERTILIZERS IN SUSTAINABLE AGRICULTURE AND ENVIRONMENTAL DEVELOPMENT**

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**ABSTRACT**

Producing healthy crops for the fulfilment of the demands of the world’s growing population is fully dependent upon kind of of the fertilizers being used to provide the plants with all the important nutrients but more dependability on the chemical fertilizers is destroying the environmental ecology and negatively impacting the health of humans. Bio based fertilizers are basically the preprations of living cells or latent of efficient potential microbial strains that assist the plants in nutrient uptake by their associations in the rhizosphere region when supplied to the plants either through the seed or the soil .Thus using microbes as bio inoculants is believed to be the best substitute of chemical fertilizers as eco-friendly manner for plant growth and soil fertility.

KEYWORDS- Bio based fertilizers ; Environmental ; Microbial strains ; Soil fertility.

**I-Introduction**

The term Biofertilizers denotes nutrient inputs of plant growth which are biological origin .The Biofertilizer restore the soils natural nutrient cycle and build soil organic matter .The role of Biofertilizer in agriculture Production assumes Special significance particularly in the present context of expensive Chemical fertilizers.Moreever it can provide to the farmers a new strategy which is helpful for achieving the goal of increasing productivity. “Bio-Fertilizers refer to various inoculants or Cultures containing a specific microorganisms in concentrated form which are derived either from nodules of plant roots or from the soils of roots of Leguminous Plants or Non Symbiotically (free living) or to transfer native soil nutrients such as P,Zn, Cu, Fe,S etc. from the non usable (fixed) form to usable form through biological processes.”.Biofertilizer is the need of modern agriculture since demand for safe and residue free food is increasing.Biofertilizer become popular to counter the negative impact of indiscriminate use of chemical fertilizers.Biofertilizers help in fixing atmoshpheric nitrogen, converting soil phosphate and potash into soluble forms to make them available to plants . Biofertilizers are selective microorganisms.They provide cost effective , eco-friendly and renewable source of nutrients.They improve the nutrient availability to the crops in which biological process is involved.

**II- Scope and Importance of Biofertilizers**

**1.Permanent effect -**Chemical fertilizers have temporary effect while Biofertilizers have permanent effect without any production problem.

**2.Protection-** Biofertilizers provide protection against drought and some soil born diseases.

**3**. **Cheap –** Biofertilizers are very cheap as compared to chemical fertilizers because raw material required for the growth of microorganism is very cheap. The infrastructure and equipment required for growth of microorganism is very cheap. Use of biofertilizers is economical with a high cost: benefit ratio, without risk.

**4**. **Simple methods –** The production method of Biofertilizer is very simple. It requires low investment, small space and less labour and equipment as compared to production method of chemical fertilizers. They can be manufactured in any simple microbiology laboratory.

**5**. **Natural –** Biofertilizers are natural. They are not foreign to the soil so they create no pollution problem.

**6**. **Biocontrol –** Few microorganisms used as biofertilizers also controls plant pathogens either developing mechanical barrier for entry of plant pathogens e.g. Mycorrhiza or produce antibiotics killing plant pathogens e.g. *Streptomyces*.

 **7**. **Supply nutrient** – They may supply other nutrients and increase fertility of soil. The Azotobacter added in the soil for nitrogen fixation may have amylolytic or proteolytic activity thus Azotobacter also helps in development of humus.

**8**. **Prevents soil erosion** – Biofertilizers may prevent soil erossion. Many microbial inoculant may produce extra cellular, capsular polysaccharide which is viscous in nature. This viscous substance adheres to the soil particle and prevents erossion of soil

**9**. **Supply hormones and vitamins –** They may supply vitamins and plant growth hormones. Many microorganisms secretes auxins, ethylene, abscisic acid, cytokinin, pantothenic acid, indol acetic acid and gibberellin like substances which promote plant growth.

 **10**. **Mobilizes immobilized nutrients –** Biofertilizers convert immobilized chemical fertilizers into soluble forms. Soluble inorganic phosphates lost in the soil due to chemical reactions in insoluble inorganic phosphate us again converted soluble phosphate by biofertilizer. Thus biofertilizer can act as a renewable supplement to chemical fertilizers and organic manures.

. **11.** **Provides essential elements and enzymes-** Biofertilizer provide essential elements like nitrogen, potash phosphorous, sulphur etc. by directly supplying them or transforming them into soluble form; in addition, they also helps plants to uptake several micronutrients. They supplies some important enzymes, hormones and antibiotics that enhance crop growth and crop yields.

**12**. **Protects from adverse environment -**Some biofertilizers protects plants against drought, high . temperature shock, high salinity etc.

III- **Microbes used as Biofertilizers**

**III-Types of Biofertilizers**

Broadly biofertilizers are divided into seven main categories, these are again divided in subtypes as follow

1. **Nitrogen Fixers**

The process of converting atmospheric nitrogen into ammonia by the diazotrophic microbes is known as biological nitrogen fixation (BNF). BNF allows the replenishment of total nitrogen content and the fixed nitrogen regulates the crop growth and yield. Chemical fertilizers cause increased nitrogen oxide emission, water eutrophication and soil acidification. Whereas, biologically fixed nitrogen is sustainable and is less available for leaching and volatilization. Nitrogen fixation is more or less limited to bacteria and archaea, which forms a large portion of diazotrophic organisms. Nitrogen-fixing groups include green sulphur bacteria, firmibacteria, actinomycetes, cyanobacteria and all subdivisions of the proteobacteria. However, only methanogens are able to fix nitrogen among archaea. Different bacterial strains are able to carry out nitrogen fixation with different physiologies including: aerobic (for example, Azotobacter), anaerobic (Clostridium), facultatively anaerobic (Klebsiella) or heterotrophs; an oxygenic (Rhodobacter) or oxygenic (Anabaena)

 **i)Symbiotic nitrogen fixers –** (symbiotic nitrogen fixers live in association with other plant) *Rhizobium, Azolla*. etc.

**ii)Non Symbiotic nitrogen fixer** –( Non symbiotic nitrogen fixers are free living forms ) *Azotobacter, Azospirillum, Anabaena,Nostoc,Oscillatoria*,*Bacillus*,etc.

**B. Phosphate Suppliers**

Phosphorous is a vital macronutrient required for the growth and development of a plant. Usually, phosphorous exists in the form of tricalcium, dicalcium phosphate and minerals. The process of solubilization and mineralization in soil i.e., conversion of organic form of phosphate into inorganic form is carried out by phosphate-solubilizing bacteria . Mycorrhiza also play crucial role in phosphorus mobilization, nutrient cycling and enhancement of microbial biomass. Generally, indigenous arbuscular mycorrhizae (AM) are found in soil, which colonizes the plant roots and stimulate plant growth. Inoculation of low phosphorous soil with mycorrhiza causes a sudden increase in availability of phosphorous.

**i) Phosphate solubilising microorganisms –***Bacillus, Aspergillus, Pseudomonas*

**ii) Phosphate absorber –** V.A. mycorrhiza (**VAM** fungi)

 **C. Sulphur Suppliers**

Sulphur is generally regarded as trace element in majority of crop plants. But this is one of the major elements in oilseed crops, some important vegetables (onion, oat, cauliflower etc.) and inn some spices (ginger, garlic etc.) it is important element. Sulphur essential for biochemical synthesis of some important glycosides, pungent compound and disease resistant properties. Soil is composed of organic as well as inorganic sulphur and the process of conversion of organic sulphur into plant utilizable inorganic sulphur (i.e., SO42−) form is carried out by sulphur-oxidizing bacteria (SOB) including Xanthobacter, Alcaligenes, Bacillus, Pseudomonas, Thiobacillus.Deficiency of sulphur in agricultural soil could be corrected using sulphur oxididizing bacteria as boifertilizer

 **D. Potash solubilizing bacteria**

Potassium is ranked at third position as crucial plant nutrient after nitrogen and Potassium is available in plentiful amount in the soil but only a small fraction (1–2%) of it is available to plants. Hence, a system of continuous replenishment of potassium in soil solution is needed for its adequate availability to crop plants Like other nutrients, potassium also influences growth and development of plants. . In deficiency of potassium, root growth becomes slow and gets poorly developed, seeds will be of small size and disease susceptibility will be more leading to reduction in crop yield PGPRs present in the soil and rhizosphere convert the potassium present in insoluble form into soluble form. Some of the potassium solubilizing microbes (KSMs) are Acidithiobacillus Arthobacter ,Enterobacter , Paenibacillus , Aminobacter, Pseudomonas, Paenibacillus,, Sphingomonas,, Bacillus,Klebsiella.a

 **E. Zinc solubilising microbes-**Among micronutrients, zinc deficiency is the most widespread nutrient deficiency. The alternative technology for providing zinc to the plant is to inoculate the crop with the zinc-solubilizing microorganisms. A major portion of zinc available to plant is provided by the microbial activity Microbes produce organic acids, which cause decline in pH and these organic acids act on zinc complexes in soil,thus cause sequestering the zinc cation.Prominent zinc-solubilizing microbes are Pseudomonas protegens RY2, Rhizobium spp., Bacillus altitudinis , Thiobacillus thioxidans  Azospirillum and *Gluconacetobacter*.

**F. Mycorrhiza -**Fungal species like *Aphalosporra, Glomous, Jaigospora, Enterophosphora* etc penetrates roots of different crops (most commonly found in Litchi) and form specialized structures like Vesicles and Arbuscles within the cortex. For this reason they are popularly known as Vesicular Arbuscular Mycorrhiza or VAM. Almost 90% of plants, including the most important agricultural crops, are associated with VAM fungi. VAM fungi reported increases the uptake of water phosphorous and some other micronutrients like Cu, Zn, Mn, or Fe. Besides these, they possess synergistic interaction with beneficial soil microorganisms such as nitrogen fixing and PSMs. VAM fungi also supply some growth regulators to plants and protects crop plants from high temperature shock, drought and salinity and prevents different disease and nematode attack

 **G. Organic matter decomposer** – Cellulolytic, Lignolytic, Proteolytic, or amylolytic

**Cellulose decomposing inoculants** Many soil borne fungal species like *Aspergillus, Penicillium, Tricoderma, Chaetomium* etc. acts as activator in the decomposition process of plant bodies containing cellulose or lignin. Plant bodies rich in cellulose and/or lignin are resistant to microbial decomposition and therefore, takes long time before they could be used as organic source of nutrition. High quality compost could be prepared within a short time by applying the mentioned fungal species into organic waste material collected from farm or community

**IV-Precaution for use of biofertilizer**

 1. Biofertilizer containing specific species of microorganism should be applied for specific crop.

 2. Biofertilizer packet should not be exposed to direct sunlight for long time, the seeds treated with

 biofertilizer should be kept for 30 minutes in shady place.

 3. For maximum result biofertilizer should always be mixed with bulky organic manures.

 4. Biofertilizer should be used before its expiry date.

 5. After treating the seeds with biofertilizers, seeds should not be treated with any kind of chemical fertilizer or pesticides.

 6. Chemical fertilizers should not be applied one week before or after application of biofertilizer

**V-Conclusion**

Biofertilizers are one of the key factors in sustainable agriculture that can assist in solving the problems

of feeding an increased world population at a time when agriculture is going through various environmental stresses.Hence research should be focussed on new aspects of Biofertilizers.. In current agriculture practices , chemical fertilizers have reduced the fertility of soil, making it unsuited for raising crop plants. Additionally, the excessive use of these inputs has also led to severe health and environmental hazards such as soil erosion, water contamination, pesticide poisoning, falling ground water table, water logging and depletion of biodiversity. Biofertilizers spontaneously activates the microorganisms found in the soil in an effective and eco-friendly way, thereby gaining more importance for utilization in crop production, restoring the soils fertility and protecting it against drought, soil diseases and thus stimulate plant growth. Biofertilizers lead to soil enrichment and are suitable with long-term sustainability. Further, they pose no danger to the environment and can be substituted with chemical fertilizers. The application of bio-fertilizers can minimize the use of chemical fertilizers, decreasing environmental hazards, enhance soil structure and promote agriculture.

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