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Role of Biofertilizer in Agriculture

Praveen Kumar Singh, Assistant Professor
College of Agriculture Sciences, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, India
Email id- dr.pksnd@gmail.com

ABSTRACT: Bio fertilizers are organic fertilizers that are live microbial inoculants comprising bacteria, algae, or fungus that supplement the bioavailability of nutrients to plants and sometimes in combination. Biofertilizers are becoming increasingly significant in agriculture, particularly in light of growing chemical fertiliser costs as well as their possibly detrimental effects on soil health. Soil enrichment is accomplished utilising biofertilizers, both of which are long-term sustainable. They are also environmentally friendly and do not represent a harm to the environment, so they should be used in place of chemical fertilisers. The author discusses the role of biofertilizer in farming in this work. Biofertilizers have developed as a powerful compared to chemical fertilisers today due to its environmentally, easy-to-apply, non-toxic, and cost-effective properties. They also serve as a complement to agrochemicals by allowing plants to use nutrients found in soils or even in the environment.

KEYWORDS: Agriculture, Bio-Fertilizers, Environment, Nitrogen Fixation, Nutrients.

1. INTRODUCTION

In modern agriculture, irrigation is encouraged not only through the use of hybrid seeds or high-yielding varieties that are sensitive to significant doses of chemical fertilizers, but also through the use of hybrid seeds or high-yielding varieties. which are sensitive to significant doses. chemical fertilizers. Chemical fertilizers have been utilized indiscriminately, resulting in land or water basin contamination and degradation. As a result, the soil has been devoid of essential plant nutrients or organic materials (Raimi et al., 2021). Beneficial bacteria including insects have become extinct; soil fertility has decreased, as well as crop disease susceptibility has increased. By 2020, requirement for nutrients is expected to be 28.8 million tonnes, while supply is expected to be 21.6 million tonnes, resulting in a 7.2 million tonne deficit, depleting feedstocks/fossil fuels as well as increasing fertiliser costs,

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which will be unaffordable for small scale farmers, accelerating soil fertility exhaustion due to broadening nutrient gaps (Sun, Bai, et al., 2020).

Fertilizers have depleted soil quality since the agricultural revolution by making the soil ecology inhospitable for soil microflora or micro fauna, which are vital for sustaining soil fertility or providing plants with certain critical and crucial nutrients. Biofertilizers are examples of products one or even more organisms that, through biochemical functions including such nitrogen fixation, phosphate solubilization, secretions of growth-promoting substances or cellulose, as well as biodegradation, can mobilize nutrient important elements from non-usable to useable format in soil, compost, or other environments (Garcia-Gonzalez & Sommerfeld, 2016). Biofertilizers, including live microbial organic amendments of bacteria, algae, or fungus, are organic fertilizers that augment the availability of nutrients for plant growth alone or in combination. Biofertilizers are becoming more significant in agriculture, particularly in light of growing chemical fertilizer prices and their possible detrimental effects on soil health (Sun, Gu, et al., 2020).

Large amounts of chemical fertilizers are expensive and have negative consequences for soil Physico-chemical characteristics. As a result, various organic fertilizers that work as natural nerve stimulation for plant growth or development have been created in recent years. Natural stimulators, also known as microbial inoculums, have a long history, extending back to a small composting manufacturing culture that has been passed down from farmer to farmer. A subset of this type of fertiliser is biofertilizers and microbial organic amendments, which are products has resulted living or latent cells of efficient strain of nitrogen-fixing, phosphate-solubilizing, and cellulolytic microorganisms (Kumari & Singh, 2020). These are administered to seed, soils, and compost sites to boost the population of microbes and speed up specific microbial activities, resulting in more nutrients accessible in a form that plants can assimilate. These biofertilizers are important components of soil-based nutrient management, and a key role in oil production or sustainability. As a cost-effective, ecologically friendly, or renewable fertiliser, these biofertilizers were slowly replacing synthetic fertilisers in agriculture (Kumari & Singh, 2020).

1.1. A Critical Need in Agriculture: Biofertilizer:

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Environmental dangers and challenges to sustainable agriculture are causing increasing worry these days. Given the above characteristics, long-term usage of biofertilizers over chemical fertilizers appears to be more cost-effective, environmentally friendly, effective, productive, as well as accessible to the farming community. As a result, the usage of biofertilizers is generally required for two reasons. First, greater fertiliser usage increases agricultural productivity; second, enhanced inorganic fertiliser use destroys soil texture or produces other environmental problems (Zwolak et al., 2019).

Biofertilizer classification in the development of biofertilizers, a variety of microorganisms and their interactions with agricultural plants are used. They may be classified in a variety of ways depending on their nature or purpose (Jia et al., 2021). Rhizobium is a soil-dwelling bacteria that colonizes legumes roots but also symbiotically fixes nitrogen from the air. Rhizobium has a wide range of shapes or physiology, from free-living to nodular bacteroid. They seem to be the most efficient company is interested in terms of nitrogen fixation. Because they comprise seven genera and are particularly selective for developing nodules in legumes, they are classed as crossover inoculation groups. Azotobacter is a bacterium that belongs to the Azotobacter genus. The most prevalent inhabitant in arable soils capable of resolving N2 in culture media is chroococcum. The bacterium produces a lot of slimes, which aid in the clumping of the soil. The population of A. niger has decreased leading to a shortage of organic matter or the occurrence of unfriendly bacteria in Indian soils. Chromococcum seldom surpasses 105 grammes per gramme of soil. Azospirillum lipoferum and Azospirillum sp. The major occupiers of graminaceous plant soils, rhizosphere, and root cortex intercellular gaps are Brasilense. With graminaceous plants, they have an associative symbiotic connection. Aside from nitrogen fixation, Azospirillum inoculation has other advantages such as the synthesis of growth-promoting substances (IAA), disease resistance, or drought tolerance (Li et al., 2019). Cyanobacteria (blue-green algae): In India, both free-living and symbiotic cyanobacteria (blue green algae) have been used in rice production. Rice producers throughout India have not been drawn to this biofertilizer, which was formerly widely advertised as a rice crop biofertilizer (Yadav et al., 2021).

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Under ideal circumstances, the advantages of legalization might be as high as 20-30 kg N/ha, but the labor-intensive technology for making ball grid array (BGA) biofertilizer is a restriction in and of itself. Azolla is indeed a free-floating water fern that works with the ammonia blue-green alga Anabaena azollae to fix atmospheric nitrogen. Azolla can be used as a substitute for or in addition to traditional nitrogen fertilisers. Azolla is a wetland rice biofertilizer that produces 40-60 kg carbon dioxide per hectare of rice. Microorganisms that dissolve phosphate (Levenda et al., 2021). Several soil bacteria and fungus, including Pseudomonas, Bacillus, Penicillium, Aspergillus, and others, release organic acids that decrease the pH in their proximity, allowing bound phosphates in the soil to dissolve. Inoculation of Bacillus polymyxa or Pseudomonas striata peat-based cultures resulted in increased wheat and potato yields (Vakulchuk et al., 2020).

Intracellular obligate fungal scientists have begun of the genera Glomus, Gigaspora, Acaulospora, Sclerocysts, but also Endogone, which have vesicles for storing nutrients but rather arbuscles for funneling these nutrients into the root system, is responsible for the transmission of nutrients from the soil milieu to the cells of the root cortex. Glomus seems to be by far the most abundant genus, with numerous species found in soil. Microorganisms that degrade silicates or aluminum silicates are known as silicate solubilizing bacteria (Van et al., 2020). Several chemical acids are formed during the metabolism of microorganisms, so these organic acids have a dual function in silicate weathering. Organic acids including citric, keto acids, oxalic acid, or hydroxy carbolic acids, that also form complexes with metal ions, increase their removal or preservation in the medium inside a dissolved state. Growth of the plants promoting rhizobacteria (PGPR): Plant growth-promoting rhizobacteria are microorganisms that colonize roots through rhizosphere soil or are advantageous to plants (PGPR). PGPR inoculants boost development by suppressing plant disease (referred to as Bioprotectants), improving nutrient uptake (referred to as Biofertilizers), or producing phytohormones (termed Biostimulants). Pseudomonas and Bacillus species may create phytohormones or growth regulators that encourage crops to develop more fine roots, increasing overall system can be represented of the root system for nutrient or water absorption. Indole-acetic acid, cytokinins,

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gibberellins, or inhibitors of ethylene synthesis are among the phytohormones produced by these PGPR, which are known as Biostimulants (Garg et al., 2012).

1.2. Biofertilizer Application Techniques Seed Treatment:

Biofertilizer is dissolved in 300-400 mL water or carefully mixed with 10 kg of seeds to use an adhesive like gum acacia, jaggery solution, or whatever similar. The seed are then placed out to dry in the shade on a clean sheet/cloth and planted immediately away. Seedling Root Dip: This method is used for transplanted crops. In order to plant rice, a fields bed is built or filled with water (Jun et al., 2021). This water is mixed with biofertilizers, as well as seedling roots are submerged for 8-10 hours before transplanting. Soil Treatment: Overnight, combine 4 kg of each of the recommended biofertilizers with 200 kg of compost. This combination is incorporated into the soil while sowing and planting. The Benefits of Biofertilizers provide several benefits, including the following:

- They are both environmentally and economically favorable.
- Their usage results in soil enrichment, and the soil's quality increases over time.
- Though they may not provide instant benefits, the long-term results are amazing.
- These fertilizers capture nitrogen from the atmosphere and make it accessible to plants immediately.
- They raise the phosphorous content of soils by solubilizing or releasing phosphorus that is otherwise inaccessible.
- The release of growth-promoting hormones by biofertilizers improves root proliferation.
- Microorganisms break down complicated nutrients into basic nutrients so that plants can use them.
- Biofertilizers include microorganisms that encourage a sufficient amount of nutrients to host plant or maintain normal growth or physiological control; they may assist increase crop production by 10 to 25 percent.
- To some extent, biofertilizers may protect plants from soil-borne illnesses.

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Biofertilizer Technology Constraints even though biofertilizer technology is a low-cost, environmentally benign technology, it is limited in its use or implementation due to several factors. Constraints might include:

- Technological restrictions, such as a shortage of excellent quality carrier material and competent technical employees in the manufacturing plants.
- Infrastructure issues such as a lack of critical equipment, electricity, and so on.
- Financial obstacles, like as lack of adequate finances or difficulties procurement bank loans.
- Ecological restrictions such as seasonal biofertilizer need, simultaneous cropping activities, or a limited period of planting/sowing in a specific location, among others.
- Human resource or quality restrictions, such as a shortage of technically trained personnel in manufacturing units or inadequate training in production procedures.
- Lack of knowledge of the technology's benefits due to challenges in farming adopting it due to various inoculation techniques but no discernible improvement in crop development when comparing to inorganic fertilisers.
- Marketing obstacles, such as a lack of availability of the proper inoculant at the right time and location, as well as lack of the retail outlet or a market networks for the manufacturers.
- Different constraints influence production, marketing, and usage techniques in one way or another.

1.3. Crop production and nitrogen fixation

Nutrients must be supplied in adequate and balanced amounts for optimal plant development. Besides photosynthesis, nitrogen fixation seems to be the second most important stage in crop development. Photosynthesis converts light into electricity, whereas nitrogen fixation transforms nitrogen gas produce ammonium. Nitrogen fixation may provide up to 400-500 kg of nitrogen per hectare per year for free. The biological conversion of dinitrogen inside the atmosphere to ammonia is possible.

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Crop plants have access to this ammonia. Few bacteria in the soil convert ammonia to nitrate, which is subsequently accessible to plants (Güney, 2019).

Biological nitrogen fixations may produce up to 200 million tonnes of nitrogen per year in terrestrial ecosystems as well as 30 to 300 million metrics in marine habitats. In addition, chemical fixation owing to atmospheric events results in 20 million tons. By the end of the nineteenth century, the first industrial manufacture of rhizobium inoculant had begun. Nevertheless, since World War II, the supply of nitrogenous synthetic fertilizers has been steadily growing to maintain the development of cereal crops, legumes, and other agriculturally important plants.

1.4. Precautions to consider while using biofertilizers:

- Store biofertilizer packets away from direct sunshine or heat inside a cold, dry spot.
- It's crucial to use the correct biofertilizer mixtures.
- Rhizobium is cropped specific, hence it should only be used for that crop.
- Biofertilizers should not be used with other chemicals.
- Before purchasing, double-check so each packet has vital information including the product's identity, the plants for which it is intended, the product's home address, as well as the date of production, the time of expiration, the serial numbers, or usage instructions.
- The packet must be used before it expires, only for the crop stated, and only with the suggested application technique.
- Biofertilizers are living products that need special handling during storage.
- To get the optimum results, combined nitrogenous, as well as phosphatic biofertilizers, should be employed.
- Biofertilizers, in addition to chemical fertilizers or organic manures, should be used.
- Biofertilizers are not fertilizer replacements, but they may help plants meet their nutritional needs.

2. DISCUSSION

Bio - fertilizers are living microbe compositions that, whether applied to root, seed, or soil, mobilise nutrient supply via biological processes, or help in the

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establishment of microflora or, as a consequence, soil health. Bacterial spores in bio-fertilizer guarantee that now the host plants receive an appropriate quantity of nutrients but that their growth but also physiology are properly regulated. The selection of suitable strains for a type of crop in such a given agro-climate is vital for the development of microbial bio-fertilizer. Because agro-climatic variables and soil qualities vary so much, each bio-fertilizer requires a significant number of strains to be separated for each location. Bio-fertilizers are environmentally benign, one of the greatest modern agricultural tools, that's used to increase soil fertility and quality. It provides a cost-effective and environmentally friendly way to supplement nutrition supplies. Leguminous crops may fix nitrogen (N) from the atmosphere organically. This will enhance not just the legumes, however any intercropped or future crops as well.

The advantages of utilizing biofertilizers:

- Increase crop yields by 25% to 35%.
- By 25 percent, chemical nitrogen or phosphorus is replaced.
- Encourage the development of plants.
- Biologically activate the soil.
- Restore the soil's natural fertility.
- Provide drought resistance and resistance to several soil-borne illnesses.

3. CONCLUSION

By fixing atmospheric di-nitrogen and mobilising fixed macronutrients inside the soils into forms usable to plants, biofertilizers, which are fundamental components of organic farming, play a critical role in ensuring long-term soil fertility and sustainability. There is already a ten million tonne gap in plant nutrients between crops removal but also supply via chemical fertilizers. Excessive dependence on chemical fertilisers, both in terms of cost and environmental effect, is not feasible in the long run due to the costs of building up fertilizer factories and maintaining output, both in terms of local resources or foreign exchange. Biofertilizers would be a realistic choice for farming to improve productivity every unit area in this situation. Bio fertilisers have evolved as a potent alternative to chemical fertilisers because to their eco-friendly, easy-to-apply, non-toxic, or cost-effective properties.

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They also work as a supplement to agrochemicals by converting minerals that seem to be naturally abundant in soil or even the atmosphere into nutrients that are valuable to plants.

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