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A Short Review On Biofertilizers In Soil Fertility

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Abstract

Soil fertility is the major component of sustainable agriculture . The health and productivity of the crop ecosystem largely depend on it. Continuous application of chemical leads to the degradation of soil, nutrient imbalances, and environmental pollution. Biofertilizers, as microbial inoculants comprising living bacteria, fungi, and cyanobacteria among others, are considered safe for the environment as an alternative input They increase soil fertility by nitrogen fixation from the atmosphere, phosphorus solubilization, and organic matter decomposition . This paper reviews the role, types, mechanisms, effectiveness in raising soil fertility and crop productivity levels, integration into sustainable agricultural systems constraints in their future development that need to be addressed.

Introduction

Soil fertility is the capacity of the soil to provide adequate nutrients essential for the growth of plants at a specific time. Fertility depends on, or rather is a function of, the chemical, physical, and biological properties of the soil (Brady &Weil, 2016). High productivity in modern systems is sustained by heavy reliance on the input of chemical fertilizers into the soil. However, long term use has made soils unproductive besides killing microbes in the soil and causing environmental pollution (Sharma et al., 2013; Mahanty et al., 2017).

Biofertilizers are defined as living microbial inoculants which may be better described as organisms that create greater supply or availability of essential nutrients to the plant (Vessey , 2003). These microorganisms reside within the rhizosphere, inside the plant itself, and facilitate uptake of nutrients by normal biological pathways. It is green, renewable energy that increases
soil fertility with no negative impact on soil health.

The major groups of biofertilizer include nitrogen-fixing bacteria such as Rhizobium, Azotobacter and Azospirillum; Phosphate solubilizing microorganisms like Bacillus and Pseudomonas; Cyanobacteria; Mycorrhiza. Application of these biofertilizers results in the restoration of ecological balance back to the degraded agricultural ecosystem and leads to sustainable crop production while reducing the input of synthesized fertilizers(Singh et al., 2011; Bhardwaj et al., 2014).

Review of Literature

Nitrogen-Fixing Biofertilizer

Nitrogen is essential for the growth of plants but is not readily accessible to most in its gaseous form as N_2. Some microorganisms are able to convert the atmospheric nitrogen into ammonia using biological nitrogen fixing(Bhattacharyya & Jha, 2012).

Symbiotic N-fixers: Species of Rhizobium induce the formation of nodules on legume roots and fix atmospheric nitrogen in return for carbohydrates. This increases nitrogen fertility in the soil for future crops(Peoples et al., 2009).

• Nitrogen-Fixing Free-Living:Azotobacter species,And Clostridium; fix nitrogen autonomously in the soil. They also secrete growth stimulating compounds: auxins and gibberellins Bhattacharyya & Jha, 2012).

• Associative Nitrogen Fixers: In cereals, Azospirillum spp. Associate with cereal roots, improving root growth and nutrient uptake(Dobbelaere et al., 2003).

Studies have also showed that the demand for chemical nitrogen fertilizers can be reduced by 20% from using nitrogen-fixing biofertilizers(Mahanty et al., 2017).

Phosphate-Solubilizing Microorganisms

Phosphorus is important for energy and root in the plant, yet it becomes immobile and unavailable in soil due to its insoluble forms. Phosphate-solubilizing microorganisms, including Pseudomonas striata, Bacillus magisterium, Aspergillum Niger and Penicillium spp. Secrete organic acids and convert the insoluble phosphate into plant utilizable form(Sharma et al., 2013; Rodriguez & Fraga, 1999).

Mycorrhiza Biofertilizers

Arbuscular Mycorrhiza Fungi (AMF) establish mutualistic associations with the roots of most plants, increasing root area via fungal hyphae. These fungi enhance nutrient uptake of phosphorus, zinc and copper; improve drought resistance and protect plants from root pathogens(Smith & Read, 2008; Miransari, 2010).

Studies have shown that AMF inoculation leads to more efficient nutrient uptake, higher soil aggregation and greater soil organic carbon stock(Gosling et al., 2006).

Cyanobacterial and Algal Biofertilizers

Cyanobacteria – Blue-green algae Anabaena, Nostoc and Tolypothrix are found to have a marge role in nitrogen fixation of paddy fields. They fix nitrogen and produce organic material, which improves fertility and structure of soil(Prasanna et al., 2008).

The aquatic fern Azolla, which contains Anabaena azollae in its leaves, is used as a green manure and nitrogen source for rice fields. Researches revealed that Azolla and blue green algae can substitute 25 % chemical nitrogen application in rice cultivation(Singh, 2014; Mahanty et al., 2017).

Fungal Biofertilizers

Fungal biofertilizers Penicillium spp. Stimulate nutrient mineralization and plant growth(Harman et al., 2004). Trichoderma stimulates root expansion and provides a defence against plant parasites of the soil through antifungal compounds. It decomposes organic matter too, and enriches the soil with vital nutrients like Trichoderma spp. And s.

Consortium Biofertilizers

New studies have focused on biofertilizer consortia containing several microbial strains with complementary properties (nitrogen fixation, phosphate solubilization, and stimulation of plant growth)(Mishra et al., 2021; Mahanty et al., 2017).

Discussion

Biofertilizers are very important in the maintenance and enhancement of soil fertility by diverse biological means. They supply nutrition to the soil, its biota, and plant growth. At the same time, they support the ecological balanceal., (Bhardwaj et al., 2014; Singh et al., 2011).

1. Nutrient Cycling:

These biofertilizers perform the conversion of atmospheric nitrogen and insoluble phosphorus into plant-easily available forms(Vessey, 2003; Rodriguez & Fraga, 1999). Chelating and enzyme secretion also improve micronutrient uptake(Mahanty et al., 2017).

2. Soil Microbial Health:

Biofertilizers increase microbial biomass. They increase enzyme activitydehydrogenase and phosphatasetherby improving biological fertility of the soil(Singh et al., 2011; Bhattacharyya & Jha, 2012).

3. The Physical Properties of the Soil:

Mycorrhizae and bacterial polysaccharides cause better aggregation and structuring of the soil, thus promoting aeration and water retention(Smith & Read, 2008; Gosling et al., 2006).

Sustainability and Environmental Benefits:

Biofertilizers are ecologically safe, biodegradable and non-toxic. They help diminish the endes improve soil aggregation and structure, favouring aeration and water retention (Bhardwaj et al., 2014; Mahanty et al., 2017).

Reduction in Chemical Fertilizer Dependence:

Vironmental effects and long term soil fertility(Peoples et al., 2009).

Challenges:

These have their inherent advantages but also limitations like shorter shelf life, less thermal stability and variable performance in the fieldBhattacharyya & Jha, 2012; Mahanty et al., 2017).. Strain selection, formulation, and storage are essential for their efficacy(Mishra et al., 2021).

Conclusion

Bio-fertilizers play crucial role in fertilizing soil, crop production and sustainable agriculture. They enrich the soil naturally by means of biological nitrogen fixation, phosphate solubilization and decomposition of organic matter, thereby decreasing reliance on chemical fertilizers(Vessey, 2003; Bhardwaj et al., 2014). They stimulate soil microbiological activity, improve soil structure and are conducive to long-time productivity (Smith & Read, 2008; Singh et al., 2011).

The use of biofertilizers In both conventional and organic cultivation systems provides an alternative, both for the balance to be achieved and also to avoid high rates of nutrient input (Mahanty et al., 2017).

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