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Biofertilizer and their importance in sustainable agriculture

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Abstract

There are many small or undeveloped countries whose economy depends on agricultural production. A healthy agriculture production depends on various factors like soil quality, water, fertilizer, skilled labor, and many more. Fertilizer is the most crucial things that influence agricultural production. A fertilizer is a kind of chemical or natural substance that is helpful in crop production. However, to achieve quick agricultural yields we usually used chemical fertilizer which is very responsive to biofertilizer but the chemical fertilizer is not as eco-friendly as biofertilizer. Biofertilizer are natural fertilizes which are living microbial inoculants of bacteria, algae, fungi alone or in combination and they augment the availability of nutrients to the plants. Mycorrhizal fungi preferentially withdraw minerals from organic matter for the plant whereas cyanobacteria are characterized by the property of nitrogen fixation. The role of biofertilizer in agriculture assumes special significance, particularly in the present context of increased cost of chemical fertilizer and their hazardous effects on soil health. Agricultural fertilizers are essential for proper crop growth and yield. Chemical fertilizers have recently been used by farmers to increase yield and speed up the process. Natural biofertilizer, on the other hand, not only have a higher yield but are also safe for humans. The benefits of biofertilizer include low cost, enhanced nutrient availability, improved soil fertility, protect plants from soil-borne pathogens, sustainable agricultural production, enhanced biotic and abiotic stress tolerance, promote phytohormone production, improve soil health, causing less environmental pollution, and its continued use improves the fertility of soil considerably.

Keywords: Biofertilizer, Chemical Fertilizers, Microbes, Sustainable agriculture, Solubilizers, Soil Fertility.

Introduction

The global population is presently still on the rise, with an estimated worldwide population of around 9.7 billion around 2050. Rapid industrialization, urbanization and farm production are inextricably linked to this rapid-fire growth. Due to the growing global population, traditional agriculture is essential to satisfy humanity's food needs and to enhance the self-sufficiency of the countries in food production.Still, the conventional styles of agriculture are basically grounded on the wide use of plant food and disease treatment synthetic fertilizers

and pesticides. The prudent cure of these chemical inputs has irrefutable advantages, not only the crop growth and quality, but also for farmers' income. The increased use of artificial supplies can unfortunately pose a considerable threat to the natural terrain by water, air and soil pollution.

That's why biofertilizer are gaining traction as a feasible choice against poisonous chemical fertilizers in the pursuit of sustainable agriculture. The role of biofertilizer in the growth of crops and the conservation of long-term soil fertility, which is pivotal to satisfy global food demand. Microbes can interact and enhance the immunity, growth and development of plants. The main nutrients needed for the proper growths of the plants are nitrogen, phosphorous, potassium, zinc and silica, but these nutrients naturally take form as insolubilized or complex [1].

1.1 Role of Biofertilizer in Plant and Soil

Biofertilizer have been used to contribute to soil fertility in a positive way, allowing farmers to increase their productivity without negatively impacting the terrain, soil or water. Bacteria play an important part in nitrogen mobilization and phosphorus solubilization for enhanced plant growth by fixing nitrogen and phosphorus. According to the study, *Azotobacter* inoculation affected in a 72.03 percent increase in plant growth, dry matter accumulation and nitrogen uptake over the control at 80 DAS, which was analogous to the addition of 20 kg N ha-1 alone. In terms of altering the nitrogen content in straw and grain, Azotobacter alone and 20 kg N ha-1 were statistically equal (2006) stated that the yields of straw, grain, and total yield was increased by inoculation of PSB alone and enhanced phosphorus uptake by around 37.97, percent above the control [2].

1.2 Biofertilizer its types and features

Based on type of microorganism, the bio-fertilizer can also be classified as follows:

- **Bacterial Biofertilizer**: e.g.*Rhizobium, Azospirilium, Azotobacter, Phosphobacteria*.
- **Fungal Biofertilizer**: e.g.Mycorhiza
- **Algal Biofertilizer**: e.g. Blue Green Algae (BGA) and *Azolla*.
- **Actinomycetes Biofertilizer**: e.g. *Frankia*.

Bio-fertilizer is mostly cultured and multiplied it the laboratory. However, blue green algae and azolla can be mass-multiplied in the field [3]

1.3 Characteristics Features of common Biofertilizer

- Rhizobium: *Rhizobium* is fairly more effective and considerably used biofertilizer. Rhizobium, in association with legumes, fixes atmospheric N. The legumes and their symbiotic association with the *Rhizobium* bacterium result in the conformation of root nodules that fix atmospheric Nitrogen. Successful nodulation of leguminous crop by rhizobium largely depends on the availability of a compatible stain for a particular legume

- Azospirillium: *Azospirillum* is known to have a close associative symbiosis with the advance plant system. These bacteria have association with cereals like; sorghum, maize, pearl millet, finger millet, foxtail millet and other minor millets and also fodder grasses.

- Azotobacter: It is a common soil bacterium. *A. chrococcum* is present widely in Indian soil. Soil organic matter is the important factor that decides the growth of these bacteria.

- Blue Green Algae (BGA): Blue green algae are referred to as rice organisms because of their plenitude in the rice field. Numerous species belonging to the genera, *Tolypothrix*, *Nostoc*, *Anoboenosois* and *Plectonema* are abundant in tropical conditions. Utmost of the nitrogen fixation BGA is filamentary, consisting of chain of vegetative cell including specialized cells called heterocyst which serve as a micro node for synthesis and N_2 fixing machinery [4]. In Table 1 commonly produced bio-fertilizers are mentioned and their uses in different types od crop plants.

Table 1: List of commonly produced bio-fertilizers in India

Name	Crops suited	Benefits
Rhizobium strains	Legumes like pulses, groundnut, soybean	10-35% yield increase, 50-200 kg N/ha.
Azotobacter	Soil treatment for non- legume crops including dry land crops	10-15% yield increase- adds 20-25 kg N/ha
Azospirillium	Non-legumes like maize, barley, oats, sorghum, millet, Sugarcane, rice etc	10-20% yield increase
Phosphate Solubilizers (there are 2 bacterial and 2 fungal species in this group)	Soil application for all crops	5-30% yield increase
Blue-green algae and Azolla	Rice/wet lands	20-30 kg N/ha, Azolla can give biomass up to 40-50 tones and fix 30-100 kg N/ha
Microhizae (VAM)	Many trees, some crops, and some ornamental plants	30-50% yield increase enhances uptake of P. Zn, S and Water [4].

1.4 Application of Biofertilizer

Seed treatment: The seeds are slightly mixed in the slurry of inoculants and also shade dried for 30 minutes. The shade dried seed are to be sown within 24 hours. One packet of the inoculants (200 g) is sufficient to treat 10 kg of seeds.

Seedling root dip: This system is used for transplanted crops. Two packets of the inoculants are mixed in 40 liters of water. The root portion of the seedlings is dipped in the mixture for 5 to 10 minutes and then replanted.

Main field application: Four packets of the inoculants are mixed with 20 kgs of dried and powdered farm yard manure and then broadcasted in the main field just before transplanting.

Set treatment: This system is recommended generally for treating the sets of sugarcane, cut pieces of potato and the base of banana suckers. Culture suspension is prepared by mixing 1 kg (5 packets) of bio-fertilizer in 40- 50 liters of water and cut pieces of planting material are kept immersed in the suspension for 30 minutes. Then the cut pieces are dried in shade for some time before planting. For set treatment, the ratio of bio-fertilizer to water is roughly 1:50.

Soil Treatment: 4 kg each of the recommended biofertilizer is mixed in 200 kg of compost and kept overnight. This admixture is incorporated in the soil at the time of sowing or planting [5].

Different bio-fertilizers used in plant growth and play diverse physiological role in plants [Table2].

Table 2: Role of bio-fertilizer in plant growth promotion and bio control

Types of bio-fertilizer	Role in plant growth	Role in bio control
Pseudomonas fluorescens	By producing siderophore.	By producing antifungal antibiotics that can inhibit the growth of phytopathogenic fungi
R. leguminosarum	Solubilization of minerals such as phosphorus and cytokinin	By secretion of antibiotics and degrading cell wall enzymes that can hinder the phytopathogens
B. japonicum	Phosphate solubilization, IAA, siderophores	By secretion of antibiotics and degrading cell wall enzymes that can hinder the phytopathogens
Bacillus	Auxin synthesis	By forming endospores and different biologically active compounds
Microbacterium pseudomonas	Phosphate solubilization	NA
Mycobacterium	IAA	Induction of plant stress resistance [6]

1.5 Present status of biofertilizer

After the introduction of chemical fertilizers in the last century, the farmers were glad of getting increased yield in the agriculture in the beginning. But slowly chemical fertilizers started displaying their ill-effects similar as filtering out, and contaminating water basins, destroying micro-organisms and friendly insects, making the crop more susceptible to the attack of sicknesses, reducing the soil fertility and thus causing irrespirable damage to the overall system dangerous chemical fertilizers cannot be taken up by the plants, they start accumulating in the ground water and some these chemicals are also responsible for causing eutrophication of water bodies and the indiscriminate uses of chemical fertilizers shows great trouble to nature by polluting water, air and soil. Using diversified organisms, crop productivity had increased to a perceptible measure. Several Plant Growth Promoting Rhizobacteria (PGPR) have been studied which can replace chemical fertilizers. This includes handful genera such as *Bacillus, Clostridium, Arthrobacter, Azotobacter, Azospirillium,* etc. Biofertilizer are promoted to crop available natural system of nutrient rallying naturally which tremendously increases the fertility of the soil and crop yield eventually [7].

1.6 Future perspective of bio-fertilizers

Inadequate amounts of nutrients (especially P) have built up in soils as a result of farmers' unchecked over application of chemical fertilizers during intensive agricultural operations, rendering the soils dead. Since the application of inorganic fertilizer can be significantly reduced to prevent further environmental issues, the development of effective and sustainable bio-fertilizers for crop plants is currently a key area of research interest. It entails conducting short, medium, and long-term research projects that bring together the expertise of soil microbiologists, agronomists, plant breeders, plant pathologists, nutritionists, and economics [8].

Conclusion

Biofertilizer being essential factors of organic agriculture play a vital part in maintaining long term soil fertility and sustainability by fixing atmospheric nitrogen, mobilizing fixed macro and micro nutrients in the soil into forms available to plants. Presently there's a gap of ten million tons of plant nutrients between junking of crops and force through chemical fertilizers. In context of both the cost and environmental impact of chemical fertilizers, inordinate reliance on chemical fertilizers isn't practicable in the long run because of the cost, both in domestic resources and foreign exchange involved in setting up of fertilizer factories and sustaining the product. In this context, biofertilizer would be the feasible option for farmers to increase productivity per unit area.

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