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Microbial Formulations for Sustainable Pulse Production

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Abstract:

Pulses are important for global food security and sustainable agriculture because of their high protein content and capacity to fix atmospheric nitrogen. However, barriers like pest pressure, deteriorating soil, and limited access to fertilizers decrease their output. Harnessing beneficial microorganisms through formulation provides a possible option to solve these difficulties in a sustainable manner. Agronomic practices today depend primarily on chemical fertilizers, which improve output while posing a significant harm to humans and the environment. The application of biofertilizers has come to light as a viable and successful solution for this issue. Biofertilizers have very cheap input costs and have not been linked to any health risks. This chapter will provide you with an overview of the wide range of biofertilizers that raise the soil's N, P, and K content, hence boosting pulse productivity. The major problem associated with biofertilizers is the method of formulations. Here we will discuss that issue.

Introduction:

India is the largest pulse producing country contributing to about 25% of global pulse production. Pulses are an important component of the agriculture economy. India produces fewer pulses than other countries. Low productivity is caused by a variety of variables, including marginal and sub-marginal land use for cultivation, improper use of biopesticides and biofertilizers, a lack of quality seeds at a given time, poor crop management methods, numerous abiotic and biotic challenges, and so on. There is a need to create ways for increasing pulse production. Thus, raising pulse output is an important job for farmers, scientists, and policymakers. We should look into crop management practices that can boost pulse production. The constant use of chemicals has created a significant hazard to the soil ecosystem. The indiscriminate use of fertilizers has posed a significant risk to soil degradation and deterioration. However, we must improve productivity in order to feed the starving population.

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To boost pulse output in India, the best solution is to apply organic biofertilizers and biopesticides together with effective microbial formulations and their consortia. This chapter focuses on eco-friendly field management of pulse crops through various microbial compositions. There are several counter strains related with microbial formulations, such as longevity, viable cell numbers and manner of application. Here we will describe different microbial formulations and their role in sustainable agriculture.

Role of Beneficial Microbes in Pulse Production

A wide range of biofertilizers are made up of one or more microorganisms that, when applied to plants, are able to offer various nutrients and, as a result, enhance overall plant growth. They help plants in nitrogen fixation, solubilization and wide phosphorus availability, abiotic stress resistance, biocontrol, and siderophore synthesis. Some notable biofertilizers are Rhizobium, Azotobacter, Azospirillum, Phosphate-Solubilizing Microorganisms (PSMs), Arbuscular Mycorrhiza (AM), Plant Growth Promoting Rhizobacteria (PGPR), Blue Green Algae (BGA), and Azolla. Aside from these, another interesting biofertilizer is Piriformospora indica, a cultivable endophytic fungus that colonizes plant roots and promotes plant growth and biomass production. These biofertilizers are applied to seeds, seedlings, or fields directly, with or without the use of a microbe carrier.

Formulations of biofertilizers for sustainable agriculture

The inoculation technology is determined by two factors: the microbial strain and the inoculation formulation technology utilized. In general, the formulation determines the effectiveness of inoculants. Farmers in underdeveloped countries practice low-input agriculture, which uses fewer fertilizers, pesticides, and sophisticated agricultural technology. In these industries, using biofertilizers requires additional understanding. In India, the biggest issue with biofertilizers is a lack of sufficient knowledge about inoculum manufacturing, application, and so on. Carriers for inoculant formulations: Choosing an adequate carrier is the most crucial part in formulation creation. The following are the characteristics that a carrier should possess.

- Capable of holding and retaining water without causing heat while soaking.
- Nearly sterile in chemical, physical, and uniformity.
- Nontoxic, biodegradable, and nonpolluting.
- Nearly neutral pH, or easily changeable.

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- Helps microorganisms grow and survive.
- Appropriate for nutritional supplementation.
- Quick release of microorganisms into the soil.
- Easy to combine, cure, and package.
- Available in suitable quantities in powder or granular form.

Solid Carrier-based Materia

Peat is the most often utilized carrier medium for Rhizobium around the world. The fundamental disadvantage of solid carriers is that their quality and composition can vary greatly. The quality of the carrier affects the quality of the biofertilizer. Solid carrier fertilizers are resistant to drought and other environmental stresses. In India, solid carrier-based biofertilizers have limited shelf life, poor quality, and a high risk of contamination. Cell availability also decreases in solid carriers. The introduction of alginate and liquid-based bioformulation has revolutionized the Indian biofertilizer business. Liquid inoculants are a particular sort of inoculant formulation that includes microorganisms, growth nutrients, cell protectants, and certain additives. Additives found in liquid media enhance the quality of inoculants. The choice of addition is determined by their ability to protect microbial cells from high temperatures, pressure, desiccation, and other harmful circumstances. Additives utilized for biofertilizer development are high molecular weight polymers with good water solubility and non-toxicity.

Liquid-based Biofertilizers

These are not your typical culture broth, ferment, or waste suspensions. These are specialized liquid formulations that include desired microbes, nutrients, cell Protestants, and amendments. Typically, liquid formulations include growth media that offers C, N, and vitamins, as well as additives that protect the formulation from heat, desiccation, and other adverse environmental conditions. Most widely used additions are high molecular weight polymers with good water solubility and non-toxic nature, such as PVP, methylcellulose, polyvinyl alcohol, polyethylene glycol, gum arabic, trehalose, glycerol, Fe-EDTA, sodium alginate, tapioca flour, etc. Trehalose is also utilized as an adjuvant, increasing tolerance to desiccation, osmotic, and temperature stress. It is widely utilized in Bradyrhizobium-based formulations PVP is widely utilized in Rhizobium-based formulations. Liquid biofertilizers have a shelf life of more than a year and can withstand temperatures up to 45˚C.

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Application Methods

There are several methods for applying biofertilizers. Soil application: The biofertilizers can be sprinkled directly into the soil. To treat pulse seeds, soak them in a slurry of biofertilizers before semi-drying and sowing them in the field. Foliar spray: The biofertilizer can be sprayed directly onto the crop. The best times to apply foliar spray are in the morning or evening. Generally, for foliar Spray with a suggested dose of 1:1000. Soil treatments of microorganisms have been found to boost plant photosynthetic activity.

Limitations

When biocontrol chemicals are used, they frequently fail to compete with the local microbial population and begin to establish themselves in the soil. Biocontrol agents are effective when their growth is maintained in the formulation. However, mismanagement can disrupt their growth, preventing them from controlling infections and enhancing plant growth.

Conclusion

Biofertilizers provide significant benefits to agriculture and have minimal input costs. Biofertilizer use showed promising results in both glass and field environments. In India, soils are deficient in nutrients, hence we should provide necessary nutrients to the soil. And the best strategy to utilize biofertilizers. Biofertilizers supply the soil with vital nutrients such as N, P, and Zn, which improves pulse output. AMF-based biofertilizer supplies P and Zn, increasing pulse productivity. To raise awareness about the use of biofertilizers in India, we must all take necessary steps. A collaborative effort among microbiologists, environmentalists, soil chemists, and agronomists is necessary to promote efficient biofertilizer development and application.

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