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Important of Biofertilizers for Sustainable Growth and Yield of Crop Plants

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Abstract

Modern intensive agricultural practices face numerous challenges that pose major threats to global food security. In order to find the nutritional requirements of the ever-increasing world population, chemical fertilizers and pesticides are applied on large scale to increase crop production. However, the improper use of agro-chemicals has caused environmental pollution that poses a threat to the public's health. Additionally, agricultural soils are progressively losing their biological, chemical (due to nutrient imbalance), and physical qualities. With their abilities to promote plant growth, plant-associated microorganisms hold great promise for overcoming these difficulties and contributing significantly to increased plant biomass and crop yield. The production of the inoculum, the addition of cell protectants like glycerol, lactose, and starch, a good carrier material, adequate packaging, and the optimal delivery techniques are included in the formulation of solid-based or liquid bioinoculants. Entrapment/microencapsulation, nano-immobilization of microbial bioinoculants, and biofilm-based biofertilizers are recent advancements in formulation. The present state-of-the-art on using microbial strains as biofertilizers is rigorously analysed in this review, as are the significant contributions made by these helpful bacteria to preserving soil fertility and boosting crop output.

Key word: Biofertilizers, chemicals, growth, soil and yield

Introduction

The use of chemical fertilizers and pesticides has increased as a result of conventional agriculture's substantial contribution to supplying the world's expanding population with food Chemical fertilizers are industrially modified chemicals with known concentrations of nitrogen, phosphorous, and potassium; their use results in eutrophication of water bodies, which pollutes air and ground water (Yossef *et al.*, 2014). In order to assure biosafety, current

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initiatives have focused more on producing "nutrient rich, high-quality food" in a sustainable manner. Encourage alternative soil fertilization techniques in agriculture that rely on organic inputs to enhance nutrient delivery and preserve field management (Araujo *et al.,* 2008). One such method that not only protects the safety of the food but also increases the biodiversity of the land is organic farming. Longer shelf lives that have no negative effects on the ecosystem are one of the extra benefits of biofertilizers (Sahoo *et al.*, 2014).

A product containing living microorganisms that colonize in the rhizosphere surrounding the interior of the plant and stimulate growth by increasing the accessibility and uptake of mineral nutrients to the host plant is referred to as "biofertilizer," also known as "micro inoculants," and was derived from the term "biological fertilizer." A cheap and sustainable source of plant nutrients is biofertilizers. Due to the recent emphasis on maintaining soil health, reducing environmental pollution, and reducing the use of chemicals in agriculture, biofertilizers are gaining popularity. The use of hybrid seeds and high-yielding types that are particularly responsive to heavy dosages of chemical fertilizers and irrigation is emphasized in modern agriculture. Synthetic fertilizers have contaminated soil and water basins as a result of their careless application. As a result, organic matter and vital plant nutrients have been removed from the soil.

Significance of conventional biofertilizer

Plants can access nutrients that are naturally abundant in soil and the environment thanks to biofertilizers. These have been proven to be inexpensive, efficient inputs that pose no environmental risks, according to numerous field studies. In essence, it offers "ecofriendly" organic agro-input with the capacity to biologically change inaccessible forms of nutritionally significant components to available forms. Therefore, the introduction of biofertilizers might be anticipated to decrease the need of chemical fertilizers and pesticides. The microorganisms in biofertilizers restore the soil's fertility and sustainability while maintaining the soil's ideal nutrient level and increasing the organic matter content of the soil. As a result, healthy plants can be developed. As a result, by providing organic nutrients, they are very helpful in enhancing soil fertility and satisfying the nutrient needs of plants. Different biofertilizers access nutrients for both present and stored up use, as well as providing growth-promoting substances to plants through the secretion of various vitamins and phytohormones, as well as by successfully enabling composting and thwarting pest and soil-borne disease attacks. It not only conserves chemical fertilizers but also aids in their efficient use, increasing output rates.

Types of biofertilizer

Rhizobium

Rhizobium is a member of the Rhizobiaceae family. These free-living, rod-shaped, Gram-negative, motile, non-sporulating organisms are found in soil and have the capacity to symbiotically fix atmospheric nitrogen. They are recognized as a root-associated endosymbiotic N-fixing bacterium. Through the root system, it enters plants and later produces nodules. Rhizobium uses the carbohydrates that legume plants generate, which are transferred to the nodules, as the only supply of hydrogen for the process that turns nitrogen into ammonia. As a result, the root nodules serve as a microfermentor for the organic fixation of nitrogen, where they can turn atmospheric nitrogen into ammonia.

Rice plants' shoot and root growth can be influenced by rhizobium. It will fix N in the particular host plant through a very precise interaction with the legume host. Members of the plant family Fabaceae (Leguminosae) and soil bacteria of the genera Azorhizobium, Bradyrhizobium, Mesorhizobium, Rhizobium, and Sinorhizobium (together called rhizobia;) form the most typical type of symbiosis. Several woody plant species, including alder trees, and soil bacteria of the genus form a common type of symbiosis.

Examples of organisms that can carry out nitrogen fixation.

Sr. No.	Groups	Examples
1. Nitrogen (N_2) fixing Biofertilizers		
i	Free-living	*Azotobacter*, *Clostridium*, *Anabaena*, Nostoc
ii	Symbiotic	*Rhizobium*, *Frankia*, *Anabaena azollae*
iii	Associative Symbiotic	*Azospirillum*
2. P-Solubilizing Biofertilizers		
i	Bacteria	*Bacillus megaterium* var. *phosphaticum*, *Bacillus circulans*, *Pseudomonas striata*
ii	Fungi	*Penicillium sp.*, *Aspergillus awamori*
3. P-Mobilizing Biofertilizers		
i	Arbuscular mycorrhiza	*Glomus sp.*, *Gigaspora sp.*, *Acaulospora sp.*, *Scutellospora sp.*, *Sclerocystis sp.*

ii	Ectomycorrhiza	*Laccaria sp., Pisolithus sp., Boletus sp., Amanita sp.*
iii	Orchid mycorrhiza	*Rhizoctonia solani*
4. Biofertilizers for Micro nutrients		
i	Silicate and zinc solubilizers	*Bacillus sp.*
5. Plant Growth Promoting Rhizobacteria		
i	Pseudomonas	*Pseudomonas fluorescens*

Source: Biofertilizers- types and their application, KrishiSewa

Azospirillum

Azospirillum is a Gram-negative motile bacterium that is associated to the roots of monocots, including important crops like wheat, corn, and rice. It is a member of the Rhodospirillales group. It is the world's most effective phytostimulator inoculant for cereals. Associative symbiosis between Azospirillum and cereals can be created, however unlike mutualistic symbiosis, the association is not manifested by the development of new organs. Azospirillum provides direct benefits to the plant through associative nitrogen fixation, the production of phytohormones (indole-3-acetic acid, IAA), and the control of the balance of plant hormones through deamination of the precursor to ethylene. It aids the plants in obtaining nitrogen from the atmosphere by creating a symbiotic organization (Abd El-Lattief, 2016).

Cyanobacteria (BGA)

The global nitrogen cycle depends on cyanobacteria. Cyanobacteria that fix nitrogen are among the most prevalent and significant N fixers on Earth. A diverse group of prokaryotes known as cyanobacteria or blue-green algae typically create intricate relationships with bacteria and green algae in structures known as cyanobacterial mats. In freshwater and marine systems, they are the primary N fixers. Nitrogen-fixing bacteria are a key source of nitrogen for the marine ecosystem in a significant portion of the world's seas. Cyanobacterial mats have been employed as biofertilizer in modern agriculture because of their capacity to fix atmospheric nitrogen (kumar and Rao, 2012).

Azolla

Tropical and subtropical Asia, Africa, and America are home to the tiny free-floating fresh water fern known as azolla. Azolla caroliniana, A. maxicana, A. filiculoides, A. microphylla, A. rubra, A. nilotica, and A. pinnata are the seven species of the family Azollaceae that are still alive today. Azolla is a long-standing member of the earth's green plant community that dates back to the Cenozoic era, which started 65 million years ago. Azolla is able to fix a substantial quantity of atmospheric nitrogen through its phyc symbiote Anabaena azolla, and as a result, it can serve as a nitrogenous biofertilizer for rice that is grown under irrigation. Azolla's potential as a biofertilizer has been realized because it can be cultivated alongside rice that has been irrigated at the same time without using more space or water.

Vesicular Arbuscular Mycorrhiza (VAM)

Commonly advantageous associations between fungi and plant roots are called mycorrhizae. The root is contaminated by and disseminated by VAM fungus. They possess unique features called vesicles and arbuscules. Mycorrhizae increase seedling tolerance to drought, high temperatures, fungus infection, illness, and even extremely acidic soil because they act as a protective covering. Application of VAM results in superior root systems that combat soil-borne diseases and root rotting. The most advantageous plants would have small root systems (Abd El-Lattief, 2016).

Nanobiofertilizer

The use of nanotechnology and biofertilizer in combination to increase crop productivity and efficiency is known as nano-biofertilizer. The conservation of soil moisture and plant uptake of essential nutrients are made possible by the synergistic action of nanomaterial and microbial fertilizer. Other fertilizers have significant drawbacks that can result in poor growth and low yield, such as instability on the field caused by changes in temperature, pH, and environmental conditions, a short shelf life, reduced microbial strains, and the need to apply a lot of fertilizer to a large area. Farmers can profit significantly from using nanobiofertilizer because it performs well in the field, is inexpensive, reduces expenses, and increases yield (Mala *et al.*, 2017). This results in the production of the highest quality crops. Additionally, this will increase microbial enzyme activity, which improves soil fertility.

Advantages and Disadvantage of nano-biofertilizers

Nanofertilizer

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Advantage	**Disadvantage**
i) Control delivery of nutrients	i) Showing High Reactivity
ii) Reduce loss rate	ii) Environmental impact
iii) Highly nutrient efficient crops	iii) No cost for human health and Sustainable environment

Conclusion

Use of biofertilizer is important for the effective growth of plants and for achieving a high crop production. Crops can become more resilient to pathogenic elements and environmental inhibitors thanks to recently developed approaches like biofilm fertilizer and nano biofertilizer. The development of considerable resistance in plants against pathogen attack, disease control, and environmental stress has been made possible by the use of sophisticated microbial inoculants in the formulation of diverse PGPR inoculum. In order to develop locally adapted microorganisms and plants that are resistant to disease, more study is being done on nanoencapsulation, the production of numerous biofilms, and mixed microbial inoculants. Future objectives of biofertilizer include the creation of creative, environmentally friendly farming methods that are less expensive than using chemical fertilizers.

References

Abd El-Lattief EA (2016).Use of azospirillum and azobacter bacteria as biofertilizers in cereal crops: A review. Int. J. Res. Eng. Appl. Sci. 6(7): 36- 44.

Araújo, A. D., Santos, V. B., & Monteiro, R. T. R. (2008). Responses of soil microbial biomass and activity for practices of organic and conventional farming systems in Piauí state, Brazil. *European journal of soil biology*, *44*(2), 225-230.

Kumar SRS, Rao KVB (2012). Biological nitrogen fixation: A review. Int. J. Adv. Life Sci.1: 1-6.

Mala, R., Celsia Arul Selvaraj, R., Barathi Sundaram, V., Blessina Siva Shanmuga Rajan, R., & Maheswari Gurusamy, U. (2017). Evaluation of nano structured slow release fertilizer on the soil fertility, yield and nutritional profile of Vigna radiata. *Recent patents on nanotechnology*, *11*(1), 50-62.

Sahoo, R. K., Ansari, M. W., Pradhan, M., Dangar, T. K., Mohanty, S., & Tuteja, N. (2014). Phenotypic and molecular characterization of native Azospirillum strains from rice fields to improve crop productivity. *Protoplasma*, *251*, 943-953.

Youssef, M. M. A., & Eissa, M. F. M. (2014). Biofertilizers and their role in management of plant parasitic nematodes. A review. *Journal of Biotechnology and Pharmaceutical Research*, *5*(1), 1-6.