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A STUDY ON THE USES AND SIGNIFICANCE OF BIOFERTILIZERS

[1]Homanshu Dewangan, [2]Himanshi Chandrakar

[1,2]BSc 6th Semester

[1,2]Kalinga University, Raipur

Abstract:

Due to the rising concern of sustainable agriculture and conservation of the environment, more attention has been accorded to the use of biofertilizers. Biofertilizers are the living microorganisms such as bacteria, fungi and algae which fixes nitrogen, solubilize phosphorus, decomposes organic matters and makes the soil fertile for the plant growth. In this paper, the author focuses on the various aspects of biofertilizers especially its uses in the current world agriculture. This research explores the various biofertilizer, namely, nitrogenfixing biofertilizers such as Rhizobium, Azospirillum, and Azotobacter; the phosphate-solubilizing biofertilizers of Pseudomonas and Bacillus; and the mycorrhizal fungi. The involvement of each type in nutrient cycling, condition that improves the soil and crop yields is also discussed. An analysis of how such microorganisms engage with the roots of plants in enhancing growth as well as disease resistance is discussed.

In the studies main findings it has been supported that the use of biofertilizers helps in enhancing the nutrient uptake into the plants besides helping in sustainable agriculture, thereby avoiding the use of chemical fertilizers and thereby preventing diseases associated with environmental pollution as well as enhancing the soil biodiversity. Finally, the saving to the farmers for using the biofertilizers and higher quality yields are also considered in the article.

Keywords: Biofertilizers, Sustainable Agriculture, Nitrogen Fixation, Phosphate.

Introduction:

Agricultural sustainability is gradually gaining more and more attention more so in the current world where food insecurity, climate change, and negative impacts of chemical fertilizers are key issues. Modern methods of farming leading to the excessive use of fertilizers and pesticides has led to deterioration of soil health, underground water and the environment in general because of it having very little cover. Such problems call for better and eco-friendly measures that can foster high agricultural yield as explored below.

It is in this regard that biofertilizers have been found to offer the above named challenges. Obtained from natural resources, biofertilizers are a formulation of living microorganisms that help release nutrients in the soil to the plants. These microorganisms such as bacteria, fungi and algae, act as mutualists, enhancing nutrient acquisition for the plant and healthy plant growth. Bioorganic fertilizer unlike chemical fertilizer does not have negative effect on the soil structure but enhances the physical and chemical structure of the soil, the content of organic matter and the degree of biological activity. Bio fertilizers have numerous benefits among them being the following; These are involved in processes like; nitrogen fixation, phosphate dissolution, and the breakdown of organic materials. This leads to enhanced nutrient status of the soils and this is very vital for the growth of plants. However, biofertilizers play an imperative role in decreasing the usage of chemical fertilizers and consequently, lessening the quantity of harms on the environment that they cause. The use of biofertilizers introduced the concept of sustainable agriculture for the future essential farming practices.

Still, the researchers could not escape various difficulties while using biofertilizers as follows; Depending on the climate, the type of soil, and specific type of crop, their efficacy may not be constant. Moreover, these other conditionality relate to the practices of storage and handling so as to uphold the viability of the microorganisms. To tackle these issues, the associated processes of how biofertilizers function and ways of improving their functionality needs to be discerned and implemented.

Types of Biofertilizers

Classification of bio-fertilizer can be done on the basis of the classification of microorganisms present in it and its role to improve the fertility of the soil and plant growth. Knowledge of these categories enable one to choose a right biofertilizer depending on type of crop and condition of the soil it is applied to. Some of the distinguished types of biofertilizers are nitrogen fixing biofertilizers, Phosphate solubilizing biofertilizers, potassium mobilizing biofertilizers and Mycorrhizal fungi biofertilizers.

1. Nitrogen-Fixing Biofertilizers

Biofertilizers which are nitrogen fixing have bacteria that can convert nitrogen from the atmosphere in to a form that plants can use. This one is called biological nitrogen fixation and it is vital for plants because it provides them with nitrogen they need to receive.

Rhizobium: Bacteria which in conjunction with leguminous plants such as beans and peas, create nodules on the roots of the plants. Deep within these nodules, certain bacteria known as Rhizobium are able to convert the nitrogen in the air into ammonia which the plant can consume.

Azospirillum: Bacteria that inhabit the rhizosphere and are non-symbiotic, parasitic bacteria living on the roots of cereals and grasses. It is known that they improve the condition of plants for growth by nitrogen fixation and secretion of growth-stimulating substances.

Azotobacter: Literally, bacteria that live a free existence in the earth and can effect nitrogen conversion, they do not parasitize on plants. Also, they are involved in producing the so called growth-promoting hormones.

2. Phosphate-Solubilizing Biofertilizers

The phosphate soluble smart bio fertilizers contain friendly microorganisms for making the insoluble forms of PO4 soluble for uptakes by plants.

Phosphorus is important in transport of energy and photosynthesis all through plants.

Pseudomonas: They are those bacteria that produce organic acids, dissolve the insoluble phosphates in the soil, and make phosphorus nutrients available to the plant.

Bacillus: Another group of bacteria is able to solubilize phosphate through the synthesis of organic acids

4. Mycorrhizal Fungi

Mycorrhizal fungi attach to plant roots and increase the surface area and availability of plant roots for nutrient absorption especially phosphorus.

Arbuscular Mycorrhizal Fungi (AMF): Mycter forms of fungi that directly invade cortical cells of plant roots and form arbuscules with a role of transferring nutrients between the tissues of the two organisms.

Ectomycorrhizal Fungi: Those that encircle the plant roots and penetrate into the soil in order to assist in the absorption of water and nutrient particularly in trees.

5. Cyanobacteria (Blue-Green Algae)

Cyanobacteria also known as blue green algae are photosynthetic microorganisms capable of nitrogen fixing and plays an important role in the fertility of soils especially out in the paddies.

Anabaena: N fixing cyanobacteria that are associated with water ferns such as Azolla usually applied in rice fields to enhance the fertility of the soil.

Nostoc: Cyanobacteria that are free-living nitrogen-fixing bacteria and improve the organic soil matter.

6. Plant Growth-Promoting Rhizobacteria (PGPR)

PGPR may involve nitrogen-fixing bacteria, phosphate solubilizing bacteria and bacteria that synthesize growth inducers.

Bacillus subtilis: It is a type of bacterium that benefits plants through such factors as production of antibiotic which inhibits the growth of pathogens in the soil.

-Pseudomonas fluorescens: Pseudomonads that are special for their effectiveness in stimulating plant growth and protecting plants from disease with help of siderophores and antibiotics.

Thus, using these different sorts of biofertilizers as a form of optimally delivering nutrients to the plant and improving the general condition of the ground to improve the yields of crop in a sustainable manner is a great way to go. All types of biofertilizers have specific function connected with nutrient cycling and plant growth promotion and therefore they can be useful in precise and complex approach to sustainable agriculture.

Mechanisms of Action

Biofertilizers improves the growth of the plant and fertility of the soil through several processes. Thus, knowledge of these mechanisms assists in explaining the soil dynamics of biofertilizers and their impact with respect to plant health in crop production.

1.Nitrogen Fixation

Nitrogen is an essential nutrient for the growth of the plants and bio-fertilizers helps in nitrogen fixation through use of suitable organisms. This process involves the change of nitrogen that is freely available in the atmosphere in a form that readily accessible to plants by being converted to ammonia.

Rhizobium: These bacteria are associated with the leguminous plants and make themselves a home on root nodules. In the nodules which develop on the root-hairs, Rhizobium bacteria fix the atmospheric nitrogen into ammonia by the help of enzyme nitrogenase. This ammonia is then incorporated into organic molecules and given to the plant as nitrogen.

Azospirillum and Azotobacter: These free living bacteria in the soil, fix atmospheric nitrogen; making nitrogen more accessible to the non- legume plants. Azospirillum also resides on the root of grass and cereal plants and enhances nitrogen acquisition for plant growth.

2. Phosphate Solubilization

As known, phosphorus plays the role of energy transfer, photosynthesis and nutrient transport for plants. However, majority of phosphorus found in the soil cannot be accessed by the plant due to the fact that it exist as insoluble compounds. Organisms such as bacteria and fungi dissolve these fluids, and change them into soluble phosphates to be used by the plants.

Pseudomonas and Bacillus: Moreover, these bacteria produce organic acids for instance, gluconic acid, citric acid which dissove the insoluble phosphates like tricalcium phosphate, ferric phosphate, and aluminum phosphate in such form that are understandable by the plants.

3. Potassium Solubilization

This element plays vital roles in plants such as in the activation of enzymes, in the regulation of water and also in the process of photosynthesis. There are reports that PSKs solubilise potassium from the insoluble form and making it available to plant in the form of potassium.

Bacillus mucilaginosus: It also synthesizes organic acids and enzymes that dissolve potassium from such related minerals as feldspar so that plant can see and absorb it.

4. Mycorrhizal Association

Mycorrhizal fungi forms mutual association with root system of plants to increase the size of the root systems and facilitate absorption of nutrients and water.

Arbuscular Mycorrhizal Fungi (AMF): These fungi invades the root cells of the plants, and creates structures known as arbuscules where exchange of nutrients occur. AMF increases the efficiency of phosphorus uptake and zinc and fortifies the plants having a positive effect on the resistibility against drought and soil diseases.

Ectomycorrhizal Fungi: These fungi encase plant roots, and penetrate deeper into the soil to effect nutrient uptake, and water by forest trees especially.

5. Organic Matter Decomposition

Another type of biofertilizers is microorganisms which are responsible for the breakdown of organic matter, making locked –up nutrients available in the rhyme.

Cellulolytic and Ligninolytic Bacteria: These bacteria reduce large organic substances such as cellulose and lignin into soluble forms which can easily be used by plants.

6. Production of Growth-Promoting Substances

Some of the biofertilizers secrete phytohormones and other growth stimulating substances that encourages growth in plants.

Indole Acetic Acid (IAA): Synthesized by different bacteria, IAA is an auxin that stimulates the root development and branching which increases nutrient and water absorption.

Gibberellins and Cytokinins: These are hormones which are secreted by some bacteria with the function of inducing both the division and elongation of cells and in view of this, the growth of the plant is boosted.

7. Disease Suppression

Besides, certain types of bio- fertilizer can inhibit the growth of certain pathogenic microorganisms in the soil, thus, decreasing the level of diseases in the plants.

Pseudomonas fluorescens: It synthesizes antibiotics, siderophores and enzymes that forms defense wall against pathogen to inhibit plant diseases.

8. Enhanced Stress Tolerance

Biofertilizers can enhance the ability of the plants to cope with such abiotic stresses as water drought, soil salinity, and heavy metal toxicity.

Plant Growth-Promoting Rhizobacteria (PGPR): Strengthen stress tolerance in respect to the fact that these bacteria cause systemic resistance establishment, stress hormones production, and a positive effect on root structure formation.

Thus, the usage of the biofertilizers with their various eliciting capability provides a sustainable form of agriculture through aural release of nutrients and other growth promoting factors in the plants as well as replenishing the quality of the soil through the decomposing of the chemical fertilizers. Realizing these mechanisms enables the proper utilization of the biofertilizers in enhancing crop yields thus improving on the sustainability of the agricultural practices.

Benefits

Benefits of Biofertilizers

Biofertilizers are beneficiary in many ways which make it play an important role in sustainable agriculture and the environment. These are environmental benefits, economic benefits and agricultural benefits.

1. Environmental Benefits:

Reduced Chemical Use: Biofertilizers ensure that nutrients are produced organically hence decreasing the use of chemical fertilizers meaning that there is less pollution of the soil and water sources.

Enhanced Soil Health: Biofertilizers enhance the physical characteristics of the soil and increase the nutrients content in the soil through the input of organic matters and stimulating the activity of the beneficial microorganisms. This results into improved soil structure, aeration water and nutrient holding capacities, as well as nutrient cycling.

Biodiversity Conservation: Bio fertilizers maintain the biological balance in the soil which helps it to get rid of diseases and pests found on the soil and can affect the crops .

2. Economic Benefits:

Cost-Effective: Biofertilizers are cheaper than chemical fertilizers in most of the cases. " It's discovered that their utilization could make a big difference in relation to cost reduction for the farmers since they do not require synthetic inputs.

Increased Crop Yields: Biofertilizers by increasing nutrient availability and better plant growth make the prospects for increasing crop yield and quality of produce possible increasing the income of farmers.

Market Value: The crops which are produced by using bio fertilizers are sold in higher price in the market since people have perceptions that bio fertilizers are safe for their health and friendly to the environment especially the products which are sold in the markets for organic and sustainable farming.

3. Agricultural Benefits:

Improved Nutrient Uptake: The benefits of bio fertilizers include the ability to increase the uptake of such important nutrients in the plants as nitrogen phosphorous and potassium to increase on plant vigor.

Enhanced Plant Health: Biofertilizers can help to enhance the resistance of plants to diseases and pests due to stimulated development of root system and the general state of the plant.

Sustainable Farming Practices: So, the use of biofertilizers in farming fits the sustainable ministration as it enhances the mollify fertility of the ground and juncture the sustaining of the land.

Conclusion

The use of biofertilizers therefore form a parameter in the fight against sustainable agriculture. Being a natural way of unlocking sources of nutrients like nitrogen, phosphorus and breaking down of organic matter through miroorganism's inherent pre-dispositions, biofertilizers befit the description of earth-friendly substitutes to chemical fertilizers. Their use results in numerous environmental gains including decrease in emission of pollutants and improvement of the quality of the soil a factor important in preservation of ecosystems and boost to the population of various species. In its economic standpoint, subsidy on biofertilizers prove to be a lucrative scheme for the farmers as it catalyzes a decrease in usage of costly fertilizer inputs and at the same time may lead to a hike in both yield quantity and quality. These advantages are accompanied by the enhanced nutritional efficiency, plant health which results from the biofertilizers enhancing the productivity and sustainability in agriculture.

Thus the future for biofertilizers has been established to be bright by the fact that although they are associated with variability in their effectiveness and delicate handling, they are eco-friendly, non-hazardous to humans and animals as well as being cost effective. However, these challenges must be effectively addressed through enhancement of research, innovation, and dissemination of information on the use of biofertilizers. It is noteworthy that the adoption of biofertilizers could be attributed to the improvement of the technologies encompassing the delivery system of the biofertilizers, favorable governmental policies fostering the usage of biofertilizers as well as farmer trainings.

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