WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Biofertilizers in Agriculture –A Review

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ABSTRACT

Biofertilizers are the substances which contain living microorganisms which when applied to soil or plant surfaces, seeds promote growth by increasing the supply or availability of nutrients to host plant. Various kinds of biofertilizers are used in agriculture such as nitrogen fixers, phosphate solubilizes, potassium mobilisers, mycorrhizae. Biofertilisers can replace chemical fertilisers which can cause loss of soil fertility, create chemical imbalance, toxicity. Biofertilizers give increased yield of crops as compared to chemical fertilisers and are economical.

Keywords: - Biofertilizers, Nitrogen fixers, Phosphate solubilisers, potassium mobilisers, Mycorrhizae, Chemical fertilizers.

Introduction:

Biofertilisers are the substances containing microorganisms that help with soil fertility and helps in making the plants grow in a healthy way.[11] Biofertilisers add nutrients to soil through natural processes such as atmospheric Nitrogen fixation, Phosphorus solubilisation, Potassium mobilization and stimulating plant growth through synthesis of growth promoting substances such as –Auxins, Gibberillins, Cytokinins. Apart from these Biofertilizers have the ability to control many diseases of crop plants by production of antibiotics, pigments, siderophores etc. Biofertilisers are ecofriendly alternative to chemical fertilizers for sustainable agriculture. Chemical fertilizers such as Urea, SSP, Muriate of Potash can cause soil pollution on the long run.[3] Moreover biofertilsers are cost effective and give increased yields. The use of Biofertilizers makes the soil rich in micro and macronutrients, humus. Biofertilizers are considered alternative to chemical synthetic fertilisers.

Bio-fertilisers in agriculture

[1] The commonly used Biofertilisers in agriculture include – Nitrogen fixers, Phosphorus solubilizing bacteria, Potassium mobilizing bacteria, Mycorrhizae (VAM- Vesicular arbuscular mycorrhizae).

Nitrogen fixing bacteria:

Although our atmosphere contains 78%(v/v) of atmosphere, it cannot be utilized by living organisms. Nitrogen fixing bacteria convert atmospheric nitrogen into nitrogen compounds useful for plants such as NH4+(ammonical), NO3-(nitrate). Nitrogen fixing bacteria are of two types: - Symbiotic nitrogen fixing bacteria and free-living nitrogen fixing bacteria.

Rhizobium:

Rhizobium is a symbiotic nitrogen fixing bacteria, which in symbiotic association with the roots of leguminous plants and fixes atmospheric nitrogen. As a result of symbiotic association, they form root nodules.[11] The nodules are the seat of nitrogen fixation, which contain a pigment leghemoglobin, which helps in nitrogen fixation. Nitrogenase enzyme helps in nitrogen fixation. Rhizobium is being used as a biofertilizer for pulse crops and effectively given increased yields up to 40%.

Table 1. Contribution of Rhizobium to biological nitrogen fixation.

S.no	Crop	Rhizobium sp.	Quantity of N fixed(kgN/ha/year)
1	Alfalfa	Rhizobium melilotii	60-80
2	Clover	Rhizobium trifolii	100-200
3	Groundnut	Rhizobium sp.	50-60
4	Pea	Rhizobium leguminosarum	52-77
5	Cow pea	Rhizobium sp	80-85
6	Green gram	Rhizobium sp.	50-55

7	Soya bean	Bradyrhizobium Japonicum	60-80

Azotobacter

Azotobacter is a free-living nitrogen fixing bacteria.[5] Azotobacter is mainly of two main species –Azotobacter chroococcom, Azotobacter vinelandii. Azotobacter is recommended as a biofertilizer for cereals, millets such as barley, oats etc. The efficiency of nitrogen fixation by Azotobacter is 20 kgN/ha/year. [9] In addition Azotobacter vinelandii produces extracellular polysaccharide slime, which enhances the ability of the bacteria to fix atmospheric nitrogen, by protecting the nitrogenase enzyme from oxygen, as nitrogenase enzyme is oxygen sensitive.

Azospirillum

Azospirillum is a free-living nitrogen fixing bacteria. It has the ability to colonies the plant roots and fixing atmospheric nitrogen.[1] It synthesizes phytohormones in particular, indole-3-acetic acid and gibberellins, which promotes the growth of the plants. Azospirillum increases the abiotic and biotic stress tolerance in crop plants. Azospirillum can be used as a biofertilizer for cereals, vegetables, plantation crops, ornamental plants and even legumes.

Blue green algae (Cyanobacteria):

[8] Cyanobacteria are free living photosynthetic nitrogen fixing bacteria. Apart from fixing atmospheric nitrogen, they increase the soil fertility, water holding capacity through the jelly like structure. Blue green algae are being used as a biofertilizer in the form Azolla (fern) Anabaena, a blue green alga is a fix 20-30 kgN/ha/year.[6] Examples of other blue green algae having the ability to fix atmospheric nitrogen are –Nostoc, Oscillatoria, Aulosira, Calothrix, Aulosira.

Phosphate solubilizing bacteria (PSB)

Phosphorus is an important limiting nutrient required for plant growth and development.[7]A large proportion of phosphorus in soil exists in inorganic insoluble form such as calcium phosphate, Aluminium phosphate etc. Some amount of phosphorus also exists in organic form such as phytate, nucleic acids etc. Phosphorus solubilizing bacteria (PSB) release organic acids such as citric acid, gluconic acid, oxalic acid etc. which convert insoluble inorganic phosphates to soluble phosphates to be taken up by plants. Apart from this, the enzymes such as phytases, phosphatases released by PSB release phosphates from organic phosphorus compounds in the soil to be taken up the plants. Examples of PSB are Bacillus megatherium, Pseudomonas putida. PSB are being recommended as biofertilizers to farmers for crops such as cereals, pulses, vegetable crops.

Potassium Mobilising bacteria (KMB)

Potassium is an important macronutrient required for the plants. Although, the soil contains some amount of potassium, muriate of potash or other forms of chemical synthetic fertilisers are being used for additional potassium nutrients for crop plants. But, the regular use of chemical fertilisers can be deleterious to soil fertility.[2] In this regard, Potassium mobilizing bacteria or Potassium solubilizing bacteria can be used as a source of potassium. Potassium mobilising bacteria (KMB) can solubilize insoluble forms of potassium to soluble forms of potassium and make it available for uptake by plants. Examples of Potassium mobilising bacteria are- Frateuria aurantia, Paenibacillus sp., Bacillus edaphicus.

Mycorrhizae (VAM):

Mycorrhizae is the association of fungus with the roots of higher plants. VAM i.e., Vesicular Arbuscular Mycorrhizae is being used as a biofertilizer for many crops.[4] VAM helps in nutrient transfer mainly for phosphorus, Zinc, Sulphur. VAM also helps in uptake of water. The fungus penetrates the root cortex and spreads around the roots of the plants. This helps in better absorption of nutrients by plants, absorbing nutrients far away from the root zone, where the root hairs cannot reach. Examples of VAM fungi are-Glomus muscae, Acaulospora, Scutellospora. The characteristic feature of VAM is it forms arbuscules and vesicles in the root cells.VAM is recommended as a biofertilizer for –Rice, Wheat, Maize, Potato, Soyabean, Cotton, Tobacco, Sugarcane, Fruit plants.

Bioremediation

[12] The Biofertilizers used in agriculture not only bring about, nitrogen fixation, phosphorus solubilization, Potassium mobilization, nutrient uptake, they also bring about bioremediation of contaminated or polluted soils of agricultural soils. Generally agricultural soils are contaminated with synthetic fertilizers, pesticides, weedicides, nematicides etc. As an example, bacteria such as Pseudomonas, Bacillus sp.

Biological control

Biofertilisers used in agriculture, have the ability to control or suppress the diseases of plants apart from enhancing the availability of nutrients to crop plants. Especially, some Pseudomonas species produce pigments which inhibit soil borne plant pathogens.[3] Siderophores produced by Pseudomonas sequester the iron from the soil in the vicinity of root zone, thereby depriving the pathogens of iron, which is an important micronutrient for the growth

of microorganisms. The microorganisms present in the Biofertilisers also produce antifungal metabolites like HCN, phenazines, pyrrolnitrin, which suppress on control plant pathogens.

Adverse effect of chemical fertilisers

Indiscriminate use of chemical fertilisers has developed disturbances in the soil reaction, development of nutrient imbalance in soil, loss of soil fertility, changes in the pH etc. [10] Apart from these, the excessive use of chemical fertilizers leads to eutrophication of fresh water bodies leading to heavy enrichment with minerals and nutrients due to run off from land. Eutrophication leads to excessive growth of water plants and algae which can kill aquatic animals. Phosphate nutrient is the main contributor of eutrophication also nitrogen rich compounds.

Conclusion

Farmers should be encouraged and educated to use Biofertilisers.Effective biofertilizers should be developed by scientists, which help the farmer to give higher yields and quality crops.

Acknowledgement

We are thankful to the directors of our company, Mr. Ramanand.Dr. Krishnan and, Mr. Srinivas for encouraging to write this article.

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