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Biofertilizers – Types and Benefits

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Adverse effects are being observed due to the excessive and imbalanced use of synthetic inputs. The soils have now become biologically dead. This situation has led to identifying harmless inputs like biofertilizers. Biofertilizers add nutrients through the natural processes of nitrogen fixation, solubilizing phosphorus, and stimulating plant growth through the synthesis of growth-promoting substances. Biofertilizers can be expected to reduce the use of synthetic fertilizers and pesticides.

Introduction

India has achieved self sufficiency in food grain production after Green revolution era of 1960s. This revolution was greatly emphasized upon the use of high yielding varieties, chemical fertilizers and irrigation water. India had brought more than 2.5 m ha land under certification of organics. The technologies created some ill-effect on the soil and environmental health in the later years due to excessive use of chemical fertilizers and pesticides. Chemical fertilizers are industrially manipulated substances composed of known quantities of nitrogen, phosphorus and potassium, and their exploitation causes air and groundwater pollution by eutrophication of water bodies. However, chemical fertilizers cause pollution of water bodies as well as groundwater, besides getting stored in crop plants. Modern agriculture is becoming more and more dependent upon the steady supply of synthetic inputs, mainly chemical fertilizers, which are products of fossil fuel (coal+ petroleum). Adverse effects are being observed due to the excessive and imbalanced use of these synthetic inputs. There is great challenge before the scientists, the researchers and policy planners in achieving the goals of sustainable crop production and in meeting the food requirements for the burgeoning population. This calls for some alternative strategies in crop management like integrated nutrient management approaches using a combination of crop rotations, organic manures, chemical fertilizers and bio-fertilizers for sustainable crop production and maintenance of ecological health. Environmentalists worldwide are pressing the market and society for a switch over to organic farming and biofertilizers. Organic farming aims to be a more environmentally sustainable form of agricultural production, combining best environmental practices, and emphasizing biodiversity protection and the preservation of natural resources. Biofertilizers may be defined as “substances which contain living microorganisms that colonize the rhizosphere or the interior of the plants and promote growth by increasing the supply or availability of primary nutrients to the target crops, when applied to soils, seeds or plant surfaces”. The bio fertilizers being eco-friendly, no hazardous less expensive, easy to use and have no detrimental effect on soil and environment health advocate their use in present day modern agricultural practices (Sharma *et al*., 2007). Thus, the inclusion of biofertilizers in nutrient management strategies would be advantageous to crops as well as environment. Application of organic manures particularly bio-fertilizers is the only option to improve the soil organic carbon for sustenance of soil quality and future agricultural productivity (Ramesh, 2008).

Role of Biofertilizers

- Biofertilizers fix atmospheric nitrogen in the soil and root nodules of legume crops and make them available to the plants.
- They solubilize the insoluble forms of phosphate, such as tricalcium, iron and aluminum phosphates, into available forms.
- They scavenge phosphates from soil layers.
- They produce hormones and anti-metabolites which promote root growth.
- They decompose organic matter and help in the mineralization of soil.
- When applied to the soils or seeds, these biofertilizers increase the availability of nutrients and improve the yield by 10% to 20% without adversely affecting the soil and the environment.

Types of Biofertilizers

Biofertilizers add nutrients through the natural processes of fixing atmospheric nitrogen, solubilizing phosphorus, and stimulating plant growth through the synthesis of growth-promoting substances. They can be categorised in different ways based on their nature and function.

A. Nitrogen fixers

1. Rhizobium: Rhizobium belongs to family Rhizobiaceae, symbiotic in nature, fix nitrogen 50-100 kg/ ha. with legumes only. It is useful for pulse legumes like chickpea, red-gram, pea, lentil, black gram, etc., oil-seed legumes like soybean and groundnut and forage legumes like berseem and lucerne. Successful nodulation of leguminous crops by Rhizobium largely depends on the availability of compatible strain for a particular legume. It colonizes the roots of specific legumes to form tumour like growths called root nodules, which acts as factories of ammonia production. Rhizobium has ability to fix atmospheric nitrogen in symbiotic association with legumes and certain nonlegumes like Parasponia. There is evidence that some of the rhizobium strains acted as bio-control agent and promoted crop growth (Kumar *et al*., 2011).

2. Azospirillum: Azospirillum belongs to family Spirilaceae, heterotrophic and associative in nature. In addition to their nitrogen fixing ability of about 20-40 kg/ha, they also produce growth regulating substances. Although there are many species under this genus like, A. amazonense, A. halopraeferens, A. brasilense, but, worldwide distribution and benefits of inoculation have been proved mainly with the A. lipoferum and A. brasilense. Thus it is mainly recommended for maize, sugarcane, sorghum, pearl millet etc. The Azotobacter colonizing the roots not only remains on the root surface but also a sizable proportion of them penetrates into the root tissues and lives in harmony with the plants.

3. Azotobacter: Azotobacter belongs to family Azotobacteriaceae, aerobic, free living, and heterotrophic in nature. Azotobacters are present in neutral or alkaline soils and A. chroococcum is the most commonly occurring species in arable soils. A. vinelandii, A. beijerinckii, A. insignis and A. macrocytogenes are other reported species. The bacterium produces anti-fungal antibiotics which inhibits the growth of several pathogenic fungi in the root region thereby preventing seedling mortality to a certain extent (Subba Rao, 2001). The A. chroococcum is most common species in various arable soils (Mahato *et al*., 2009).

4. Blue Green Algae (Cyanobacteria) and Azolla: These belongs to eight different families, phototrophic in nature and produce Auxin, Indole acetic acid and Gibberllic acid, fix 20-30 kg

N/ha in submerged rice fields as they are abundant in paddy, so also referred as 'paddy organisms'. N is the key input required in large quantities for low land rice production. To achieve food security through sustainable agriculture, the requirement for fixed nitrogen must be increasingly met by BNF rather than by industrial nitrogen fixation. The 50-60% N requirement is met through the combination of mineralization of soil organic N and BNF by free living and rice plant associated bacteria (Roger and Ladha, 1992). Tripathi *et al.* (2008) reported that BGA along with other amendments improved the growth, yield and mineral composition of rice plants and decreased the demand for nitrogen fertilizers.

B. Phosphate Absorbers

Mycorrhiza (an ancient symbiosis in organic agriculture)

The term Mycorrhiza denotes "fungus roots". It is a symbiotic association between host plants and certain group of fungi at the root system, in which the fungal partner is benefited by obtaining its carbon requirements from the photosynthates of the host and the host in turn is benefited by obtaining the much needed nutrients especially phosphorus, calcium, copper, zinc etc., which are otherwise inaccessible to it, with the help of the fine absorbing hyphae of the fungus. Most common genera are Glomus, Gigaspora, Acaulospora, Sclerocysts and Endogone commonly used for biofertilizer production (Bagyaraj, 1992). Glomus fasciculatum reported to improve the wheat grain yield (Singh and Rana, 2005).

Benefits of using Biofertilizers

1. Increasing harvest yields

- An average increase in crop yields by 20 to 37 percent.
- Algae-based fertilizers give improved yields in rice at rates ranging between 10 and 45 %.

2. Improving soil structure-

- The use of microbial biofertilizers improves the soil structure by influencing the aggregation of the soil particles

3. Better water relation

Arbuscular mycorrhizal colonization induces drought tolerance in plants by:

- Improving leaf water and turgor potential,
- Maintaining stomatal functioning and transpiration,
- Increasing root length and development.

4. Lowering production costs

- Made from easily obtained organic materials such as rice husks, soil, bamboo and vegetables etc.
- Reduce the input expenses by replacing the cost of chemical fertilizers.

5. Providing protection against drought and some soil-borne diseases

- Aquatic cyanobacteria provide natural growth hormones, proteins, vitamins and minerals to the soil.
- Azotobacters infuse the soil with antibiotic pesticide and inhibit the spread of soil borne pathogens like Pythium and Phytophthora.

6. Suppressing the incidence of insect pests and plant diseases

Advantages

- They help to achieve high yields of crops by enriching the soil with nutrients and useful microorganisms necessary for plant growth.

- They replace the chemical fertilizers, as the latter are not beneficial for plants. Chemical fertilizers decrease the plant growth and pollute the environment by releasing harmful chemicals.
- Plant growth can be increased because biofertilizers contain natural components which do not harm the plants but do the opposite.
- They are eco-friendly due to the fact that they protect the environment against pollutants.
- If the soil is free of chemicals, it will retain its fertility, which will be beneficial for the plants as well as the environment, because the plants will be protected against diseases and the environment will be free of pollutants.
- Biofertilizers destroy those harmful components from the soil which cause diseases in plants. By using biofertilizers, plants can also be protected against drought and other restrictive conditions.
- Biofertilizers are cost effective. They are not costly and even low-income farmers can make use of them

Disadvantages

- Gives much lower nutrient density – it requires large amounts to get enough for most crops
- Requires a different type of machinery to apply from that used for chemical fertilizers
- Sometimes is hard to locate in certain areas; odour; difficult to store
- Specific to the plants- Requires skills in production and application. - There is inadequate awareness about the use and benefits of biofertilizers.

Precautions

- Biofertilizer packages need to be stored in a cool and dry place away from direct sunlight and heat.
- The right combinations of biofertilizers have to be used.
- Other chemicals (fertilizers and pesticides) should not be mixed with the biofertilizers.
- Sow the treated seeds (with biofertilizer) immediately, preferably in the morning or afternoon avoiding scorching sunlight.
- The package has to be used before its expiry, only for the specified crop and by the recommended method of application.
- Seed treatment chemicals like Bavistine etc. should be mixed 3 days prior to mixing with biofertilizer treatment.

Conclusion

Modern agriculture heavily relies on excessive use of chemical fertilizers especially, nitrogenous and phosphatic fertilizers for meeting the crop nutrient demand. For a sustainable agriculture system, it is essential to use renewable inputs which benefit the plant and cause no or minimal damage to the environment. Biofertilizers have their own advantages over chemical fertilizers and are economically and environmentally friendly as well. In this context, Biofertilizers would be the viable option for farmers to increase productivity per unit area.

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