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Biofertilizers - A enemy of chemical fertilizer

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Biofertilizers are known to play a number of vital roles in soil fertility, crop productivity and production in agriculture as they are eco friendly and can not at any cost replace chemical fertilizers that are indispensable for getting maximum crop yields. Increasing use of chemical fertilizers in agriculture make country self dependent in food production but it deteriorate environment and cause harmful impacts on living beings. Due to insufficient uptake of these fertilizers by plants results, fertilizers reaches into water bodies through rain water, causes eutrophication in water bodies and affect living beings including growth inhabiting micro organism. The excess uses of chemical fertilizers in agriculture are costly and also have various adverse effects on soils *i.e.* depletes water holding capacity, soil fertility and disparity in soil nutrients.

A number of micro-organisms (bacteria fungi and algae) are considered as beneficial for agriculture and used as biofertilizers. Biofertilizers are supposed to be a safe alternative to chemical fertilizers to minimize the ecological disturbance. Biofertilizers are cost effective, eco-friendly and when they are required in bulk can be generated at the farm itself. They increase crop yield upto 10-40% and fix nitrogen upto 40-50 kg. The other plus point is that after using 3-4 years continuously there is no need of application of biofertilizers because parental inoculums are sufficient for growth and multiplication. They improve soil texture, pH, and other properties of soil. They produces plant growth promoting substances IAA amino acids, vitamins etc. They have 75% moisture and it could be applied to the field directly. Biofertilizers contained 3.5% - 4% nitrogen, 2% - 2.5% phosphorus and 1.5% potassium.

Important functions of biofertilizers in agriculture:

– They supplement chemical fertilizers for meeting the integrated nutrient demand of the crops.

– They can add 20-200 kg N/ha year (eg. Rhizobium sp. 50-100 kg N/ha year; Azospirillum, Azotobacter : 20-40 kg N/ha /yr; Azolla : 40-80 kg N/ha; BGA :20-30 kg N/ha) under optimum soil conditions and thereby increases 15-25 per cent of total crop yield.

– They can at best minimize the use of chemical fertilizers not exceeding 40-50 kg N/ha under ideal agronomic and pest-free conditions.

– Application of biofertilizers results in increased mineral and water uptake, root development, vegetative growth and nitrogen fixation.

– Nitrogen fixing bacteria

Rhizobia : Legumes plants have root nodules, where atmospheric nitrogen fixation is done by bacteria belonging to genera, Rhizobium, Bradyshzodium, Sinorhizobium, Azorhizobium and Mesorhizobium collectively called as rhizobia. When rhizobial culture is inoculated in field, pulse crops yield can be increased due to rhizobial symbiosis (Dubey, 2001). Rhizobium can fix 15-20 N/ha and increase crop yield upto 20%.

– *Azorhizobium*: It is a stem nodule forming bacteria and fixes nitrogen symbionts of the stem nodule also produce large amount of IAA that promotes plant growth.

– *Bradyrhizobium*: Bradyrhizobium is reported a good nitrogen fixer. Bradyrhizobium strain inoculation with Mucuna seeds enhances total organic carbon, N_2, phosphorus and potassium in the soil, increases plant growth and consequently plant biomass, reduction in the weed population and increased soil microbial population.

Types of biofertilizers:

– *Rhizobium*: Rhizobium is a soil habitat bacterium, which can able to colonize the legume roots and fixes the atmospheric nitrogen symbiotically. The morphology and physiology of Rhizobium will vary from free-living condition to the bacteroid of nodules. They are the most efficient biofertilizer as per the quantity of nitrogen fixed concerned. They have seven genera and highly specific to form nodule in legumes, referred as cross inoculation group.

– *Azotobacter* : They are the free living aerobic, photoautotrophic, non-symbiotic bacteria. They secretes vitamin-B complex, gibberellins, napthalene, acetic acid and other substances that inhibit certain root pathogens and improves root growth and uptake of plant nutrients. It occurs in the roots of Paspalum notatum (tropical grasses) and other spp. and adds 15-93 kg N/ha/annum on *P. notatum* roots. Azotobacter indicum occurs in acidic soil

in sugarcane plant roots. It can apply in cereals, millets, vegetables and flowers through seed, seedlings soil treatment.

– *Azospirillum***:** These are gram negative, free living, associative symbiotic and non-nodule forming, aerobic bacteria, occurs in the roots of dicots and monocot plants *i.e.* corn, sorghum, wheat etc. It is easy to culture and identify. Azospirillum is found to be very effective in increasing 10-15% yield of cereal crops and fixes N_2 upto 20-40% kg/ha. Different *A. brasiliense* strains inoculation in the wheat seed causes increase in seed germination, plant growth, plumule and radicle length. Herbaspirillum species occurs in roots, stems and leaves of sugarcane and rice. They produce growth promoters (IAA, Gibberillins, Cytokinins) and enhance root development and uptake of plant nutrients (N, P & K).

– *Blue green algae* : Both free-living as well as symbiotic cyanobacteria (blue green algae) have been harnessed in rice cultivation in India. A composite culture of BGA having heterocystous Nostoc, Anabaena, Aulosira etc. is given as primary inoculum in trays, polythene lined pots and later mass multiplied in the field for application as soil based flakes to the rice growing field at the rate of 10 kg/ha. The final product is not free from extraneous contaminants and not very often monitored for checking the presence of desiredalgal flora.

– *Azolla* : It is a free floating, aquatic fern found on water surface having a cyanobacterial symbiont Anabaena azollae in their leaves. It fixes atmospheric nitrogen in paddy field and excrete organic nitrogen in water during its growth and also immediately upon trampling. Azolla contributes nitrogen, phosphorus (15-20 kg/ha/month), potassium (20-25 kg/ha/month) and organic carbon etc. and increases 10-20% yield of paddy crops and also suppresses weed growth. Azolla also absorbs traces of potassium from irrigation water and can be used as green manure before rice planting. Azolla spp. are metal tolerant hence, can be applied near heavy metal polluted areas.

– *Phosphate solubilising bacteria*: *Pseudomonas fluorescens, Bacillus megatherium* var. phosphaticum, Acrobacter acrogens, Nitrobacter spp., *Escherichia freundii*, Serratia spp., *Pseudomonas striata, Bacillus polymyxa* are the bacteria have phosphate solubilising ability. 'Phosphobacterin' are the bacterial fertilizers containing cells of *Bacillus megatherium* var. phosphaticum, prepared firstly by USSR scientists. They increased about 10 to 20 % crop yield (Cooper, 1959) and also produces plant growth promoting hormones which helps in phosphate solubilising activity of soil.

– *Plant growth promoting Rhizobacteria (PGPR):* They are also called as microbial pesticides e.g. Bacillus spp. and Pseudomonas fluorescence. Serratia spp. and Ochrobactrum spp. are able to promote growth of plants. Pseudomonas fluorescence application to the Black pepper enhanced uptake of nutrients which increased plant biomass. Fluorescent rhizobacteria improve the growth of *H. brasiliensis*.

Mycorrhiza: Mycorrhizas are developed due to the symbiosis between some specific root inhabiting fungi and plant roots and used as biofertilizers. They absorb nutrients such as manganese, phosphorus, iron, sulphur, zinc etc. from the soil and pass it to the plant. Mycorrhizal fungus increases the yield of crops by 30-40% and also produces plant growth promoting substances.

Benefits: The advantages of Liquid Bio-fertilizer over conventional carrier based Bio-fertilizers are listed below:

– Longer shelf life -12-24 months.
– No contamination.
– No loss of properties due to storage upto 45ºC.
– Greater potentials to fight with native population.
– High populations can be maintained more than 109 cells/ml upto 12 months to 24 months.
– Easy identification by typical fermented smell.
– Cost saving on carrier material, pulverization, neutralization, sterilization, packing and transport.
– Quality control protocols are easy and quick.
– Better survival on seeds and soil.
– No need of running Bio-fertilizer production units through out the year.
– Very much easy to use by the farmer.
– Dosages is 10 time less than carrier based powder Bio-fertilizers.
– High commercial revenues.
– High export potential.
– Very high enzymatic activity since contamination is nil.

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