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# EFFECT OF BIOFERTILIZERS ON GROWTH OF DIFFERENT CROPS : A REVIEW

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## Abstract

Biofertilizers contain large number of beneficial microorganisms in a live state incorporated in a sterilized carrier material like lignite or talc and its application to seed, seedling, plant or soil helps in mobilizing plant nutrients for crop growth through biological nitrogen fixation or by phosphorus solubilization or mobilization of any other plant nutrient required for the crop growth. Some of the biofertilizers also act as effective bio control agents in controlling many root borne pathogens. They induce disease resistance in plants and enrich soil fertility. The inoculation of pulse seeds with *Rhizobium* is known to increase nodulation, nitrogen uptake, growth and yield. *Phosphate solubilizing bacteria* (PSB) or fungi (PSF) help to solubilize the inorganic phosphate such as rock phosphate, tricalcium phosphate, iron phosphate and aluminium phosphate by producing certain organic acids. Arbuscular Mycorrhizal fungi helps in translocation of available P in to the plant system. They are known to mobilize the available micronutrients like Fe, Cu, Zn, Mo, Mn etc to plants and helps in scavenging water from the distant zones of crop rhizosphere through root ramification process. Thus its inoculation to crop plants is a promising technology in crop production especially in dry land crops. Mycorrhizae are known to control many root borne pathogens through induction of ortho dihydroxy phenol activity in plant system. Biofertilizers are natural fertilizers containing micro-organism which help in enhancing the productivity by biological nitrogen fixation or solubilization of insoluble phosphate or producing harmones, vitamins and other growth regulators required for plant growth. Biofertilizers are living micro-organisms, which when applied through seed or soil treatment, promote growth by increasing the supply or availability of nutrients to the host plant.

***Keywords*:** Rhizobium, PSB, Acetobactor, Biofertilizers

## Introduction

Biofertilizers offer a new dimension to Indian agriculture holding a promise to balance many of the shortcomings of conventional chemical based agriculture Microbial inoculants generally called as “Biofertilizers”, are carrier based preparations containing beneficial microorganisms in a viable state intended for seed or soil application designed to improve soil fertility and to help plant growth by increasing the number and biological activity of desired microorganisms in the root environment. The most commonly used biofertilizers in crop cultivation are *Rhizobium, Azotobacter* and *Azospirillum*, *phosphate solubilizing bacteria* and fungi. Arbuscular Mycorrhizal (AM) fungi*, Trichoderma sp*. and *Pseudomonas sp*. are considered as plant growth promoters and as potential biocontrol agents (Smitha, 2005).

Biofertilizers are low cost, renewable resource of plant nutrients and their usage in agriculture assumed a special significance particularly in the present day context of organic farming, integrated farming and in nutrient management practices. Adesemoye and Kloepper (2009) reported that biofertilizers can be used in conjunction with chemical fertilizers as an economic input to increase crop productivity. The key limiting factors in crop productivity is the availability of nitrogen. Because of the constraints on the production, availability and use of chemical nitrogenous fertilizers, biologically fixed nitrogen will play an important role in increasing the crop production. A small dose of biofertilizer is sufficient to produce desirable results because each gram of carrier of biofertilizers contains at least 10 million viable cells of a specific strain.

### Role of Biofertilizers

Biofertilizers on the other hand are cost-effective and renewable source of plant nutrients to supplement the parts of chemical fertilizers. Biofertilizers are known to play an important role in increasing availability of nitrogen and phosphorus besides improving biological fixation of atmospheric nitrogen and enhance phosphorus availability to crop. Dual inoculation of vermi compost and bacteria biofertilizers proved more effective in increasing the growth of different crop plants. Biofertilizers are products containing living cells of different types of micro-organisms which when, applied to seed, plant surface or soil, colonize the rhizosphere or the interior of the plant and promotes growth by converting nutritionally important elements (nitrogen, phosphorus) from unavailable to available form through biological process such as nitrogen fixation and solubilization of rock phosphate.

The seed inoculation with *Rhizobium* increases nodulation, influences seed yield and economies the input cost of fertilizers to some extent and protects against chances of soil deterioration and environmental pollution caused by heavy use of chemical fertilizers. The efficient strains of *Rhizobium* can fix about 90 kg of nitrogen per hectare in one season and enrich soil nitrogen. Introduction of efficient strains of *Rhizobium* in soils with low nitrogen may help augment nitrogen fixation and there by boost production of crops.

*Rhizobium* inoculation increased the root nodulation through better root development and more nutrient availability, resulting in vigorous plant growth and dry matter production which resulted in better flowering, fruiting and pod formation and ultimately there was beneficial effect on seed yield.

**Role of Azotobacter and Azospirillum**

*Azotobacter* and *Azospirillum* are the most predominant and important ones. Both are known to provide a nitrogen economy of 20-30 kg nitrogen $ha^{-1}$, coupled with production of growth promoting substance, besides improving growth yield quality attributes of fruit and thus, leading to the improvement of crop. The favorable effect of *Azotobacter* and mineral nitrogen fertilizer on growth, chemical composition of leaves, and yield was reported on pea indicated that both inoculation with *Azotobacter* and application of N increased seed yield. *Azotobacter* is free living nitrogen fixer, however in plant rhizosphere due to availability of various readily utilizable carbon compounds, the bacteria are considered to be advantage for plant growth and yield.

*Azotobacter* and *Azospirillum* are the two most important non-symbiotic N-fixing bacteria in non-leguminous crops. Under appropriate conditions, *Azotobacter* and *Azospirillum* can enhance plant development and promote the yield of several agricultural important crops in different soils and climatic regions. These beneficial effects of *Azotobacter* and *Azospirillum* on plants are attributed mainly to an improvement in root development, an increase in the rate of water and mineral uptake by roots, displacement of fungi and plant pathogenic bacteria and to a lesser extent, biological nitrogen fixation.

**Role of PSB**

PSB in agricultural practice would not only offset the high cost of manufacturing phosphate fertilizers but would also mobilize insoluble in the fertilizers and soils to which they are applied. Among the whole microbial population in soil, phosphate solubilizing bacteria (PSB) constitute 1 to 50 per cent, while phosphorus solubilizing fungi (PSF) are only 0.1 to 0.5 per cent in P solubilization potential. Positive effects of phosphorein (PSB or PDB) and chemical phosphorus fertilizer on growth, yield, seed yield and quality were found on fiber bean. Enhancing P availability to crop through phosphatesolubilizing bacteria (PSB) holds promise in the present scenario of escalating prices of phosphate fertilizers and a general deficiency of p in Indian soils. Sundara et al. (2002) reported that PSB application reduced the required P chemical fertilizers dosage by 25 per cent, when used in conjunction with P fertilizers and the PSB application has improved the juice quality and yield of sugarcane

**Effect of biofertilizers on seed treatment**

1. **Seed treatment and sowing**: Rhizobium culture: 200g of jaggery was dissolved in 200ml of water. Jaggery solution as per the volume of seed was prepared. The Rhizobium culture was thoroughly mixed for slurry preparation in above solution. Seeds were treated with this mixture carefully, so that seed coat was not injured and uniform coating is made. Treated seeds were dried under shade on gunny bags and then used for sowing
2. **Azotobactor culture**: 200g of jiggery was dissolved in 200ml of water. Jiggery solution as per the volume of seed was prepared. The Azotobactor culture was thoroughly mixed for slurry preparation in above solution. Seeds were treated with this mixture carefully, so that seed coat was not injured and a uniform coating is made. Treated seeds were dried under shade on gunny bags and then used for sowing
3. **PSB culture** : 200g of jaggery was dissolved in 200ml of water. Jaggery solution as per the volume of seed was prepared. The PSB culture was thoroughly mixed for slurry preparation in above solution. Seeds were treated with this mixture carefully, so that seed coat was not injured and a uniform coating is made. Treated seeds were dried under shade on gunny bags and then used for sowing.

**Role of *Bacillus subtilis* and *Azospirillum brasilense***

Singh and Panwar (2000) recorded enhanced leaf area, chlorophyll content, nitrate reductase (NR) activity, total biomass production and grain yield of wheat cv. HD 2428 and DL 153-2 when inoculated with *Bacillus subtilis* and *Azospirillum brasilense* under field conditions. The cultivar DL 153-2 had given higher response to inoculation than HD 2428. The analysis of grain revealed that P and K uptake were enhanced when inoculated with *Bacillus subtilis* whereas N uptake was more with *Azospirillum brasiliense. Bacillus subtilis* and *Pseudomonas fluorescens* were equally effective as that of fungicide in reducing the severity of Cercospora leaf spot and powdery mildew and enhanced the yield of urd bean.

**Role of *Trichoderma sp.***

*Trichoderma* spp. either added to soil or applied as seed treatments grow readily along with the developing root system of treated plants. Lamba *et al*. (2008) studied the biochemical changes in sunflower plants due to seed treatment or by foliar application of bio-control agents like *T. harzianum* and Pseudomonas fluorescens which led to increase in dry matter content, starch, total soluble sugars and reducing sugars in the leaves of sunflower (*Helianthus annuus*) when they were used as seed treatment or coupled with spray. Biocontrol agents increased the activity of phenylalanine ammonia lyase (PAL) in leaves and stem tissue after 30 days of sowing and significantly reduced total phenolic content and PAL activity in the stem at 60 days after sowing

**Role of VAM**

VAM fungi are one of the important components of the soil micro biota and obviously interact with other microorganisms in the rhizosphere. The effect of VAM on the growth of transplanted chillies under field conditions and found a significant increase in the plant growth due to mycorrhizal inoculation. VAM cause greater uptake of P by their expanded network of hyphae and also help in the uptake of Zn, Cu, Fe, Mn, etc. VAM fungal hyphae play an important role in soil aggregation by creating the skeletal structure of macro aggregates through physical entanglement of soil particles and organic materials. Such aggregates enhance carbon and nutrients storage and create conducive environment for the survival and growth of soil microorganisms.

VAM fungi are particularly important in organic and/or sustainable farming systems that rely on biological processes rather than agrochemicals to control plant diseases. AM fungi plays an important role in bio-protection to plants against many soil-borne pathogens such as species of *Aphanomyces, Cylindrocladium, Fusarium, Macrophomina, Phytophthora, Pythium, Rhizoctonia, Sclerotinium, Verticillium, Thielaviopsis* and *nematodes*.

**Role of Azotobacter**

Kader *et al*. (2002) studied the effect of Azotobacter inoculants on the yield and nitrogen uptake of wheat. It was found that the free living nitrogen fixer Azotobacter in the rhizosphere zone has the ability to synthesize and secrete some biologically active substances like B vitamins, nicotinic acid, pantothenic acid, biotin, auxins, gibberellins, etc. which enhances the root growth.

Kramany *et al*. (2007) found that treatment of 25 per cent recommended dose of NPK + 75 per cent FYM + biofertilizer (microbien) was best in improving the groundnut yield, yield components, oil yield (kg ha$^{-1}$), P (%), Fe and Zn (ppm) while number of seeds/pod and weight of straw (g plant-1) was highest with 50 per cent NPK+ 50 per cent FYM + microbien. The effect of combined inoculation of Rhizobium, phosphate solubilizing bacterium, *Bacillus megaterium* sub sp. *Phospaticum* strain-PB and a biocontrol fungus *Trichoderma* spp. on growth, nutrient uptake and yield of chickpea under glasshouse and field conditions. Combined inoculation of these three microorganisms showed increased germination, nutrient uptake, plant height, number of branches, nodulation, pea yield, and total biomass of chickpea compared to either individual inoculation or uninoculated control. Almas *et al*. (2006) evaluated the effects of nitrogen fixing *Bradyrhizobium* sp. (Vigna group) and phosphate solubilizing bacterium *Bacillus subtilis* on growth, chlorophyll content, nodulation and seed yield of cowpea and found that combined inoculation has improved nodulation and seed yield.

Manisha Basu and Bhadoria (2008) reported that the combined application of Rhizobium and phosphobacterium (*Bacillus polymyxa*) inoculants and cobalt applied at the rate of 0.21 kg ha$^{-1}$ has significantly increased the yield and uptake of N, P and K in groundnut compared to single application of either inoculants or cobalt. The beneficial effects of application of microbial inoculants and cobalt were also reflected on the soil fertility status.

Inoculation of bioinoculants viz., *Azotobacter chroococcum, Azospirillum lipoferum, Acetobacter* sp. and phosphate solubilizer *Bacillus megaterium* alone or in combination increased plant height, number of tillers and ultimately the yield of pearl millet. Dual inoculation of Azospirillum and Azotobacter could able to substitute up to 50 per cent of the N requirement in sunflower under rainfed conditions.

Effect of VAM fungi and its interaction with other beneficial microbial inoculants, *Azospirillum* spp., *Azotobacter* spp. and phosphate solubilizing bacteria on plant biomass, nutrients and biochemical constituents in Jatropha curcas. Application of combined microbial inoculants has significantly enhanced the fresh biomass, total soluble protein and phenols as well as relative water content over other treatments and uninoculated control

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