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Biofertilizers Technology and Pulses Production: A Review

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India is such a country were large population depending on agriculture and most of them in arid and semiarid areas where rainfall is scare or limited. Hence, the cultivation of pulse crops like Chickpea, Red gram, Pea, Green gram, Black gram, and few other crops are abundant in these regions. However low yields were noticed in these areas due to less available water, nutrient available status (mostly nutrients are in unavailable form due to strong bonding with soil particles and most of nutrients are in atmospheric gaseous form mainly nitrogen). For better yields farmers applying lot of chemical fertilizers that can increase yield but damage the soil strength and biota. To overcoming this problems recent Agricultural practices mainly utilization of biofertilizers like Rhizobium strains, PSB(phosphate Solubilizing Bacteria), VAM(Vascular Arbuscular Mycorrhiza), Cyanobacteria and various other microorganism fertilizers that plays a vital role in pulse crops as increasing nutrients uptake in crops by fixation of nutrients by forming nodules in roots that helps in Mineralization process that can convert the unavailable form of nutrients to available form that can easily uptake by plant and these biofertilizers are mostly host specific type that can symbiont with particular pulse crop and also boost the growth and yield attributes.

Crop management practices continued to use inorganic fertilizers and synthetic pesticides for supply of nutrients and control of pests and diseases to full fill increased food demand by the emerging population. India is one of the largest consumers of fertilizers so sustainable agricultural productivity without affecting the soil fertility is a matter of great concern. Though the high input chemical fertilizers increase the production, excessive use of these fertilizers effects air, soil and water quality with reduced nutrient-use efficiency. So by supplementing nutrients and hindering pests by means of biofertilizers and other organic sources results in enhanced productivity and sustainable crop production with improved yields.

Biofertilizers are preparations containing living cells or latent cells of efficient strains of microorganisms which are capable of fixing atmospheric nitrogen, solubilizing and enhancing uptake of soil phosphorus, stimulating plant growth through synthesis of growth promoting substances and also helps to improve soil health in general. Totally harmless, pollution free and low-cost renewable agricultural inputs. With the introduction of green revolution technologies the modern agriculture is getting more and more dependent upon the steady supply of synthetic inputs (mainly fertilizers). Adverse effects are being noticed due to the excessive and imbalanced use of these synthetic inputs. This situation has lead to identifying harmless inputs like biofertilizers. Use of such natural products like biofertilizers in crop cultivation will help in safeguarding the soil health and also the quality of crop products.

Coupling of pulse-based cropping system can provide audacious ecological security and enhanced sustainability owing to their inherent nitrogen-fixing capacity and less reliability on agrochemical inputs. Further, to protect the environment from negative effects of inorganic fertilizers, endless efforts are also needed to enhance nutrient-use efficiency by incorporating

biofertilizers as supplements to fertilizers. These biofertilizers are less expensive inputs compared to the chemical fertilizers, and the revive plant growth by the use of these inoculants is a eco-friendly process. Thus, the moto of this review will focus on biofertilizers, their role in plant functional traits, potential use in plant production and challenges associated with them.

A extensive range of biofertilizers contains one or more microorganisms which when applied to plants may help to provide numerous essential nutrients which are crucial for plant growth. They supports plants in fixing nitrogen, solubilizing and largely accessing phosphorus, tolerance to abiotic stresses, bio-control and siderophore production. Some of the important biofertilizers are *Rhizobium, Azotobacter, Azospirillum,* Phosphate-Solubilizing Microorganisms (PSMs), Arbuscular Mycorrhiza (AM), Plant Growth Promoting Rhizobacteria (PGPR), Blue Green Algae (BGA) and Azolla. These biofertilizers are used to seeds, seedlings or directly to fields with or without utilizing a carrier for the microbes.

Pulses are rich in protein content (20–25%) and they also supplies vitamins, minerals and some essential micronutrients. They are important part of Indian culture and daily diet. India ranks first in the production of pulses but is also world's largest consumer of these. The consumption of pulses in India was 18.65 million tonnes against the average production of 15.8 million tonnes during 2010–11. The enhanced area under cultivation of pulses did not show improved yield potential (Fig. 1; FAO statistics) and insufficient supply of nutrients is suggested to be a major limiting factor in identifying the yield potential of pulse crops. Endless and enormous efforts have been made to induce pulse production by utilization of inorganic fertilizers. anyhow, with identifying adverse effects of chemical fertilizers on soil, water and air quality, biofertilizers are considered as potential supplements.

Role of biofertilizers technology for pulses crop production

Pulse crop and its production mainly depends upon the fixation of Biological Nitrogen mainly by *Rhizobium* strains which may help in better nodule formation in symbiotic manner with host plants. Pulse crops in root zone helps as host for nitrogen fixing bacteria mainly *Rhizobium* species in opposite these rhizobia species fix Nitrogen from atmosphere by forming nodules that may be helpful for plant to take nitrogen. In pulse crops there are different species that may be host specific to different pulses. Hence using appropriate species may be beneficial for pulse crops. *Rhizobium* species may help in Nitrogen fixation, in addition to its other main macro primary nutrient Phosphorus (P) were fixed by Phosphate solubilizing bacteria (PSB). It involves mainly the microorganisms of Aspergillus, Bacillus and Pseudomonas that can supply phosphorus to plants. Microorganisms belongs to PSB can produce bioactive molecules and organic acids which is helpful for uptake of Phosphorus to plants and increase growth, yield of crops. These organisms also helpful to contribute phytate activity in plants that can produce phosphorus in plant by phytate mineralization (Idriss et al.,2002). Rather than PSB an obligate symbiont of VAM (Vascular Arbuscular Mycorrhiza) fungi which may help in stimulating absorption of Phosphorus in plants by spreading hyphal growth in rootzone near to nutrient area (Smith and Smith,1990).

Rhizobium is highly used biofertilizer for N uptake and induced yield in pulses. anyway, in addition to *Rhizobium*, the other helpful microbes such as phosphobacteria, PGPRs, AM fungi and

more other helpful microorganisms are recognized for enhanced symbiotic capacity, nutrient absorption, better growth and yield as well as yield-contributing characters, and also improved forbearance towards biotic and abiotic stresses. A list of PGPRs such as *Azotobacter, Azospirillum, Rhizobium, Pseudomonas, Bacillus, Arthrobacter, Burkholderia, Enterobacteria, Klebsiella,* etc. are designed in ready-to-use 'live-formulations' which upon using to seed, root or soil, improve the growth and yield of crop plants. They themselves do not supply any nutrients to crops, but their interactions in the plants' rhizosphere can enhances the nutrient supplement to crops.

Biofertilizers categories:

Symbiotic nitrogen fixing bacteria:

Species name	**Group name**	**Crops**
Rhizobium leguminosarum	Pea group	All types of pea, lentil, bean
Rhizobium japonicum	Soyabean group	soyabean
Rhizobium phaseoli	Phaseolus group	Kidney and garden beans
Rhizobium trifoli	Clover group	White clover
Rhizobium meliloti	Alfalfa group	Lucerne

Non symbiotic nitrogen fixing bacteria:

Azatobacter: Aerobic microbes which thrives well in neutral soils and susceptible to deficiency of phosphate.

Clostridium: Anaerobic fixes less amount of nitrogen fixation than azatobacter.

Mycorrhizae: It is a mutually beneficial association between fungi and roots of higher plants. It is divided in to two groups.

Vesicular Arbuscular Mycorrhiza: VAM, a fungus colonize the plant root system and increase the growth and yield of crop. It increase nutrient uptake (P, Zn) and growth of associated plants by producing auxins, antibiotics etc. It can save 50% Phosphatic fertilizer without affecting the yield.

Frankia: Association of actinomycetes and plants. Actinomycetes is transitional between bacteria and fungi. Produces smell of earth which we feel initial rain drops after falling on earth called V geosmin. Breakdowns recalcitrant compounds.

Phosphorus solubilizing bacteria: Most of the phosphorus sources are gets fixed in soil and becomes unavailable to plants so availability and absorption of phosphorus is induced by the utilization of phosphorus solubilizing microbes such as aspergillus, pseudomonas, bacillus and mycorrhizal fungus.

Conclusion

Biofertizers are boon for pulse crops production as they play a crucial role in fixation of nutrients in crops from atmosphere. These biofertizers can apply directly to soil or also used as a seed treatment. Different strains of biofertilizers have different role in plant nutrient fixation. These may be helpful for increasing growth and yield attributes of crops majorly leguminous plants. It stimulates the pulses crops growth, yield attributing characters, increase quality, yield and profitability. Nitrogen and phosphorus can be saved by about 25% by treating the seeds/seedling with nitrogen fixing biofertilizers (*Rhizobium, Azotobacter*, BGA, *etc*.) and phosphorus solublizing biofertilizers (*Pseudomonas, Bacillus*, VAM fungi *etc*.) respectively.

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