**Phosphate solubilizing as effective biofertilizer- an introduction**

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Agriculture plays a significant role in the entire life of a given economy. Agriculture is the backbone of economic system of a given country. Besides providing food and raw material, agriculture also provides employment opportunities to very large percentage of population. As the world’s human population is drastically increasing, the demands forced upon agriculture to provide future food will be one of the highest problem facing the entire world. In order to solve this issue, a great deal of effort focusing on the soil biological system and the agro-ecosystem as a whole is needed to understand better the complex processes and interactions governing the stability of agricultural land. The green revolution is one of the most significant human activities leading to global food security and, consequently transformed some of the developing countries, such as India, from being food-deficient to a food surplus condition. However, the consistent and alarming increase in the human population has again threatened the world’s food security. Moreover the increased application of chemical fertilizers and fungicides to maintain the productivity has led to many adverse effects on soil and human health. Also the continued cultivation of Indian soils has led to the depletion of fertility of soil.

Phosphorus is one of the most important nutrients essential for plant growth. Its functions cannot be performed by any other nutrient, and an adequate supply of P is required for optimum growth and reproduction. Phosphorus is considered as a major nutrient, meaning that it is usually deficient for crop production and is needed by crops in comparatively large amounts. Phosphorus plays a significant role in every plant process that involves energy transfer. High energy phosphate, held as a part of the chemical structure of ADP and ATP, is the source of energy that drives the multitude of chemical processes within the plant. Phosphorus deficiency mostly leads to small brown leaves, weak stem and slow plant growth (Sonam *et al*., 2011). Phosphorus constitutes about 0.2% of plant dry weight. Generally plants absorb P from soil as phosphate anions which become immobilized through precipitation with cations such as Mg 2+, Ca 2+, Fe 3+ and Al 3+, depending on the soil properties. In these forms, P is highly insoluble and remains unavailable to plants. Hence the amount of P available to plants remains low. Adequate P fertilization enhances the quality of fruits and vegetables and enhance their resistance to adverse conditions and diseases.

The continuous and uncontrolled use of chemical Phosphorus fertilizers will degrade the soil fertility (Gyaneshwar *et al*., 2002) by reducing the microbial load and thereby affects the crop yields. Phosphorus deficiency restricts crop yields severely. Generally tropical and subtropical soils are acidic in nature, with insufficient phosphorus level (Gaume, 2000. The comparatively low levels of phosphorus are mainly due to high reactivity of soluble phosphate with other elements.

Under these circumstances, naturally occurring soil microorganisms possessing phosphate solubilization capacity is a promising alternative for chemical sources. The use of mineral phosphate solubilizing microorganisms (PSM) in solubilizing phosphorus and making them available to plants has been studied under various soil conditions throughout the world and have been recognized as a potential means to convert insoluble form of phosphorus to soluble form. Microorganisms are important component of soil and directly or indirectly influence the soil health through their detrimental or beneficial activities. Many bacteria and fungi like *Burkholderia*, *Bacillus*, *Pseudomonas*, *Streptomyces*, *Aspergillus* and *Trichoderma* spp. are known to have phosphate solubilization potential (Kucey *et al*., 1983 and Vassilev *et al*., 2006). A wide range of bacteria belonging to *Pseudomonas* and *Bacillus* genera are proved to be efficient P solubilizers. Bacteria belonging to *Pseudomonas* genera are known to be efficient phosphate solubilizers (Gulati *et al*., 2007). The production of P solubilizing activity has been found to be highly dependent on the cultural conditions (Deepshikha *et al*., 2014). Each species or a strain has a characteristic minimum, optimum and maximum temperature, pH and nutrient sources for P solubilization.

Phosphate solubilizing microorganisms are significant and their load varies from soil to soil. Generally in soil phosphate solubilizing bacteria constitute 1-50% and fungi 0.5%-0.1% of the total respective population. The high proportion of PSMs is seen in the rhizospheres and is metabolically more active than those isolated from sources other than the rhizosphere (Vazquez *et al*., 2000).

The viable microbial preparations having phosphate solubilizing activity are generally termed as microphos (Zaidi *et al*., [2009](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4320215/#CR134)). The phosphate solubilizing microbes showing greater P solubilization under *in vitro* conditions were subjected to field trials prior to bulk production and transmission as biofertilizer. Moreover inocula developed from a particular soil fail to function effectively in a different soil. Hence there is a need to study phosphate solubilizing activity in correlation with different physiological and nutritional factors before application as a biofertilizer.

The primary mechanism of phosphate solubilization in microorganisms is organic acid production (Stephen and Jisha, 2011). Low molecular weight organic acids, mainly gluconic and ketogluconic acids are responsible for tricalcium phosphate and rock phosphate solubilization (Kumari *et al*., 2008). These organic acids solubilize insoluble forms of phosphate to a soluble form, such as orthophosphate, thus increasing the potential availability of phosphate for plants. Strains from the genera *Pseudomonas*, *Bacillus* and *Rhizobium* are among the most powerful phosphate solubilizers. Phosphate solubilization process also involves the action of enzymes *viz*., phosphatase, phytase and phosphonatases. Among them phosphatases (phosphohydrolase) perform dephosphorylation of phosphor-ester or phosphoanhydride bonds in organic matter, phytases cause p release from phytic acid and phosphonatases and C–P lyases that perform C–P cleavage in organo phosphonates. The enzyme phosphatase functions as organic phosphor-ester scavengers, releasing inorganic phosphates from nucleotide and sugar phosphates and thereby providing the cell with essential nutrients. As a result interest in these enzymes increased during the last decades due to their potential biotechnological applications (Rodriguez *et al*., 2006). Several acid phosphatase genes from Gram negative bacteria have been isolated and characterized (Rossolini *et al*., 1998) and some of them code for acid phosphatase that are capable of performing well in soil.

The plant growth promoting rhizobacteria such as *Alcaligenes, Arthrobacter, Bacillus, Burkholderia, Enterobacter, Flavobacterium, Pseudomonas, Rhizobium* and *Serratia* are used as biofertilizers or biocontrol agents for rural improvement. Several studies reported the ability of different bacteria producing phosphate from inorganic phosphate such as tricalcium phosphate, dicalcium phosphate, hydroxyl apatite and rock phosphate through solubilization and mineralization (Vassilev *et al*., 1996). PSB have a high potential to be used for the management of phosphorus in P deficient soils as well as disease suppression. Therefore, usage of environmental friendly microorganisms is needed for plant-growth promotion and disease control for sustainable agriculture.

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