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

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Agriculture have inevitable influence on the day to day life of human economy. Cultivation influences economic balance of a country. In addition to supplying food sources and raw material, agriculture is source of income to majority of population. Since human population is increasing, the needs forced on agronomy to provide future food will be one of the highest problem threatening the entire world. In order to overcome this situation a great focus on the soil biological system and the agroecosystem is needed to enhance the agriculture production by maximum utilization of biological sources of soil. The green revolution is the most significant human activities leading to stable food system which consequently transformed most of the developing countries to a food stable condition. But on the other side the consistent increase in human population is a threaten to world’s food stability. Besides this 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 soil fertility reduction.

Phosphorus is one among the most important nutrients needed for crop production. It cannot be replaced by any other nutrient, and an adequate amount of Phosphorus is essential for plant growth and yield. Phosphorus is a limiting nutrient to plants since it is essential for plant growth and yield but not available in soil in solubilized form for plant uptake. 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 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 live microbial preparations having phosphate solubilizing activity are generally termed as microphos (Zaidi *et al*., [2009](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4320215/" \l "CR134)). The phosphate solubilizers with high P solubilization capacity 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 function 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 eco friendly microorganisms is needed for plant-growth promotion and disease control for sustainable agriculture.

**References**

Deepshikha, T., Mohinder, K., and Vineet, S. (2014). Optimization of best cultural conditions for high production of phosphate solubilizing activity by fluorescent *Pseudomonas* isolated from normal and replant sites of apple and pear. *The Bioscan*, **9**(1):143-150.

Gaume, A. (2000). Low P tolerance of various maize cultivars; the contribution of the root exudation, Ph.D.dissertation, Swiss Federal Institute of Technology, Zurich, Switzerland.

Gulati, A., Rahi, P., and Vyas, P. (2007)**.** Characterization of phosphate solubilization fluorescent pseudomonadsfrom the rhizosphere of seabuckthorn growing in the cold desert of Himalayas. *Current* *Microbiology,* **56:** 73-79.

Gyaneshwar, P., Naresh, K.G., Parekh, L.J. and Poole, P.S. (2002). Role of soil microorganisms in improving P nutrition of plants. *Plant Soil*, **245**:83–93.

Kucey, R.M.N. (1983). Phosphate solubilizing bacteria and fungi in various cultivated and virgin Alberta soils. *Canadian Journal of Soil Science*, **63**:671–678.

Kumari, A., Kapoor, K.K., Kundu, B.S., and Mehta, R.K. (2008). Identification of organic acids produced during rice straw decomposition and their role in rock phosphate solubilization. *Plant Soil and Environment*, **54**:72–77.

Rodriguez, H., Fraga, R., Gonzalez, T., and Bashan, T. (2006). Genetics of phosphate solubilization and its potential applications for improving plant growth promoting bacteria. *Plant and Soil*, **287:**15–21.

Rossolini, G.M., Shippa, S., Riccio, M.L., Berlutti, F., Macaskie, L.E., and Thaller, M.C. (1998). Bacterial nonspecific acid phosphatases: physiology, evolution, and use as tools in microbial biotechnology. *Cellular and Molecular Life Sciences*, **54:**833–850.

Sonam, S., Vijay, K., and Ram Babu, T. (2011). Isolation of Phosphate Solubilizing Microorganism (PSMs) From Soil. *Journal of Microbiology and Biotechnology Research*, **1**(2): 90-95.

Stephen, J., and Jisha, M.S. (2011). Gluconic acid production as the principal mechanism of mineral phosphate solubilization by *Burkholderia* sp. (MTCC 8369). *Journal of Tropical Agriculture*, **49** (1-2):99-103.

Vassilev, N., Baca, M.T., Vassileva, M., Franco, I., Azcon, R., and De Nobili, M. (1996). Mineralization of three agro-industrial wastes by an acid producing strain of *Aspergillusniger*.*In The Science of Composting* (Springer), 1376-1379.

Vassilev, N., Vassileva, M., and Nikolaeva, I. (2006). Simultaneous P-solubilizing and biocontrol activity of microorganisms: potentials and future trends. *Applied Microbiology and Biotechnology*, **71**:137-144.

Zaidi, A., Khan, M., Ahemad, M., and Oves, M. (2009). Plant growth promotion by phosphate solubilizing bacteria. *Actamicrobiologica et immunologicaHungarica,* **56**:263-284.