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Phosphorus Uptake and Growth Promotion of Agriculturally Important Crop Plant by Inoculation of Phosphate Solubilising Bacteria

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ABSTRACT

Phosphate is an important macronutrient for plant species but in soil it reacts rapidly and remains in inorganic form, which plant cannot utilize. A large amount of organic phosphate is made available to soil in form of chemical fertilizer but it is immobilized rapidly and becomes unavailable for plants. Phosphate Solubilising Bacteria (PSB) possesses the capacity to convert inorganic phosphate into organic form. The principal mechanism for phosphate solubilising is the production of organic acids which play a major role in forming organic phosphorus in soil. Generally, Rhizospheric microorganisms in association with with PSB enhances plant's inorganic (phosphate) nutrition uptake. PSB that is a rhizosphere are directly introduced into agricultural field as biofertilizer or can be added at the time of seed innoculation, with rock phosphate and also through fertigation. Currently agriculturists have tried many ways to manage soil's phosphate quantity and minimize phosphate loss from the soil. Thus PSB such as *Microbacterium laevaniformans*, *Pseudomonas putida* etc. have attracted the attention of many agriculturists as soil inoculums to provide phosphate to soil and improve the growth and yield of agriculturally important crop plant.

INTRODUCTION

Phosphorus is essential for all living organisms. It plays a very important role in photosynthesis, respiration, cell division and other biochemical reactions. It is a vital component of ATP and plant DNA (Gyaneshwar, 2002). It helps in root development, fruit production, flower formation, seed production and many more (Hilda and Fraga, 2000). Some of the plants suffer from phosphate deficiency which is one of the main problems of soils in different areas which needs to consider. A large amount of phosphate is applied to the agricultural field as chemical fertilizers but it immobilizes rapidly, which plant cannot use (Gyaneshwar, 2002). Root development is remarkably sensitive to the supply of phosphate to the plant (Jones and Darrah, 1994; Hinsinger, 2001). Phosphate boosts the development of the plant by enhancing nutrients through the process of photosynthesis (Zaidi et al., 2009). Phosphorus continues its function from the beginning of seedling to the date of senescence. It is also associated with energy transformations on plants. Its content in soil may be high but it is not in usable form. So this unusable form needs to convert into a usable form which plant can use for its growth. So the PSB is used to convert the inorganic phosphate into the usable form and use in the agricultural field as bio-fertilizer (Rodriguez and Reynaldo, 1999).

Deficiency of phosphorus and plant growth

The phosphate is essential for plant growth and development, thus, the deficiency in phosphate has an adverse effect on the plant growth and development. On the other-hand hosphorus deficiency is much difficult to sense. Crop pants such as *Triticum aestivum*, *Oryza sativa* which are agriculturally important crop plants displays no permanent symptoms rather than stunted growth. The deficiency of phosphorus can sometimes be detected by the color of the leaf. In some cases absence of phosphorus, the leaf turned dark purple in color (Alemu, 2013). The main problems associated with phosphorus deficiency are late cell division, accumulation of sugar in plant surface, affects seed development and crop maturity (Panigrahy et al., 2009).

Phosphorus deficiency also creates an imbalance in the storage of carbohydrate; the rate of photosynthesis comes under normal rate, hence affecting plant food availability. The deficiency of phosphate can be scientifically confirmed by soil test using suitable chemicals (Frydenvang et al., 2015). Therefore, the deficiency in phosphate needs to be check and phosphate quantity of soil should be improved.

Importance Phosphate Solubilizing Bacteria

Phosphate solubilizing bacteria (PSB) have the capacity to convert inorganic immobilized phosphate to a usable form for the plant (Alam et al., 2002). PSBs release low molecular weight acids such as organic acids

(lactic acid, fumaric acid, malic acid, oxalic acid) through which either by hydroxyl or carbonyl groups chelate the cations bound to phosphate converting into soluble forms. *Microbacterium* sp., *Pseudomonas* sp. and Rhizobium are some of the most significant phosphate solubilizing bacteria (Akhtar and Siddiqui, 2009). PSB can be added at the time of inoculum or at time of cultivation to increase the phosphate quantity in the soil. Phosphorus bio-fertilizer in form of microorganisms can also be used in the soil deficient in phosphate (Alvaro et al., 2004). The microorganisms involved in the phosphate solubilization can further increase the efficiency of the nitrogen fixation in plants. PSB are isolated by the means pure culture using Pikovaskaya's medium (PVK) after proper treatment can be used as bio-fertilizer. The PSB solubilize the soil phosphate and make it available to the plants.

Bio-Fertilizer Preparation Using Phosphate Solubilizing Bacteria

A loop full of PSB inoculums in a liquid media and kept in a rotary shaker for 10 days. After sterilization broth is inoculated with mother culture and calcium carbonate is added and autoclaved for 3 hours. Then lignite powder is mixed with broth and kept at room temperature for 6-10 days. Then it is packed with airtight bag and can be stored for 6 months at 15°C.

CONCLUSION

The use of PSB as bio-fertilizer opens up a new horizon for better crop productivity along with maintaining soil sustainability. As the agriculturally important crops like Wheat, Paddy, Rice are generally affected by phosphate deficient so the biofertilizer for this crop plants needs some more works. So phosphate bio-fertilizer is a good alternative for chemical fertilizer. Thus, more experimentation and evaluations are needed to be done for improving the sustainability and tolerability of agriculturally important crop plants under various abiotic and biotic stresses.

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