Phosphate solubilizing bacteria as biofertilizer and its applications

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ABSTRACT

Objective: Phosphorus (P) is the second major plant nutrient limiting factor for crop productivity. It has a defined role in plant metabolism such as cell division, development and photosynthesis nutrient transport, transfer of genetic information and regulation of metabolic pathways. In most of the soil, phosphate is present in combination with Ca\(^{2+}\), Al\(^{3+}\), Fe\(^{2+}\) or Mn\(^{2+}\) depending on soil pH, organic matter and type of microorganisms. It occurs in the soil as inorganic phosphate, produced by weathering of parent rock as organic phosphate derived from decayed plants, animals or microorganisms. Conclusion: Therefore, application of phosphatic fertilizers is essential for optimum crop yield.

KEYWORDS: Phosphorus, microorganisms, biotechnology, biofertilizer, optimum.

INTRODUCTION

The unbalanced use of chemical fertilizers is responsible for reduction in soil fertility and environmental degradation\[41\]. Phosphorus biofertilizers in the form of microorganisms can help in availability of accumulated phosphates for plant growth\[42\]. In addition, the microorganisms involved in phosphate solubilization can enhance plant growth by increasing the efficiency of biological nitrogen fixation, enhancing the availability of other trace elements and by production of plant growth promoting substances\[43\]. A range of bacteria, fungi and actinomycetes are known as solubilize phosphorus and enumerated from different sources such as soil\[39\], rhizosphere of various plants\[4\]. The use of PSB as bio-inoculants plays a vital role in maintaining soil nutrient status, structure and sustains the production base. Phosphate solubilizing bacteria (PSB) are routinely isolated and screened by researchers using Pikovskaya’s (PVK) medium. PSM cause the release of nutrients into soil in naturally balanced proportion\[55\] and exerts beneficial effects on plant development\[66\]. Thus, the beneficial effect of inoculation on the availability of P to crops has led to the development of inoculum which is popularly known as phoshobacterin\[7\]. Tripura et al. (2007) screened 23 bacterial isolates for their mineral phosphate solubilizing ability on Pikovskaya and National Botanical Research Institute’s phosphate agar\[8\]. The solubilization in liquid medium corresponded with a decrease in the pH of the medium. Bacterial genera like Azotobacter, Bacillus, Beijerinckia, Burkholderia, Enterobacter, Erwinia, Flavobacterium, Microbacterium, Pseudomonas, Rhizobium and Serratia are reported as the most significant phosphate solubilizing bacteria\[9\]. Typically, the solubilization of inorganic phosphorus occurs as a consequence of the action of low molecular weight organic acids which are synthesized by various soil bacteria\[10\]. Conversely, the mineralization of organic phosphorus occurs through the synthesis of a variety of different phosphatases, catalyzing the hydrolysis of phosphoric esters\[11\]. Importantly, phosphate solubilization and mineralization can coexist in the same bacterial strain\[12\]. The possibility of enhancing P uptake of crops by artificial inoculation with P-solubilising strains of rhizobacteria presents an immense interest to agricultural microbiologists.

MECHANISMS OF PHOSPHATE SOLUBILIZATION

The release of organic and inorganic compound by phosphate solubilizing microorganisms (PSM) has been reported as a primary mechanism of P-solubilization. Besides organic acids (lactic, citric, glycolic, succinic, fumaric, malic, oxalic, tartaric, 2-ketogluconic and α-ketobutyric acids), the production of chelating substances (2-ketogluconic acid), humic substances, mineral acids (sulphuric acids), siderophores and proton extrusion mechanisms also play an important role in phosphate solubilization\[13\]. Growth of P solubilizing microorganisms is generally accompanied by decrease in pH of the medium\[14\]. Reduction in pH is due to the production of organic acids which include citric, gluconic, fumaric, malic, oxalic, lactic, 2-ketogluconic, malonic acids etc.\[15\]. However, quantity and quality of organic acid produced is fully dependent on the type of P-solubilizing microorganisms. Organic acids produced by PSB solubilize insoluble phosphates by lowering the pH, chelation of cations and...
BIOFERTILIZER PRODUCTION TECHNOLOGY

1. A loopful of inoculum is transferred in liquid medium and keeps the flack on rotary shaker for 3-7 days. The content of these flasks called mother culture or starter culture. After sterilization suitable broth is incubated with the mother culture or starter culture. After sterilization suitable broth is flushed on rotary shaker for 3-7 days. The content of these flasks called broth culture in galvanized trays. After mixing the broth culture in galvanized trays then it is kept for curing at room temp (28°C) for 5 to 10 days.

2. The sterilized and neutralized lignite or peat is mixed with high count broth culture in galvanized trays. After mixing the broth cultures and lignite or peat powder in 1:2 proportion in the galvanized trays then it is kept for curing at room temp (28°C) for 5 to 10 days. After curing, sieved powder is filled in polythene bag as of 0.5 mm thickness leaving 2/3 space open for aeration of the bacteria. Then the bag is packed by sealing.

3. The viable cells count in the carrier based inoculants should be maintained as per ISI specifications. The inoculants shall be stored by the manufacture in a cool place away from direct heat preferably at a temp of 15°C for six months.

CONCLUSION

The use of efficient phosphate-solubilizing microorganisms opens up a new horizon for better crop productivity besides sustaining soil health. Therefore, there is a need for extensive and consistent research efforts to identify and characterize more PSM with greater efficiency for their ultimate application under field conditions. Biofertilizers help in increasing crop productivity by various mechanisms. Development in the use of PSM is one of the recently promising options for meeting agricultural challenges imposed by the still-growing demand for food. In brief, PSM biotechnology provides an excellent opportunity to develop environment-friendly phosphorus biofertilizer to be used as supplements and/or alternatives to chemical fertilizers.

REFERENCES


