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APPLICATION OF PHOSPHATE SOLUBILIZING BACTERIA IN THE PRODUCTION OF BIOFERTILIZER

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ABSTRACT

Phosphorous is one of the important nutrients required in the plant development and majority of the plant growth. Good percentage of phosphate-solubilizing microbes is present in the rhizosperic layer and they are more active metabolically than other sources. Microbes solubilizing of phosphate correlative with property of microorganisms producing selected organic acids and extracellular polysaccharides. Plants acquire phosphorus from soil as phosphate ion. It's the smallest amount mobile component in plant and soil contrary to alternative nutrients. The phosphate ion precipitate in the form of orthophosphate in the soil. It is also absorbed in the soil by iron and aluminum oxide. The absorption takes pace with the help of legend exchange. Phosphorus solubilizing microorganism plays very important role by enhancement of phosphate handiness to the pants. The phosphate solubilizing microorganisms solubilize and mineralize the soil which helps in the release of organic and inorganic form of phosphorus. The phosphate solubilizing bacteria lowers the pH of soil and hydrogen ion concentration by bacterial production of organic acids, the phosphate solubilizing bacteria with the help of acid phosphatase enzyme, mineralize the organic phosphorus. Use of PSB as

inoculants will increase Phosphate intake in plants. These bacteria additionally increase the utilization of phosphorus rocks in the production of crop in agriculture. Bigger potency of the bacteria that solubilize phosphate can be detected through the co-inoculation with alternative useful microorganism and mycorrhiza.

Keywords: Biofertilizers, Phosphorus solubilizing microorganisms, Agricultural soil, crops, crop production

INTRODUCTION

Phosphorus (P) is one among the main growth-limiting macronutrients required for correct plant growth, particularly in tropical areas, thanks to its low availability within the soil. Phosphate is important in adequate quantity for the proper development and plant growth, from physiological level and molecular level to the biochemical activity of plant which includes growth of the roots, photosynthesis and seed development **[1]**. Adequate amount of phosphate is also required for the growth of plant reproductive parts during the early development of the plant. Phosphate is the most vital micronutrient pant needs after nitrogen. Yet, the supply of soluble sorts of phosphate to plants in the soil is restricted because of its fixation as non soluble phosphates of al (aluminium), ca (calcium), fe (iron) from the soil **[1]**. Considerable amount of phosphate is present in every type of soil, but an outsized proportion is sure to soil components. Phosphate fertilizer is often added to the soil having low percentage of phosphate as a supplement but the soil often rejects or do not hold the added supplement of phosphate. To use the phosphate solubilizing bacteria as a bio fertilizer to enhance the agricultural activities has been a study subject for many years. This review is done to study the availability of phosphate in the soil and the varies phosphate solubilizing bacteria, the mechanism, how phosphate is solubilized, and how can phosphate solubilizing bacteria can be used as biofertilizers, the use of bio fertilizer in the crop yield and production **[2]**.

AVAILABILITY

The P present in the soil is present in a reactive form and doesn't exist as an element in the soil. The P in the soil is present in insoluble and inorganic form **[3]**. The phosphate cycle in the atmosphere is known as "sedimentary," as a result of there's no interfere with the external atmosphere in contrast to the case for N, no massive atmospheric supply will be created biologically on the market Consequently, deficiency of phosphorus severely restricts the expansion and production yield **[2, 3]**. The Phosphate percentage in the soil is 0.05% **[1]**. Soil check values are typically a lot of higher, however the larger a part of it, concerning 95 to 99, is gift within the kind of non soluble form of phosphate. The soluble phosphate concentration within the soil is very much low, usually at levels variable from ppb in terribly poor soils to 1 mg/L in heavily fertile soils **[1-3]**. Plant cell may take up many P forms, however the best half is absorbed within the varieties anions of P chiefly or relying on the pH of the soil. The phosphate fertilizer which is applied to the soil, nearly seventy to ninetieth percent is fastened by the regeneration of inorganic phosphate. With the help of cations like Ca2+ in carbonate or traditional soil, phosphate is immobilized to make a fancy phosphate ($Ca_3(PO_4)_2$) and with Al3+ and Fe+3 in acidic soils to make Aluminum PO (AlPO) and metallic element phosphate (FePO) **[4]**. These forms cannot be obtained easily and is in insoluble form. These phosphate forms that is present in the agricultural soil are in adequate quantity that maintain most crop production for concerning if it might be mobilized, regenerate into soluble Phosphate forms mistreatment of PSM **[4]**. A larger question has been created to urge an alternate system nonetheless cheap technology that would offer abundant quantity of phosphate to the plants. The primary mechanism of phosphate solubilizing bacteria is the release of inorganic and organic form of compounds by the phosphate solubilizing microorganisms. Besides organic acids (lactic, citric, glycolic, succinic, fumaric, malic, oxalic, tartaric, 2-ketogluconic and α-ketobutyric acids), the release of chelating substances (2-ketogluconic acid), humic substances, mineral acids (sulphuric acids), siderophores mechanisms also plays a vital role in the phosphate solubilization **[5]**. Growth of PSM microorganisms is generally accompanied by lowering of pH in the soil. The reduction in pH is because of the production of organic acids includes citric, gluconic, fumaric, malic, oxalic, lactic, 2-ketogluconic, malonic acids etc. **[5]**. However, quantity and quality of organic acid produced is fully dependent on the type of P-solubilizing microorganisms. PSM results in the production of the acids that are organic in nature. These organic acids then further solubilize the insoluble form of phosphate present in the soil **[3, 5]**. The inorganic acids like HCl can also help in phosphate solubilization. The inorganic acids are not that helpful compared to the acids that are organic in nature at the adequate pH.

Solubilization of phosphate rock can be enhanced with the help of Acid producing bacteria. The PSB strains exhibit inorganic P-solubilizing or organic phosphate mineralizing abilities.

EFFECTS OF PSM ON GROWTH, YIELD AND PHOSPHOROUS ECONOMY

Inoculation of plants with PSMs usually leads to improved growth of the plant and production yield, particularly, below greenhouse conditions **[6]**. Additional significantly, investigations conducted below field level victimization wheat and maize plants have unconcealed that PSMs might drastically scale back the usage of chemical or organic fertilizers **[6-8]**. As rumored by **[8]** improvement of plant phosphorus nutrition can be thanks to stimulation of root growth or elongation of root hairs by specific microorganisms, therefore no direct increase within the handiness 2of soil phosphorus is usually expected. PSMs are isolated from soil of varied plants like feather palm **[6, 5]**, walnut **[8]**, rice **[9]**, mustard and maize **[10]**, chili and aubergine **[11]**, and soybean **[12]**, and. Higher crop performance was rumored to be achieved from many husbandry plants and vegetables, that were with success inoculated with PSB **[12]**. Phosphorus use potencial in agricultural field that can be improvised with the immunization of relevant PSMs that is truly, associate integrated and property mean of nutrient management of crop production systems. Except for phosphate solubilizing skills, 2a number of these microorganisms will profit the growth of the plant with the help of different mechanisms like enhancing biological process, and plant product production. Though phosphorus PSMs square measure long in several of the soils, isolation, identification and choice of PSMs haven't theretofore been with success commercialized, therefore application continues to be restricted **[13-15]**. Investigations on the topic square measure typically designed to verify a particular response of PSMs to a selected setting, therefore massive scale application piece of land level continues to be restricted **[16, 17, 21]**.

BIOFERTILIZERS

Fertilizers are the substance that contain nutrients for the growth of the plants, it increases the nutrient value of the soil. There are two type of fertilizers that increase the soil fertility, first is chemical fertilizer and second is biofertilizer **[18]**. Chemical fertilizers contain chemicals that increase the fertility of the soil, but excessive use of chemical fertilizers can also result in the decrease of nutrients in long run. Nowadays the use of chemical fertilizer has been excessive in the farm field, because of which the quality of the yield has been affected. Contrary to the chemical fertilizers, biofertilizers have been a boon to the plants and soil. Biofertilizers are the fertilizers that contains living organisms or microorganisms in them **[19, 18]**.

Biofertilizers these days have been shifting fortunes to farmers and agriculture. The use of biofertilizers have been proven successful technology in the field of agriculture in the developed countries. These days, the agriculture depends on the chemical fertilizers for most of the nutrient demand of the crops which result in high and economical yields. Moreover, fuel reserves are finite and thus unsustainable in long-term scale **[20]**. Phosphorus (P) is that the second important element after nitrogen which is important to survival and growth of plants. However, within the soil solution, it always exists in very low quantities (a micromolar level) as compared with most of the opposite vital nutrient elements which are present in millimolar levels. About 75–90% of the chemical P fertilizers applied in agricultural soils become unavailable quickly due to P combination with other elements such as Fe, Al, Ca, and Mg depending on the soil pH level.

BIOFERTILIZER PRODUCTION

A loopful of inoculum is transferred in liquid medium and keeps the flask on rotary shaker for 3-7 days **[13]**. The content of these flasks called mother culture or starter culture. After sterilization suitable broth is inoculated with the mother culture. For 96-120 hours, the flask is on the rotatory shaker until the viable, count per ml reaches to 9-10ml/cells **[13]**. With the addition of 1% calcium carbonate, the peat powder is neutralized. It is then sterilized for 4-5 hours at 14lbs pressure. The moisture holding capacity rate of the carrier should be as high as 150-200% by its weight and high rate of organic matter that provide a nutritive medium for the survival in the culture. The high organic matter also provides growth of microorganisms in the culture **[13]**. In the galvanized trays, the peat which was sterilized and neutralized is mixed with the broth culture or liquid culture. The broth liquid culture and peat is mixed in1:2 proportion in the galvanized trays then it is kept for curing at room temp (28°C) for 6 to 12 days **[10, 12, 13]**. After curing, the powder form of mixture is added in the polythene bag containing ½ cm thickness leaving 2/3 space open for aeration of the bacteria. The polythene is sealed. The viable cells count within the carrier-based inoculants should be maintained as per ISI specifications. The inoculants then be stored in a cool place faraway from direct heat preferably at a temperature of 15°C for six months **[9]**.

FUTURE ASPECT

Phosphate is a vital nutrient in terms of plant growth as well as plant development. Thus, phosphate solubilizing microorganisms also plays a vital role in the nutrition of plant with the increase of P intake of the plant. The mechanisms explaining thesynergistic interaction should be a matter of further research to elucidate the biochemical basis of those interactions **[21]**. On the other hand, genetic manipulation of phosphate-solubilizingbacteria toenhance their phosphate-solubilizing capabilities and/or the introduction of thistrait in strains with other plant growth promoting effects is not only important but also practical **[22]**.

In addition, the choice by classical genetic methods of mutants with increased production of organic acids and/or phosphatase activity, could constitute an efficient approach that cannot be underestimated. Rae Cloning of genes involved in mineral phosphate solubilization, like those influencing the synthesis of organic acids, also asphosphatase encoding genes, would be the primary step in such a genetic manipulation program.Subcloning of these genes in appropriate vectors and their transfer and or overexpression) in target host strains could be a successful procedure for improving the phosphatesolubilization capabilities of selected strains **[22]**.

Future research should also investigate the steadiness and performance of the phosphate solubilization trait once the bacteria are inoculated in soil, in both natural and geneticallymodified strains. The survival and establishment of the introduced strain are often suffering from low competitiveness, thus limiting the effectiveness of application. On the other hand,the putative risk involved within the release of genetically engineered microorganisms in soil may be amatter of controversy. For these reasons, the utilization of genetic reporter systems, like bioluminescence genes, or green fluorescent protein genesis crucial in studying the fate and survival of the strain in soil **[23]**.

CONCLUSION

We can apply PSM by inoculating in soil which appears to be an efficient way to convert the insoluble P compounds to available phosphate form which can be utilized by plants. As the plants will utilize the available Phosphate form, it will result in better plant growth, crop yield, and quality. PSM also supports plant growth through production of siderophores as well increase efficiency of nitrogen fixation. Certain organisms like *Bacillus, Pseudomonas, Rhizobium, Aspergillus, Penicillum* etc. are acting to be most efficient Phosphate solubilizers for increasing bioavalaibility of Phosphate in soil. PSM can boost immediate plant growth by providing easily absorbable Phosphate form and also increases the production of plant growth hormones such as Indole 3 acetic acid and Gibberellic acid. PSM also helps in biocontrol against plant pathogens by producing antibiotics, HCN, and antifungal metabolites. To improve yield in sustainable agriculture, PSMs pretends to be potential substitutes for inorganic phosphate fertilizers to fulfill phosphate demands of plants. The mechanism of P solubilizing by PSM is related with the formation of acid that are organic in nature and have lower molecular weight, through their carboxyl and hydroxyl groups which chelate the cation bound to phosphate, which is why it converts it into the form which is soluble.

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