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Review on Assessment of phosphate solubilization

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ABSTRACT

Microorganisms are useful for biomineralization of bound soil and make nutrients available to their host and/or its surroundings. Nitrogen and phosphorus are major plant nutrients which occupy a key place in balanced use of fertilizer. Phosphorus is an important requirement of legumes for their nitrogen fixation process (Huda et al., 2007). Phosphate solubilizing organisms those solubilize the bound form of phosphorus and AM fungi acts as up-taker of phosphorus and make it available to the host plants. Microorganisms facilitate plant mineral nutrition by changing the amounts, concentrations and properties of minerals available to plants. There are various groups of organisms that can be solubilize and/or leaching of phosphate, iron and other mineral metals. A large number of literatures are available regarding the microbial interaction and beneficial uses in plants of agriculture, horticulture and forestry. Keeping this in view, some important information regarding the biofertilizing potential of some important group of microbes and their application for the development of sustainable technology has been reviewed here.

Keywords: *Aspergillus, Penicillium, Phosphate solubilizing fungi & solubilization*

INTRODUCTION

Reddy *et al.* (2002) was isolated phosphorus solubilizing *Aspergillus tubingensis* and two strains of *Aspergillus niger* which showed higher phosphate solubilization capacity when grown in presence of 2 % rock phosphate. Gupta *et al.,* (2010) calculated the efficiency of mangrove phyllosphere fungi in solubilization of tricalcium phosphate and rock phosphate in liquid culture and found the better efficiency of *Aspergillus* sp. over *Penicillium* sp. Yadav *et al.,* (2011a) experienced phosphate solubilizing potential of three fungal strains *Aspergillus niger* strain BHUAS01, *Trichoderma harzianum* and *Penicillium citrinum* strain BHUPC01 using Pikovskaya's broth containing tricalcium phosphate. *Aspergillus niger* showed maximum amount of soluble phosphate after 6 days of incubation.

Mahamuni *et al.,* (2012) isolated 138 Phosphate solubilizing fungi from the sugarcane and sugar beet rhizosphere soil of Western Maharashtra region, on the basis of clear zones formation on Pikovskaya's agar medium and solubilization index. They reported *Aspergillus* as dominating species.

Srinivasan *et al.,* (2012) were isolated 23 different phosphate-solubilizing bacteria and 35 different phosphate-solubilizing fungi in the rhizospheric and non-rhizospheric soils from Madhya Pradesh and Karnataka. The bacterial isolates were belonging to *Pseudomonas, Xanthomonas, Bacillus, Aerococcus, Alteromonas, Erwinia and Enterobacter* and fungal isolates was identified as *Aspergillus* and *Penicillium*. Verma and Ekka (2015)

isolated 56 fungai from rhizospheric soil of paddy field plants. Fungi isolated were belonging to Arthrinium, aspergillus, Chaetomium, Curvularia, Fusarium and Penicillium sp. Among these Aspergillus niger 8 (RSA4), Aspergillus niger 13 (RAB01) and Penicillium purogenum (RAB06) showed higher efficiency for phosphate solubilization.

There are many reports of phosphate solubilization capacity by fungi. Panda et al., (2008) reported maximum phosphate solubilization by three strains of Aspergillus niger (78.63%, 56.32%, 52.65%) followed by Penicillium sp. (46.32%). Kang et al., (2008) was tasted the potential of Aspergillus sp. PS104 to solubilize rock phosphate in vitro with decrease in pH up to 2.48. They also reported the role of citric acid and phosphatase in the phosphate solubilization mechanism.

Bhattacharya et al., (2015) isolated Aspergillus niger from mangrove sediment and determine their phosphate solubilization competence. Various Carbon and nitrogen sources are added in PVK broth medium, maximum solubilization is 443µg/ml and 468µg/ml were recorded with glucose and ammonium supplementation. Optimum pH and temperature for maximum solubilization was 7.0 and 30°C respectively.

There are many reports of effect of nutritional sources and environmental factors on the growth of microorganism and their phosphate solubilization capacity. Bolan and Hedly (1990) explained the rock phosphate dissolution increased from 29.3% to 83.5%, from 18.2% to 78.9%, and from 12.5% to 60.3% for NCPR (North Carolina Phosphate Rock), JPR (Jordan Phosphate Rock) and NPR (Nauru Phosphate Rock) respectively as the pH decreased from 6.5 to 3.9. Reyes *et al.,* (1999) were measured mineral phosphate solubilization behavior in liquid media using sucrose as carbon source, nitrogen sources (arginine, nitrate, ammonium, and nitrate-ammonium) and phosphorus sources (KH_2PO_4, hydroxyapatite, $FePO_4$ and $AlPO_4$).

Pradhan & Shukla (2005) were isolated *Aspergillus* sp. and *Penicillium* from the rice field soil of Bhubaneswar, Orissa, India, and observe that phosphate solubilization was related to pH decrease caused by growth of fungus in medium added with glucose as carbon source. *Aspergillus* sp. solubilized 480 µg/ml of phosphorus, while *Penicillium* sp. solubilized 275 µg/ml of phosphorus from 0.5% tricalcium phosphate after 4 and 3 days of growth respectively**.** Srividya *et al.* (2009) demonstrated effect of different carbon and nitrogen sources on phosphate solubilization by *Aspergillus niger* F7. They observed maximum solubilization in the presence of maltose as carbon source followed by sucrose and glucose and ammonium sulphate as nitrogen source. *A. niger* showed maximum significant solubilization of tricalcium phosphate in Pikovskaya broth containing glucose as carbon source followed by glycerol, maltose, sucrose at 21 days of incubation (Yadav *et al.*, 2011). Habte and Osorio (2012) investigated the effect of nitrogen source on the solubilization of rock phosphate by Mortierella sp. He was reported that more dissolution is observed in the presence of ammonium chloride and ammonium nitrate than potassium nitrate.

Wakelin et al., (2004) was screen out 47 fungal isolates for phosphate solubilization on solid medium containing hydroxyapatite (HA). These isolates were recognized as Penicillium or its teleomorphs. All the isolates were assessed for solubilization of Idaho rock phosphate in broth culture. Penicillium bilaiae strain RS7B-SD1 was establish to be most effective in mobilizing P after 7 days followed by Penicillium simplicissimum, five strains of Penicillium griseofulvum, Talaromyces flavus, two unidentified Penicillium spp. and newly isolated strain of Penicillium radicum (KC1-SD1). Additionally, they also evaluated the RP solubilization, biomass production

and solution pH for three fungal strains namely P. bilaiae RS7B-SD1, P. radicum FRR4718 and Penicillium sp. 1 KC6-W2. In between them P. bilaiae RS7B-SD1 showed the highest RP solubilization activity per unit of biomass produced.

Scervino *et al.,* (2010) compared the solubilization activity of three different sources of phosphorus (tricalcium phosphate-PC, aluminium phosphate-AP and phosphorite-PP) by different fungal isolates namely *Talaromyces flavus* (S73), *T. flavus* var *flavus* (TM), *T. helices* (L7b), *T. helices* (N24), *Penicillium janthinellum* (PJ) and *P. purpurogenum* (POP). They also considered the possible mechanisms involved in the solubilization process. The type and concentration of organic acids formed by each isolates varied according to the source of available P. The medium containing PC showed highest proportion of gluconic acid, while in the media added either with AP or PP showed that of citric and valeric acids.

Sharma (2011) investigated the phosphate solubilization potential of two fungal isolates *Aspergillus* sp. and *Penicillium* sp. in both solid and liquid medium. Presence of clear halo zone after five days of incubation indicated their phosphate solubilization ability. Czapek Dox liquid medium containing rock phosphate was used for quantitative estimation of soluble phosphate concentration. Lowering in medium pH was recorded during the study. Phosphate solubilization was connected to decrease in pH caused by the growth of fungus. The rock phosphate was solubilized upto 61.6%. One more study, *A. niger* showed maximum phosphate solubilization followed by *Penicillium citrinum* and *Trichoderma harizanum* (Yadav *et al.*, 2011a). Mahamuni *et al.* (2012) demonstrate tricalcium phosphate and rock phosphate solubilization by different fungal strains. They reported the percent phosphorus solubilization that ranged from 34.2-58.0% for tricalcium phosphate and 16.6-36.6% for rock phosphate. A further study revealed that, fifteen varieties of fungal species were isolated from the Arecanut husk waste; of these nine isolates showed phosphate solubilization ability and seven showed lignolytic property. The zone of appearance of phosphate solubilization on Pikovskaya's medium *Aspergillus terreus*, was medium in *Botrytis cenerea* and very low in *A. niger* (Strain-2) and Unidentified-3. On the other hand, the lignolytic activity shows that the zone of clearance was higher in *Gibberella fujikuroi*, medium in *A. niger* (Strain-1) and very low in *A. flavus*. The phosphate solubilization effectiveness was also tested in Pikovskayas liquid medium and was found to be higher in Unidentified-2, medium in Unidentified-1 and very low in *A. niger* (Strain-2). The fungal isolate *A. niger* (Strain-1) showed highest growth rate based on total biomass yield followed by Unidentified-2 and Unidentified-1 after 12 days incubation periods (Naveenkumar *et al.*, 2012).

Gizaw *et al.,* (2017) were also seperated phosphate solubilizing fungi from teff rhizosphere soil. Fungi were identified using lactophenol cotton blue staining and Biolog microstation. The identified fungal isolates were screen out for their phosphate solubilizing capacity by using the Pikovaskaya medium. Isolate species showed positive response for phosphate solubilization namely Trichosporon beigelli B, Phichia norvegensis, Cryptococcus albidus var aerius, Candida elchellsii, Cryptococcus albidus var albidus, Rhodotrula auranticus A, Rhodotrula auranticus B, Cryptococcus luteolus, Cryptococcus albidus var diffluens, Neosartorya fisheri var Fischeri, Cryptococcus terreus A, Candida montana, Penicillium purpurogenum var Rubrisclerotium, yeast isolates GTRWS18, GTS9B and GTS7C. The solubilizing index ranged 1.2-5.3 after 15 days of incubation. The maximum solubilization was demonstrated by Trichosporon beigelli B (5.3) followed by Phichia norvegensis (3.35) and Cryptococcus albidus var aerius (3.2).

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