Scientist|X89X367X|7.72|Published by LMG|
https://www.thescientist.online/

Research Paper

PHOSPHATE SOLUBILIZING BACTERIA ASSOCIATED WITH NODULES OF ARHAR (*CAJANUS CAJAN L.)* AND LATHYRUS (*LATHYRUS SATIVUS* L.) AND THEIR TRICALCIUM PHOSPHATE SOLUBILIZING ABILITIES

Mahendra Singh[1*],

ABSTRACT

Phosphorus is a minor nutrient and known for its vital role in crop plants. Its lower use efficiency makes it costlier inpute for farmer and enhanced the production cost. In this context, eight endophytic bacteria were isolated from the root nodules and rhizospheric soil of various plants grown at 4 locations in Bihar, India and were screened for their *in vitro* insoluble phosphorous (P) solubilization activity. were Based on the amplification, sequencing, and phylogenetic analysis of 16S rRNA gene, the most potential P-solubilizing bacterial isolate was identified as *Bacillus aryabhattai* BAUMS8, followed by *Klebsiella pneumoniae* MBAU4. Plant growth-promoting potential of two selected bacteria was analyzed *in-vitro* and these were found to produce optimum quantities of indole acetic acid, gibberellic acid as well as P-solubilization abilities. The isolates PSB5 and PSB3 were solubilized (mg/L) maximum phosphate (4.542and 4.472, respectively) followed by PSB8 (4.378), PSB1 (4.132), PSB4 (4.074), PSB7 (3.965), PSB6 (3.818), PSB2 (3.802). This study demonstrates that nodules are important resources for searching the endophytic bacteria possessing insoluble P-solubilization as well as other PGPR properties, to mitigate the phosphorous deficiency in the soils and improve crop production.

KEYWORDS: *Bacillus* sp., *Klebsiella* sp., Insoluble phosphorus, Soulibilzation

CONCLUSION

This study demonstrates that nodules of lathyrus could be used for bio prospecting of endophyticbacteria possessing insoluble P-solubilization as well as other PGPR properties, in order to mitigate the phosphorous deficiency in the soils and improve crop production and soil health. Plant growth-promoting potential of two selected bacteria, as *Klebsiella pneumoniae* MBAU4 and *Bacillus aryabhattai* BAUMS8 were analyzed *in-vitro* and these were found to produce, indole acetic acid, gibberellic acid and phosphate solubilization abilities. These properties were help tounlock the P mineralization kinetics in soil by mediating the rhizophericenvironment. An array of bacteria was isolated from undisturbed soil, characterized, and studied for their P solubilization potential. Eight bacterial isolates were found to be promising (PSB4 - *Bacillus* sp. and PSB8 –*Klebsiella* sp.), of which, PSB5 (NCBI-MK850114 and MN533949) was found to be the most potent strain owing to its enhanced P solubilization capacity exhibited in both qualitative and quantitative assays. This was also reflected in the soil incubation study wherein PSB5 exhibited remarkably high P release rates. This was attributed to decreased pH owing to its high acid production capacity. From the study it can be recommended that these bacterial strains can be used for the prepoaration of phosphate solubilizing bacterial biofertilizers.

REFERENCES

1. Goldstein AH. Bacterial solubilization of mineral phosphates: historical perspectives and future prospects. Am. J. Altern. Agricult.1986; 1:57–65.
2. Hilda R, Fraga R. Phosphate solubilizing bacteria and their role in plant growth promotion.Biotechnol. Adv. 1999; 17:319–359.
3. Kim KY, Jordan D, Krishnan HB. *Rahnella aqualitis*, a bacterium isolated from soybean rhizosphere, can solubilize hydroxyapatite. FEMS Microbiol. Lett. 1997; 153:273–277.
4. Kpomblekou K, Tabatabai MA. Effect of organic acids on release of phosphorus from phosphate rocks. Soil Sci. 1994; 158: 442– 453.
5. Halder AM, Mishra AK, Bhattacharya P, Chakrabarthy PK. Solubilization of rock phosphate by *Rhizobium* and *Bradyrhizobium*. J. Gen.

Appl. Microbiol. 1990; 36:81–92.
6. Wang ET, Tan ZY, Guo XW, Rodríguez-Duran R, Boll G, Martínez-Romero E. Diverse endophytic bacteria isolated from a leguminous tree *Conzattia multiflora* grown in Mexico.Arch. Microbiol. 2006; 186: 251-259.
7. Palaniappan P, Chauhan PS, Saravanan VS, Anandhan R, Sa T. Isolation and characterization of plant growth promoting endophytic bacterial isolates from root noduleof *Lespedeza* sp. Biol. Fertil. Soil. 2010; 46:807-816.
8. Santoyo G, Moreno-Hagelsieb G, Orozco-Mosqueda MDC, Glick BR. Plant growth- promoting bacterial endophytes. Microbiol Res.2016; 183:92–99.
9. Sprent JI. Nodulation in Legumes. 2001; Kew, London :Royal Botanic Gardens.
10. Ma Y, Mani R, Yong ML, Helena F. Inoculation of endophyticbacteria on host and non- host plants. Effects on plant growth and Ni uptake. J Hazard Mater. 2011; 195:30–237.
11. Miller KI Chen Q, Man-Yuen SD, Roufogalis BD, Neilan BA. Culturable endophytes of medicinal plants and the genetic basis for their bioactivity. Microb Ecol. 2012; 64:431– 449.
12. Pikovskaya RI. Mobilization of phosphorus in soil in connection with the vital activity ofsome microbial species. Mikrobiologiya. 1948;17:362-370.
13. Singh M. Isolation and characterization of insoluble inorganic phosphate solubilizer rice rhizosphere strain Enterobacter cloacae BAU3. Journal of Applied and Natural Science. 2018 10: 1204-1209, cle Info DOI:10.31018/jans.v10i4.1929.
14. Premono ME, Moawad AM, Vleck LG. Effect of phosphate solubilizing *Pseudomonas putida* on the growth of maize and its survival in the rhizosphere. Indones. J. Crop Sci. 1996; 11: 13-23.
15. Buchanan RE, Gibbons NE. *Bergey's Manual of Determinative Bactriology.* 1974; Baltimore: Williams and Wilkins Co.
16. Pospiech A, Neumann B. A versatile quick prep of genomic DNA from Gram-positive bacteria. Trends Gen. 1995; 11:217–218.
17. Van Berkum P, Beyene D, Eardly BD. Phylogenetic relationships among *Rhizobium* species nodulating the common bean (*Phaseolus vulgaris* L.). Int J Syst Evol Microbiol. 1996; 46:240–244.
18. Zhang Z, Schwartz S, Wagner L, Mille W. A greedy algorithm for aligning DNAsequences. J. Comput. Biol. 2000; 7: 203-214.
19. Tamura K, Peterson D, Peterson N, Stecher G, Nei M, Kumar S. MEGA5: Molecular Evolutionary Genetics Analysis using Maximum Likelihood, Evolutionary Distance, and Maximum Parsimony Methods. Molecular Biology and Evolution. 2013; 28: 2731-2739.
20. Thompson JD, Gibson TJ, Plewniak F, Jeanmougin F, Higgins DG. The CLUSTAL_X windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. Nucleic Acids Res. 1997; 25:4876-4882
21. Paul D, Sinha SN. Isolation and characterization of phosphate solubilizing bacterium *Pseudomonas aeruginosa* KUPSB12 with antibacterial potential from river Ganga, India.Annals of Agrarians Science. 2017; 15: 130-136.
22. Glickman E, Dessaux YA. Critical examination of the specificity of the Salkowski reagent for indolic compounds produced by phytopathogenic bacteria. Appl Environ Microbiol. 1995; 61:793–796.
23. Bruckner B, Blechschmidt B. The gibberellin fermentation. Crit Rev Biotechnol. 1991; 11:163-192.
24. Gomez K.A, Gomez A.A. Statistical Procedures in Agricultural Research. Wiley Publishing House, New York. 1984.
25. Bhardwaj G, Shah R, Joshi B, Patel P. *Klebsiella pneumoniae* VRE36 as a PGPR isolatedfrom Saccharum officinarum cultivar Co99004. J App Biol Biotech. 2017; 5: 047-052.
26. Sadiq HM, Ghulam ZJ, Nasir ID, Mehwish I, Muhammad I. Isolation and Characterizationof Phosphate-Solubilizing Bacteria from Rhizosphere Soil. Biotechnology and Biotechnological Equipment. 2013; 27:4248-4255. DOI:10.5504/BBEQ.2013.0091.
27. Liu Z, Li YC, Zhang S, Fu Y, Fan X, Patel JS, Zhang M. Characterization of phosphate- solubilizing bacteria isolated from calcareous soils. Applied Soil Ecology. 2015; 96: 217-224.
28. Ghosh PK, Maiti TK, Pramanik K, Ghosh SK, Mitra S, De TK. The role of arsenic resistant*Bacillus aryabhattai* MCC3374 in promotion of rice seedlings growth and alleviation of arsenic phytotoxicity. Chemosphere. 2018; doi: 0.1016/j.chemosphere. 2018.07.148.
29. Lee S, Jong-Ok, Hong-Gyu S. Growth Promotion of *Xanthium italicum* by Application ofRhizobacterial Isolates of *Bacillus aryabhattai* in Microcosm Soil. The Journal of Microbiology. 2012; 50:45–49. DOI 10.1007/s12275-012-1415-z.
30. Singh RP, Jha P, Jha PN. The plant-growth-promoting bacterium *Klebsiella* sp. SBP-8 confers induced systemic tolerance in wheat (*Triticum aestivum*) under salt stress. Journalof Plant Physiology. 2015; 184:57–67.
31. Saitou N, Nei M. The neighbor-joining method: A new method for reconstructing phylogenetic trees. Molecular Biology and Evolution . 1987; 4:406-425.
32. Felsenstein J. Confidence limits on phylogenies: An approach using the bootstrap. Evolution. 1985; 39:783-791.
33. Tamura K, Kumar S. Evolutionary distance estimation under heterogeneous substitution pattern among lineages. Molecular Biology and Evolution. 2002; 19:1727-1736.