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Study on Potassium Release from Mica Minerals and its Alteration as Influenced by Microbial Inoculation

M. R. Sarikhani[1]*- O. madani[2] – Sh. Oustan[3]

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Introduction: Potassium (K) is one of the major essential macronutrients for biological growth and development. The ability of some bacteria to release potassium from unavailable forms is an important feature for increasing plant yields of high-K-demand crops. Application of soil microorganisms is one approach to enhance crop growth. Some bacteria are efficient in releasing K from mineral sources and in recent years in order to produce and make of potassium biofertilizers, attention to the potassium releasing bacteria has been increased. Production of organic acids and acidic polysaccharides by the microorganisms are the main mechanisms by which K is released. Microorganisms play a central role in the natural P and K cycles. Many microorganisms in the soil are able to solubilize 'unavailable' forms of K-bearing minerals, such as micas, illite and orthoclases, by excreting organic acids which either directly dissolves rock K or chelate silicon ions to bring the K into solution. Recently, attention to the release of potassium from bacteria has been increased because some of efficient bacteria can be used as potassium biofertilizers to meet plant K needs. Hence, the objectives of this study were to in-vitro assessment of potassium releasing of some isolates belonged to *Pseudomonas* genus.

Materials and Methods: A laboratory dissolution study was carried out using a completely randomized design with three replicates. The factorial experiment contained two factors; 1-bacteria (including five bacterial treatments and un-inoclated treatment) and 2- mica minerals (including biotite and muscovite). Micas flakes were powdered and passed through a 0.5 mm sieve. Available forms of K were removed by washing with 0.1 M HCl and then distilled water, before adding the minerals to Aleksandrov medium For this reason, a microbial incubation study in the Aleksandrov liquid medium containing mica and tricalcium phosphate was designed for a period of one month and 5 strains of potassium releasing bacteria belonged to the genus *Pseudomonas* (S6-6, S10-3, S14-3, S19-1 and S21-1) along with the un-inoculated treatment (control) were applied. In this experiment, the release of potassium and phosphorus in liquid Aleksandrov medium were measured at intervals of 5 days in incubation period of 30 days. Nutrient Broth was used to prepare an overnight culture of bacteria to inoculate Aleksandrov medium. It should be mentioned that Aleksandrov medium was used to determine the amount of released P from tricalcium phosphate (TCP) while muscovite was added to the medium as a sole source of potassium. Concentration of P was determined spectrophotometrically by ammonium-vanadate-molybdate method and K was determined by flame photometry.

Results: The results showed that dissolved potassium and phosphorus in the inoculated medium were significantly increased and the amount of potassium released by the isolates was between 2.17 and 3.23 mg g^{-1} and the highest potassium release was achieved with isolate S14-3 (3.23 mg g^{-1}), which that compared to the non-bacterial control showed an increase of 48.85 %, and significant difference was found with other isolates. Bacterial incubation experiment indicated the ability of isolates to release potassium from K-containing minerals such as biotite and muscovite and the XRD analysis revealed an alter in chemical structure of clay minerals. Especially, presence of 19.5Å peak in muscovite (saturated with magnesium) treated with isolate S14-3 showed the released space of K from the interlayer is filled or associated with a number of bacterial metabolites. It seems that the same mechanisms could be effective in releasing K from micas and P from TCP, in other words there is a co-solubilizing mechanism for mica and TCP.

Discussion and conclusion: It appears tha depletion of potassium from minerals has occurred but further tests will confirm this topic. The enhanced releasing of mineral K might be attributed to the release of organic acids from the bacteria, a mechanism which plays a pivotal role in solubilizing phosphate from inorganic source of phosphate. The mechanism of potassium release from minerals is still not clear. Productions of acids or chelates are main mechanisms to release K from potassium containing minerals. Among the bacterial strains under study, *Pseudomonas sp.* S14-3 was the most efficient strain in K release from micas and phosphate

1, 3- Associate Professor of Biology and Biotechnology and Professor of Soil Chemistry, Department of Soil Science, Faculty of
Agriculture, University of Tabriz, Tabriz, Iran
(*-Corresponding Author Email: rsarikhani@yahoo.com)
2- Former M.Sc Student of Soil Biology and Biotechnology, Department of Soil Science, Faculty of Agriculture, University of Tabriz, Tabriz, Iran

solubilization from TCP. However, more experiments need to be done especially in pot and field experiments to study the role of these strains in K nutrition of crops.

Keywords: Potassium releasing bacteria, Biotite, Biological weathering, XRD