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Potassium Solubilizing Bacteria Ability to Increase Wheat Growth and Potassium uptake under in vitro Condition

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Introduction: Potassium (K) is the third major essential macronutrient for plant growth. Without adequate potassium, the plants will have poorly developed roots, grow slowly, produce small seeds and have lower yields. Due to imbalanced fertilizer application, potassium deficiency is becoming one of the major constraints in crop production. The concentrations of soluble potassium in the soil are usually very low and more than 90% of potassium in the soil exists in the form of insoluble rocks and silicate minerals. Soil microbes have been reported to play a key role in the natural K cycle and therefore, potassium solubilizing microorganisms present in the soil could provide an alternative technology to make potassium available for uptake by plants. Thus, identification of microbial strains capable of solubilizing potassium minerals quickly can conserve our existing resources and avoid environmental pollution hazards caused by heavy application of chemical fertilizers.

Materials and Methods: This study aimed to isolate and identified potassium solubilizing bacteria and evaluate those effect on K availability from muscovite and vermiculite sources to wheat crop under *in vitro* condition. The study was conducted as factorial in completely randomized design at three replications included bacterium inoculation (control, isolate1, isolate 2) and four k sources (muscovite, vermiculite, muscovite+ K_2HPO_4, vermiculite+ K_2HPO_4). Bacterial isolates were obtained from wheat rhizosphere on modified Aleksandrov medium containing muscovite and vermiculite powder as potassium source. Nutrient broth medium was used to prepare an overnight culture of bacteria to inoculate in Aleksandrov medium, which was used to study the dissolution of silicate minerals. The zone of solubilization recorded on Aleksandrov medium. Then the ability of two bacterial strains, including *Bacillus subtilis* and *Corynebacterium glutamicum* to release mineral K from muscovite and vermiculite was investigated. After 18 days of seed culture, aerial part of plant growth was dry digested and K concentration was determined by flame photometry. Dry and fresh weight of aerial part and root, plant height and root length was recorded.

Results: Three K-solubilizing isolates from 15 isolates identified by biochemical and molecular methods which belonged to *Bacillus subtilis, Pseudomonas putida* and *Corynebacterium glutamicum*. The potassium solubilization zone of each strain on Aleksandrov medium containing muscovite were 8.1, 65.1 and 6.3, respectively. The zone was also 9, 8 and 5.8 in Aleksandrov medium in the presence of vermiculite as insoluble potassium source. According to these results potassium release from vermiculite was more than muscovite, in spite of more potassium content of muscovite. According to the obtained results two strains *Bacillus subtilis* and *Corynebacterium glutamicum* were selected for in vitro experiment because of halo to colony diameter ratio. The ratio of halo to colony diameter in the presence of muscovite for *Bacillus subtilis, Pseudomonas putida* and *Corynebacterium glutamicum* was 1.5, 0.72 and1.3, respectively. These ratios were 2, 1.4 and 0.8, respectively in the medium containing vermiculite as insoluble potassium source. The results showed that the effect of bacteria inoculation was significant ($p<0.01$) on all measured parameters. After being treated with the each of KSB strains, plant dry weight and uptake of K by wheat seedlings increased significantly. These increases were higher with the combination of *Bacillus subtilis* inoculation and vermiculite powder addition. Potassium concentration of plant was depended to culture medium. Maximum K solubilization occurred when vermiculite was used as a potassium source followed by K_2HPO_4. Also K concentration of plants was significantly ($p<0.05$) affected by bacteria. In our study *Bacillus subtilis* showed the most pronounced beneficial effect on plant growth and K concentration by wheat seedlings. There was significant difference between potassium concentration in aerial part of wheat seedling cultivated in bacteria free medium with soluble potassium and medium containing bacteria without soluble potassium. This results shows the importance of potassium solubilizing bacteria to supply potassium for plant.

Discussion and Conclusion: The enhanced release of mineral K might be attributed to the release of organic

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acids from the bacteria, a mechanism which plays a pivotal role in solubilizing potassium from inorganic source of potassium. According to the results combining the inoculation of potassium solubilizing bacteria and the addition of K bearing minerals could be a promising sustainable alternative to commercial K fertilizer and may help maintain the availability of soil nutrients. Further studies are necessary to determine the effects of these bacterial strains on mobilization of potassium-bearing minerals under field conditions.

Keywords: Dry weight, Height, Insoluble potassium, Muscovite, Vermiculite