POTASSIUM SOLUBILIZATION BY BACTERIAL STRAIN IN WASTE MICA

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Abstract

The release of K from waste mica (muscovite and biotite) was tested with 4 K-solubilizing isolates collected from maize rhizosphere, for 7, 14 and 21 days of incubation at 28 ± 2°C. K-solubilization by different bacterial isolates showed significant change on muscovite and biotite powder supplemented plates and the amount of K released varied from 1.28 - 46.75 µg/ml. The soluble K contents in all isolated treatments were significantly higher than control. Herein, isolate KSB2 had higher K-solubilization ability when compared with other isolates (KSB1, KSB3 and KSB4) in vitro.

Average soil reserves of K are generally large, but most of it is not plant-available. Therefore, crops need to be supplied with soluble K fertilizers, the demand of which is expected to increase significantly, particularly in developing regions of the world (Meena et al., 2013). Recent investigations have shown that organic exudates of some bacteria play a key role in releasing otherwise unavailable K from K-bearing minerals (Zob et al., 2013). K-solubilization could be attributed to excreting organic acids which either directly dissolves rock K or chelate silicon ions to bring K into solution (Prajapati et al. 2013). Therefore, in this study, K-solubilizers isolated from maize rhizosphere were tested for their solubilizing ability from muscovite and biotite minerals.

Waste mica a potassium-bearing mineral, obtained from the surroundings of mica mines located at Koderma district of Jharkhand, India. It is a by-product of mica industry (Table 1). Serially diluted samples were plated on Aleksandrov medium containing (per l) 5 g glucose, 0.005 g MgSO4.7H2O, 0.1 g FeCl3, 2.0 g CaCO3, 3.0 Mica as a potassium mineral (2.0 g in original media), 2.0 g calcium phosphate and 20 g agar-agar Aleksandrov media (Sugumaran and Janartham 2007) to isolate the potassium solubilizing bacteria.

At 7 DAI maximum K-solubilization from muscovite by KSB2 with 2 and 1 mm particle size (5.68 and 6.38 µg/ml, respectively) and this isolate was significantly at par with KSB1. At 14 DAI maximum K-solubilizing capacity 15.05 and 28.50 µg/ml (KSB3) with 2 and 1 mm, respectively. This isolate was significantly superior to all others isolates. The lowest value measured in control. However, at 21 DAI maximum K-solubilizing capacity (17.28 and 39.50 µg/ml with KSB2) was recorded in the both particle size of mica (Fig. 1). Similar finding were also reported by Archana et al. (2013). KSB isolates produced organic acids that influenced mica and feldspar dissolution either by decreasing pH, forming frame work-destabilizing surface complexes, or by complexing metals in solution (Zhang et al. 2013). Maximum K-solubilization at 7, 14 and 21 DAI was observed with KSB2. Similar inference was reported by (Archana et al. 2012). Solubilization generally increases with days of incubation, ranging from 1.28 to 46.75 µg/ml at 21st day of incubation (Fig. 2) and was maximum in all the isolates. This may be due to strong acidic conditions resulting from the metabolic processes (Liu et al. 2006).

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Table 1. Elemental composition (%) of biotite and muscovite.

<table>
<thead>
<tr>
<th>Minerals</th>
<th>SiO₂</th>
<th>Fe₂O₃</th>
<th>K</th>
<th>MgO</th>
<th>Na₂O</th>
<th>MnO</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biotite</td>
<td>38.42</td>
<td>16.24</td>
<td>9.70</td>
<td>11.94</td>
<td>0.24</td>
<td>0.41</td>
<td>0.019</td>
</tr>
<tr>
<td>Muscovite</td>
<td>45.10</td>
<td>2.54</td>
<td>9.82</td>
<td>0.61</td>
<td>0.37</td>
<td>Traces</td>
<td>0.022</td>
</tr>
</tbody>
</table>

Fig. 1. Effect of inoculation periods and particle size of biotite on K-release by bacterial K-solubilizers.

Fig. 2. Effect of inoculation periods and particle size of muscovite on K-release by bacterial K-solubilizers.

The results obtained from the current study concerning isolation, screening, and characterization of thirty isolates of KSB from Inceptisol revealed that KSB₂ can potentially enhance the dissolution of muscovite and biotite. Therefore, when used as K-biofertilizers, some
of the isolates might contribute to K supply of crops with a high K demand. Strain showed that higher potential of K-solubilization with biotite in comparison to muscovite and rapid release of K occurred from 1 mm size particle in comparison to 2 mm.

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References


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