Potassium Solubilizing Bacteria (KSB)

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Introduction

The population of India is increasing at an alarming rate and in order to feed this growing population there is a need to produce more from the present arable land. To increase the agricultural food production, various organic and inorganic source of nutrients are used in order to increase soil fertility and to increase the crop yield. One of the major inputs used is fertilizers. But, the application of chemical fertilizers has a considerably negative impact on environmental sustainability thus causing a negative effect on agricultural sustainability.

Among the three essentials nutrients required by plants, one of them is potassium. Potassium(K) is the third important essential major plant nutrient with numerous functions. It plays a vital role in enzyme activation, water relations (osmotic regulation), opening and closing of stomata, starch synthesis, protein synthesis and water nutrient transport. K represents 2.6% of the weight of the earth's crust. The soluble forms of K are present in approximately 2% and insoluble forms of K are present 98% in form of minerals like biotite, feldspar, mica, muscovite and vermiculite and most of this K is unavailable for plant uptake. Common potassium containing minerals are sylvite, carnallite, kainite, langbeinite, schoenite and polyhalite.

Soil microorganisms affect the soil fertility because of its influence on soil processes like decomposition, mineralization and immobilization. Soil microbes have been reported to play an important role in the natural K cycle and therefore, potassium solubilizing bacteria (KSB) present in the soil could provide an alternative means to make potassium available for uptake by plants. KSB can solubilize K-bearing minerals and convert the insoluble K to soluble form of K.

Example of KSB are-

- *Pseudomonas*
- *Acidothiobacillus ferrooxidans*
- *Bacillus mucilaginosus*
- *Bacillus edaphicus*
- *Bacillus circulans*
- *Paenibacillus* spp.

K solubilizing mechanisms

- **Acidolysis** – Production of protons by bacteria is one of the mechanisms which is able to convert the insoluble K (mica, muscovite, and biotite feldspar) to soluble forms of K which can be easily taking up by the plant.
- **Organic acid production** – Different types of organic acids such as oxalic acid, tartaric acids, gluconic acid, 2-ketogluconic acid, citric acid, malic acid, succinic acid, lactic acid, propionic acid, glycolic acid, malonic acid and fumaric acid have been reported in KSB. These acids which are effective in releasing K from K bearing minerals.
- **Chelation -** Organic ligands, extracellular enzymes and chelates produced by KSB are capable of chelating or forming complex with Si^{4+}, Al^{3+}, Fe^{2+}, and Ca^{2+} ions associated with K minerals. This results in conversion of mineral form of potassium to the form which is easily available for plant uptake.
- **Biofilm formation -** KSB also synthesizes biofilms which creates a microenvironment around the microbial cells for weathering. Biofilm formation increases the residence time of water on aluminosilicate as compared to the residence time at the bare rock or mineral surface and enhances the mineral weathering.
- **Lowering of soil pH**
- **Polysaccharides secretion** – Polysaccharides and proteins production by microbes can serve as an attachment structure to the mineral surfaces. This can cause release of K from K bearing minerals for plant uptake.

Screening of KSB

- KSB are isolated by serial dilution plate method using modified Aleksandrov medium containing 5.0 g glucose, 0.5 g $MgSO_4.7H_2O$, 0.1 g $CaCO_3$, 0.006 g $FeCl_3$, 2.0 g $Ca_3(PO_4)_2$, 3.0 g potassium aluminium silicate and 20.0 g agar in 1 l of deionized sterile water. The pH of this medium is adjusted to 7.2 by adding 1 N NaOH.
- A solubilization zone is formed in the medium after incubation for 3-4 days. The diameter of the solubilization zone is calculated in mm using following Khandeparkar's selection (Prajapati, 2012):

  Ratio = Diameter of zone of clearance / Diameter of growth
- Rajawat *et al*. (2016) suggested a modified plate assay for rapid screening of KSB. In this method, an acid-base indicator dye (bromothymol blue, BTB) is used to modify the Aleksandrov medium. As a result, halo zone formation occurs around the colonies and it causes improved visualization.

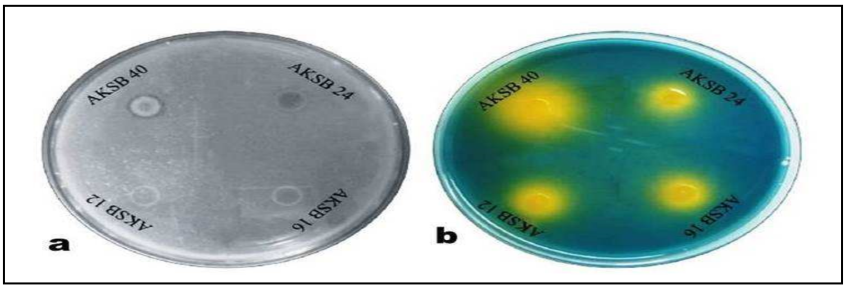

Fig.1: Comparison of K solubilization on (a) Aleksandrov agar plate and (b) modified agar medium plate after 72 h of incubation (Rajawat et al., 2016).

Conclusion

Since, potassium is one of the macronutrient for plant, therefore it is very important to meet the plant's K requirement. Overuse of K fertilizers causes increase in the cost of input and can also cause environmental problems. Therefore, use of microbial inoculants containing KSB can serve as an environmental friendly approach which can further aid in K nutrition of plants and ultimately meeting the plant's nutritional needs.

References

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