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Research Article

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Comparative Studies of Concomitant Release of Secondary and Micronutrientsby Potassium Solubilizing Bacteria (KSB) from Different Minerals

Sanjukta Biswas[*] and M. K. Shivaprakash

Department of Agricultural Microbiology, University of Agricultural Sciences,
GKVK Campus, Bengaluru-560065, India

*Corresponding Author E-mail: sanjuktaa2004@gmail.com

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ABSTRACT

Potassium solubilizing bacteria releases potassium from insoluble minerals in the soil and provide beneficial effects on plant growth by improving soil nutrients and structure and are also economically viable and environment friendly. Potassium solubilizing bacteria (KSB) shows effective interaction between soil and plant systems. Secondary nutrients are required by plants in very smaller quantities and deficiency of these secondary nutrients limits the growth of crop. Calcium, magnesium are the major secondary plant nutrients. The microbial activity of potassium solubilizing bacteria (KSB) potentially solubilizes the secondary nutrients like magnesium and calcium and micro nutrient zinc along with the solubilization of potassium from rock minerals. The present study was focused on to evaluate the ability of solubilization of secondary and tertiary nutrients by KSB isolates, isolated from two different potassium bearing minerals viz., muscovite mica and orthoclase feldspar. Six KSB isolates were selected for the study and out of the six isolates four isolates were found to be capable of solubilizing calcium, magnesium and zinc. Isolate SBF and SDM were the efficient soubilizer of calcium, magnesium and zinc.

Keywords: *Potassium solubilizing bacteria, Secondary nutrient, Micro nutrient, Potassium bearing minerals, Biofertilizers*

INTRODUCTION

Soil is a dynamic system where all the mineral nutrients are present. Among these potassium is the third vital macro nutrient required by plants and are mostly present in rock mineral forms like feldspar, illite, muscovite mica, biotite (Sparks & Huang, 1985). These forms of mineral K are found in nonexchangeable form and are not readily available for uptake by the plants for their growth and development. Potassium solubilizing bacteria has the ability to solubilize K from these potassium bearing mineral.

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It is gaining importance in sustainable agriculture due to its several charateristics. Potassium solubilizing bacteria (KSB), plays a vital role as a biofertilizer in crop growth and production. It is a very efficient microorganism which releases the potassium from the mineral by solubilization process (Archana et al., 2013, Gundala et al., 2013, Keshavarz Zarjani et al., 2013, Meena et al., 2014, Meena et al., 2015b, Parmar & Sindhu, 2013). During the solubilization process, they produce the organic acids by lowering the pH. The changes in pH in the soil influence the availability of secondary and micro nutrients *viz.*, Ca, Mg, Zn etc (McNear Jr,2013).

Plant needs both primary and secondary nutrients for the growth and development. Calcium, magnesium and zinc are the essential secondary and micro nutrients required by plants in lesser quantity compare to macronutrients. Availability of the nutrients in the soil helps the crop to achieve the growth and yield. Macro and micro nutrients are always not present in usable and available form in the soil to receive by plants. The microorganisms play a vital role by their activities in the rhizosphere region and make the nutrients easily available for the plants for their development and growth. Though micronutrients required in very less quantity but the inadequacy of these nutrients leads to different deficient metabolism in plants.

Calcium provides structural support to the plants and also served as secondary messenger when the plants are under stress. Calcium is a vital component of cell walls and is involved in the metabolism and formation of the cell nucleus. Deficiency of calcium leads to stunted growth and root diseases.

Magnesium is an essential part of chlorophyll. It helps in the utilization of mobility of phosphorus. It also aids in the formation of sugars, oils and fats. Insufficient amount of magnesium degrades the chlorophyll content in leaves leading to interveinal chlorosis.

Zinc is eighth essential micronutrient required for growth of plants. Zinc is the key constituent for proteins and enzymes Zinc deficiency causes discolouration of leaf leading to chlorosis. Soil deficient of zinc causes stunted growth of plants.

Several factors are involved in limiting the availability of these secondary nutrients like soils low in organic matter, low pH, cool and wet soil conditions etc. Extensive cultivation with chemical fertilizers, soil texture, leaching are also involved in depletion of micronutrients from soil. Micronutrients are very essential for plants for their growth and development and plants depends on soil to receive nutrients. Humans and animals are also depend on plants for adequate amount of mineral nutrients. Since these micronutrients are the building blocks of all forms of life, there is a need to retain the micronutrients in the soil in adequate quantity and make them easily available to plants. Microorganisms play an important role in availability of micronutrients by their different microbial activities in soil. Hence, the present study has taken up to evaluate the efficiency of solubilization of secondary and micro nutrients in soil by potassium solubilizers.

MATERIALS AND METHODS

The experiments were carried out at Department of Agril. Microbiology, UAS, GKVK, Bengaluru. The KSB isolates were isolated from two different potassium bearing minerals *viz.*, muscovite mica and orthoclase feldspar. The broth culture of KSB isolates were used to evaluate the solubilization of Calcium and Magnesium. Basal medium containing glucose, NH_2SO_4, KCL, K_2HPO_4, $MgSO_4$ was prepared and distributed in 250 ml flasks containing 100 ml of broth media. Talc, dolomite and magnesium tri silicate were added separately at 0.25% as a magnesium and calcium source. The six KSB isolates were inoculated in the respective media and incubated at 30 ± 2^0 C for one week. At 2, 4 and 8 days interval cultures were centrifuged at 10,000 rpm for 15 mins and the supernatant was analyzed for calcium and magnesium.

For the solubilization of zinc , the KSB isolates were inoculated in Bunt and Rovira Medium containing glucose, peptone, yeast extract, $(NH_4)_2SO_4$, K_2HPO_4, $MgCl_2$, $FeCl_3$ supplemented with soil extract. Soil extract was prepared by autoclaving 1000g of garden soil in 1000ml of water for 30 mins at 110 kgsqm^2; pinch of $CaCO_3$ was added and filtered through a filter paper till a clear suspension was obtained. Zinc oxide (ZnO) was used as an insoluble source of zinc at 0.1 %. KSB isolates were inoculated by following streak plate method and incubated at 30±2^0 C for 4 days. A clear zone of inhibition around the growth of the bacteria indicated the solubilization of the insoluble zinc. The zone of inhibition was measured along with the bacterial growth.

RESULTS AND DISCUSSION

Release of secondary nutrients

The data pertaining to release of Mg and Ca from KSB isolates is given in Figure 1.

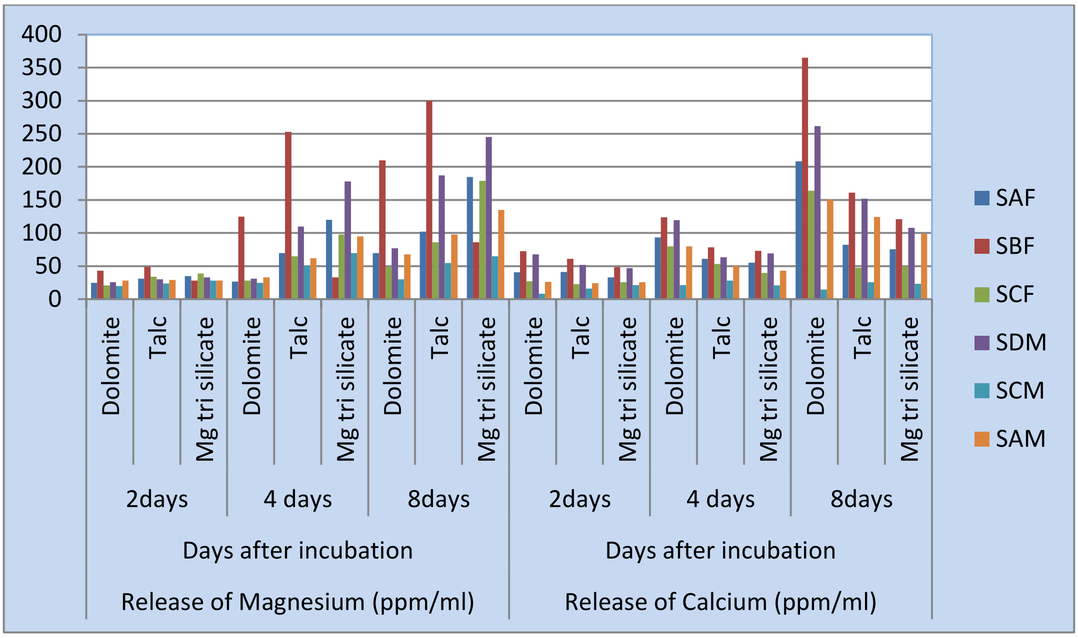

Fig. 1: Release of calcium and magnesium by KSB isolates

KSB isolates was found to be efficient solubilizer of Ca, Mg and Zn. Isolates SAF, SBF, SCF and SDM showed maximum solubilization of Mg and Ca when the media was supplemented with dolomite and talc compared to magnesium tri silicate. Release of Ca was significantly highest in media supplemented with dolomite, whereas magnesium was found highest to be solubilized maximum in talc and dolomite respectively. SBF was proved to be an efficient in releasing Ca and Mg from the minerals. Similar work has been carried out (Sparks & Huang, 1985) and showed that silicate solubilizing bacteria can release calcium and magnesium from dolomite, talc and magnesium tri silicate under *in vitro* condition.

Solubilization and release of zinc

The data produced in Table 1 reveals the solubilization of zinc and the release of zinc in broth culture.

Table 1: Solubilization and release of zinc from different minerals by KSB isolates

KSB isolates	Diameter of zone (D) mm	Diameter of clearance of growth (d) mm	D/d (Ratio)	Solubilization Efficiency (%)	Release of Zinc (ppm/ml) Days after incubation	
					4 days	8 days
SAF	2.8	2.5	1.12	89.28 %	55	125
SBF	1.6	1.5	1.06	**93.75 %**	**68**	**137**
SCF	2.3	2.0	0.73	86.95 %	23	36
SDM	3.1	2.8	1.10	90.32 %	61	119
SCM	0	0.5	0	0 %	10	17
SAM	0	0.2	0	0 %	11	15
CD @ 5%	1.86	1.69	0.77	69.19	40.89	86.22
SEM±	1.31	1.20	0.55	48.83	28.91	60.97

Isolate SAF, SBF and SDM showed good amount of zinc solubilization along with release of zinc in agar plates and broth media respectively. Diameter of zone of solubilization exhibited by the six isolates was observed in varied range from 3.1 to 1.6. The result revealed that highest zinc solubilization was found with the isolate SBF and isolate SCM and SAM did not show any zone of inhibition. SAF and SDM had also exhibited good inhibition zone. The result is supported by the work (Senthil Kumar, 1997). showed that *Bacillus* sp., can solubilize zinc from spheralite zinc ore which have beneficial effect on rice.

Significantly highest amount of release of zinc was observed in SBF followed by SAF and SDM; whereas very least was found in SAM and SCM. The results are in par with previous work (Vasanthi et al., 2012), studied the capability of *in vitro* solubilization of zinc from insoluble zinc oxide by *Bacillus* sp, Similar work (Senthil Kumar, 1997), showed the ability of zinc solubilization by *Bacillus* and *Pseudomonas* from insoluble zinc oxide, zinc phosphate (Spheralite) and zinc carbonate in both plate and broth assay.

Plate. 1: Solubilization of Zinc oxide by KSB isolates SBF and SDM

A varied range of solubilization was observed between the potassium solubilizing isolates. This might be due to the related differences in the source from which they were isolated. SBF showed the highest zinc solubilization capacity from insoluble Zinc oxide, potential among all the isolates. Dissolution of the insoluble zinc source may be caused due to the production of organic acids as the broth culture media inclined towards acidic pH. The solubilization of Zinc phosphate by *Pseudomonas fluorescens* and found gluconic acid and 2 keto gluconis acid was produced in broth cultures resulting in the solubilization of insoluble zinc (Simine et al., 1998). The study of zinc solubilization from insoluble zinc carbonate showed that 10 strains were capable of solubilizing zinc from zinc carbonate by the mechanisms followed by lowering the pH in the culture media may be due to the production of organic acids (Goteti, 2013).

The statistical analysis was done by one way Anova.

CONCLUSION

The present study demonstrates that, potassium solubilizing bacteria (KSB) being rhizospheric microorganism solubilizes secondary and micro nutrients during solubilization of potassium from K-bearing minerals. The mechanism of solubilization process involves the production of organic and inorganic acids accompanied by acidolysis, chelation of the ions and exchange reactions. Production of organic acids results in acidification of the microbial cell and its surrounding environment which promotes the solubilization of the minerals. During the solubilization process, the organic acids are produced by lowering the pH. The change in pH influence in the soil leads to the solubilization of secondary and micro nutrients. The present study shows that among the six KSB isolates three isolates *viz.*, SAF, SBF and SDM were the efficient solubilizer of calcium and magnesium as well as zinc. From the observed result, it can be concluded that potassium solubilizing bacteria can be used as a potential biofertilizer for improvent of the crop growth. It not only solubilizes the potassium from the mineral but simultaneously also release the secondary and micronutrients in the soil and make readily available forms to the plants for its uptake.

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REFERENCES

Archana, D., Nandish, M., Savalagi, V., & Alagawadi, A. (2013). Characterization of potassium solubilizing bacteria (KSB) from rhizosphere soil. *BIOINFOLET-A Quarterly J. Life Sci*. *10*, 248-257.

Goteti, P.K., Leo Daniel Amalraj Emmanuel, Suseelendra Desai, & Mir Hassan Ahmed Shaik, (2013). Prospective Zinc Solubilising Bacteria for Enhanced Nutrient Uptake and Growth Promotion in Maize (*Zea mays* L.), *International Journal of Microbiology*, ArticleID869697,7pages.

Gundala, P.B., Chinthala, P., & Sreenivasulu, B. (2013). A new facultative alkaliphilic, potassium solubilizing, Bacillus Sp. SVUNM9 isolated from mica cores of Nellore District, Andhra Pradesh, India. *Research and Reviews. J. Microbiol. Biotechnol*. *2*, 1-7.

Keshavarz Zarjani, J., Aliasgharzad, N., Oustan, S., Emadi, M., & Ahmadi, A. (2013). Isolation and characterization of potassium solubilizing bacteria in some Iranian soils. *Arch. Agron. Soil Sci*. *59*, 1713-1723.

McNear Jr., D. H. (2013). The Rhizosphere - Roots, Soil and Everything In Between. Nature Education Knowledge *4*(3), 1.

Meena, V.S., Maurya, B.R., & Verma, J.P. (2014). Does a rhizospheric microorganism enhance K+ availability in agricultural soils?. *Microbiol*. Res. *169*, 337-347.

Meena, V.S., Maurya, B.R., Verma, J.P., Aeron, A., Kumar, A., Kim, K., & Bajpai, V.K. (2015b). Potassium solubilizing rhizobacteria (KSR): Isolation, identification, and K-release dynamics from waste mica. *Ecol. Eng. 81*, 340-347.

Parmar, P., & Sindhu, S.S. (2013). Potassium solubilization by rhizosphere bacteria: influence of nutritional and environmental conditions. *J. Microbiol. Res*. *3*, 25-31.

Saravanan V.S., Subramonium, S.R., & Anthoni Raj S. (2003). Assessing In Vitro Solubilization Potential Of Different Zinc Solubilizing Bacterial (Zsb) Isolates, *Brazilian Journal of Microbiology*, *34*, 121-125.

Senthil Kumar, R. (1997). Studies on the Biodissolution of Zinc in rice ecosystem.M.Sc.(Ag) thesis submitted to the Tami Nadu Agriculture University, Coimbatore, India, 134.

Simine, C.D.D., Sayer, J.A., & Gadd, G.M. (1998). Solubilization of zinc phosphate by a strain of Pseudomonas fluorescens isolated form a forest soil. *Biol. Fertil. Soils*., *28*, 87-94.

Sparks, D.L., & Huang, P.M. (1985). Physical chemistry of soil potassium. *Potassium in agriculture*. 201-276.

Vasanthi, N., Lily, M. Saleena & Anthoni Raj, S. (2012). Concurrent release of Secondary and micronutrient by a *Bacillus* sp., *American-Eurasian J. Agric., & Environ. Sci*, *12*(8), 1061-1064.