Microbial Aided Leaching of Potassium from Sri Lankan Feldspar

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Introduction

Potassium is an essential major plant nutrient and also a non-renewable resource. It plays a vital role in plant nutrition. Majority of the soils of the world are too low in available potassium for production of good yields. Potassium containing agrochemicals remains relatively expensive and supplementing potassium deficiency with agro fertilizers is costly. The uses of alternative indigenous resources such as feldspar and mica which are potassium rich naturally occurring minerals are gaining importance against costly agro fertilizers (Badr *et al.*, 2006). Certain groups of microorganisms including bacteria such as *Bacillus mucilaginosus* and fungi like *Aspergillus niger* are known to solubilize potassic minerals into soluble form which can be utilized by the plants (Lin *et al.* 2002; Han, and Lee, 2006). Microbes can enhance mineral dissolution rate by producing and excreting metabolic by products that interact with mineral surface (Barker *et al.*, 1998). Combination of potassic rock minerals with potassium solubilizing microorganisms could constitute a biofertiziler which provides a sustainable solution to improve plant nutrition and production. This study investigates the potassium solubilizing effect of *Bacillus mucilaginosus, Bacillus cereus,* and *Aspergillus* from Sri Lankan potassic rock mineral feldsfar.

Materials and Methods

Feldspar rock samples were collected from *Kaikawala* deposit. Next, the samples were crushed using a mechanical crusher and passed through a series sieves to separate into particles of 710-500 µ, 500-250 µ, 250-125 µ and <125 µ. Crushed particles were separately autoclaved at 121C and 105Kpa for 30 min. Pure cultures of *Bacillus mucilaginosus, Bacillus cereus,* and *Aspergillus niger* were established and maintained throughout the study period to inoculate liquid broth cultures of Aleksandrove medium and Potatoes Dextrose Broth (PDB). 200 ml of either Aleksandrove medium or PDB was prepared in 500 ml conical flasks and each flask was supplemented separately with 4 mg of ground feldspar of above mentioned particle sizes. Next, the flasks were introduced separately with *Bacillus mucilaginosus, Bacillus cereus,* and *Aspergillus niger* and incubated at room temperature on a orbital shaker rotating at 90 rpm for seven days. Conical flask with 250 ml PDB, 4 mg of feldspar and with no microbes served as the control. A daily sample of 5 ml was drawn from each of the flasks separately into 15 ml centrifuge tubes. Tubes were then centrifuged at 10000 rpm for 45 min to pellet bacterial/fungal cells. The supernatant were collected separately and used in Atomic Absorption Spectrometric (AAS) analysis to determine the concentration of leached potassium. Three AAS readings were taken for each of the sample and expressed as mean concentration of leached potassium.

A treatment combination constitutes a type of microbe, particle size of ground feldspar and type of culture medium. One conical flask served as the experimental unit. Two sets of experiments were conducted including all treatment combinations and each treatment combination was replicated tree times within an experiment.

Results and Discussion

Table 2: Concentration of leached potassium by *Bacillus mucilaginosus, Bacillus cereus,* and *Aspergillus niger* grown in Aleksandrove medium after seven days from initial inoculation.

Particle sizes of feldspar (μ)	Concentration of potassium (mg/L)		
	Bacillus mucilaginosus	*Bacillus cereus*	*Aspergillus niger*
710-500	137.2	127.8	127.8
500-250	148.44	143.4	134.5
250-125	163.6	143.5	143.2
<125	170.5	168.2	150.6

Table 3: Concentration of leached potassium in controls after seven days in Aleksandrove and PDB medium

Particle sizes of feldspar (μ)	Aleksandrove medium	PDB medium
710-500	90.7	83.4
500-250	114.5	100.1
250-125	123.7	118.1
<125	137.1	131.4

The release of potassium from insoluble rock mineral feldspar was used to examine the ability for mineral dissolution of bacteria and fungi species which are highly involved in silicate mineral degradation. Generally, compared to the control, inoculated media supplemented with insoluble feldspar mineral, the bacterial and fungus inoculation have given improved results when compared with the Table 2. results .That reveals the effect of the microorganisms on feldspar.

Results indicated that all three microbes *Bacillus mucilaginosus, Bacillus cereus,* and *Aspergillus niger* had a significant ($p<0.05$) potassium solubilizing effect on ground feldspar than the controls without microbes (Table 01 and 02). Less potassium leaching in controls could be attributed to the agitation on the shaker. particle size also had a significant impact on solubilizing and a higher potassium leaching observed with particles of <125 μ was mainly due to the increased surface area when particle size get smaller.

Bacillus mucilaginosus had a significant impact on potassium release from feldspar for all the particle sizes than *Bacillus cereus,* and *Aspergillus niger* which demonstrated a more or less similar potassium solubilizing ability (Table 1). Liu *et al.* (2006) also reports a higher decomposition of silicate mineral by *Bacillus mucilaginosus*. Potassium leaching was significantly higher in Aleksandrove medium than in PDB medium.

Conclusion

This study demonstrated the ability of some selected microbes to solubilize and leach potassium from feldspar which is naturally potassium rich mineral rock commonly found in Sri Lanka. Ground feldspar of particle size <125 μ could be coupled with *Bacillus mucilaginosus* to constitute a biofertilizer that could leach sufficient potassium for plant growth. This type of biofetlizers could provide a cheaper alternative to supplement the required potassium content for plant nutrition. Studding the effectiveness of this biofertizer

in a field trial with some selected crop plants would be an interesting future perspective of this study.

References

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