International Journal of Agricultural Technology 2019 Vol. 15(3): 465-470
Available online http://www.ijat-aatsea.com
ISSN 2630-0192 (Online)

Research and development on phosphorus and potassium biofertilizer

Pongnak, W. and Soytong, K.*

Department of Plant Production Technology, Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand.

Pongnak, W. and Soytong, K. (2019). Research and development on phosphorus and potassium biofertilizer. International Journal of Agricultural Technology 15(3): 465-470.

Abstract The research project found the potent degrading microorganism isolated from rock phosphate and potassium feldspar that effectively degraded rock phosphate and potassium feldspar to release available forms of P_2O_5 and K_2O. Result showed that the non-sterilized ground rock phosphate inoculated with *Aspergillus niger, Penicillium* sp., *Chaetomium* sp and Actinomycetes demonstrated that the most potent microorganism to dissolve ground phosphate to be available form was *A. niger* (available P = 164.12 ppm) and followed by Actinomycetes which available P as162 ppm., respectively when compared to the non-treated one. *Penicillium sp* .could help to degrade sterilized ground rock phosphate which available P was 166. 75ppm and followed by *Chaetomium* sp. Testing for P-solubilizing microorganism. Moreover, result showed that Actinomycetes was the most potent microorganism to dissolve potassium feldspar which gave K available form of 19.25 ppm and followed by *Chaetomium* sp. The sterilized potassium feldspar incubated with Actinomycetes could significantly release available potassium of 20.00ppm which higher than the non-treated control that released available potassium of 9. 50ppm. The other tested microorganism also released some amount of available P and K. The research findings were developed the potent degrading microorganism to be high phosphorous biofertilizer and high potassium biofertilizer used for organic crop production.

Keywords: phosphorus, potassium, biofertilizer

Introduction

It has been used chemical fertilizers for crop production to increase quantity and quality of yield over 100 years. The agricultural experts as well as the farmers have known that over use of chemical fertilizer leads to soil acidity, become dry and compact, bad drainage of air and water in the soil, low organic matter. Moreover, the chemical fertilizer is very expensive today that let the growers increase production cost. Biofertilizers as phophorous-solubilizing fungi and potassium-solubilizing fungi play an important role in promoting plant growth, health, productivity and improving soil fertility. Rock phosphate

* **Corresponding Author**:Soytong, K.; **Email**: ajkasem@gmail.com

and Potash feldspar are naturally rocks/stones that can released available phosphorous (P) and potassium (K) to serve as plant nutrients in nature. Thereafter, microorganism degradation in nature is happened to serve plant nutrients in forestry for years. *Penicillium bilaiae* is reported to increase phosphorus uptake in canola (Sanders and Knight, 2002). *Penicillium radicum* and *Penicilluium italicum* are phosphate-solubilizing taxa (El-Azouni, 2008). Several species of *Aspergillus* spp have been reported to solubilize inorganic phosphates to be available form of P such as *A. flavus*, *A. niger* and *A. terreus* (Akintokun *et al.,* 2007). Gomezjurado *et al*. (2015) showed that the ability of fungal strains to solubilize calcium phosphate and promoted corn and cowpea growth with inoculation the strains to give high solubilization index eg *Haematonectria ipomoeae* CML 3249 and *Pochonia chlamydosporia* var. *catenulate* CML 3250. Singh *et al.* (2011) stated that filamentous fungi were isolated from the soils that showed phosphate solubilizing ability. Aspergillus niger showed good tricalcium phosphate (TCP) solubilizing ability. The ability of Aspergillus niger strain-1 solubilized and released inorganic-P was 285 µg ml-1, while Aspergillus niger strain-2 solubilized 262 µg ml-1 from 0.5% TCP after 7 days. El-Azouni (2008) stated that *Aspergillus niger* and *Penicillium italicum* had their efficacy to solubilize tri-calcium-phosphate to promote the growth of soybean plants.

Potassium is involved in number of physiological process, protein synthesis and activation of enzymes (Naidu *et al.,* 2011). Total potassium in soil is averaged between 0.5 to 2.5%, depend on soil and environmental conditions, about 90 to 98% is not in available form and a number of potassium sources of low solubility such as feldspar (Havlin *et al.,* 2005). Microbes can release soluble K from K-feldspar from the non-exchangeable pools of soil and using certain microbes can assist the solubilization of K (Masood and Bano, 2016). Etesami *et al.* (2017) said that potassium (K) is considered as an essential nutrient and a major constituent within all living cells. Naturally, soils contain K in larger amounts than other nutrients, the most of potassium is unavailable for plant uptake. It is known that potassium solubilizing bacteria (KSB) can solubilize K-bearing minerals and convert the insoluble K to soluble forms of K available to plant uptake. Many bacteria such as *Acidothiobacillus ferrooxidans*, *Paenibacillus* spp., *Bacillus mucilaginosus, B. edaphicus*, and *B. circulans* have capacity to solubilize K minerals e.g., biotite and feldspar etc. The objectives were to investigate the potent degrading microorganism including fungi and actinomycetes solubilize rock phosphate and potassium feldspar, and to develop high P-biofertilizer and high K-biofertlizer as the agricultural inputs for organic crop production.

Materials and methods

The experiment was used two factor factorial in Completely Randomized Design (CRD) with 4 replications. Treatment combination consisted of factor A (sterilized and non-sterilized ground rock phosphate or potassium feldspar). Factor B was tested degrading microorganism as follows:- *Aspergillus niger*, *Pennicilium*, *Chaetomium* sp and Actinomycetes. Each isolate was derived from Dr. Kasem Soytong, KMITL, Bangkok, Thailand who isolated from the samples of rock phosphate and potassium feldspar.

All tested degrading microorganism were cultured on potato dextrose agar (PDA) for fungi and yeast soluble agar (YSA) for Actinomycetes, and incubated for 15 days at room temperature (30 C). Thereafter, all isolates were mixed into either ground the moistened rock phosphate or potassium feldspar and incubated for 30 days before analyzed available phosphorous by Bray II method and available potassium by 1 N Ammonium acetate method.

Results

Result showed that the non-sterilized ground rock phosphate inoculated with *Aspergillus niger*, *Penicillium* sp., *Chaetomium* sp and Actinomycetes demonstrated that the most potent microorganism to dissolve ground phosphate to be available form was *A. niger* (available P = 164.12 ppm) and followed by Actinomycetes which available P as162 ppm., respectively when compared to the non-treated one. *Penicillium sp* .could help to degrade sterilized ground rock phosphate which available P was 166. 75ppm and followed by *Chaetomium* sp. Testing for P-solubilizing microorganisms.

Moreover, result showed that Actinomycetes was the most potent microorganism to dissolve potassium feldspar which gave K available form of 19.25 ppm and followed by *Chaetomium* sp. The sterilized potassium feldspar incubated with Actinomycetes could significantly release available potassium of 20. 00ppm which higher than the non-treated control that released available potassium (K) of 9. 50ppm. The other tested microorganism also released some amount of available P and K. It is suggested that high phosphorus-biofertilizer and high potassium-biofertilizer could possibly be developed to be applied into soil for organic crop production.

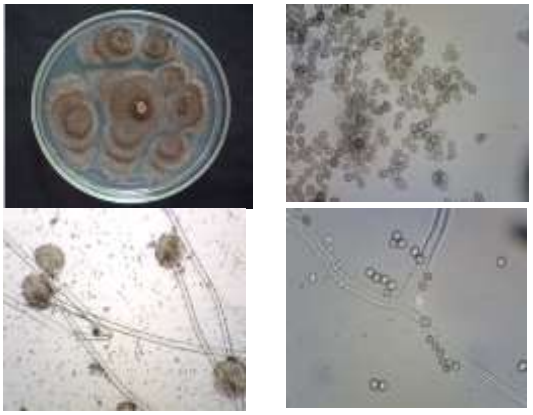

Figure 1. *Aspergillus niger* , A = culture on PDA at 7 days, B= conidia (1,000X), C = thalli (400X), and D = foot cell (1,000X)

Figure 2. *Penicillium* sp, A = culture on PDA, B = conidia (1,000 X), C= thalli (400X)and D= hyphal branches (400X)

Discussion

As results, the non-sterilized ground rock phosphate inoculated with *A. niger*, *Penicillium* sp., *Chaetomium* sp and Actinomycetes released more available P than the non-inoculated control. *A. niger* was the most dominant to degrade rock phosphate to be available form of 164.12 ppm and followed by Actinomycetes which available P as162 ppm. *Penicillium* sp resulted to degrade sterilized ground rock phosphate which available P was 166. 75ppm and followed by *Chaetomium* sp.

The research finding was similar to the work of Khan *et al.* (2007) who reported that *P. italicum* solubilized and released the inorganic P was 275 µg P

ml^{-1} whereas *A. niger* showed better efficiency and produced 490 µg P ml^{-1} after seven days of incubation. Narnian and Patel (2000) stated that phosphorus is the least mobile and available to plants in most soil conditions. It is abundant in soils in both organic and inorganic forms and a major limiting factor for plant growth. Khan *et al.* (2007) mentioned that phosphorus is added in the form of phosphatidic fertilizers, part of which is utilized by plants and the remainder converted into soluble fixed forms.

The research finding showed Actinomycetes showed the most degradation to dissolve potassium feldspar and followed by *Chaetomium* sp. The other fungi and Actinomycetes released some amount of available P and K. With thgis, Jabin and Ismail (2017) reported that *Pseudomonas* sp KSB-PD-1-A formed superior and greater potassium solubilization. Maximum reduction in pH was recorded in *Pseudomonas* sp (KSB-PD-1-A) treatment. Pratama *et al.* (2016) stated that potassium-solubilising microbes are able to solubilise potassium compounds to be potassium ions available for plant growth. *Achromobacter xylosoxidans* and *Burkholderia cepacia* isolated from ex-mining land expressed ability to solubilise feldspar.

Acknowledgement

This work was financially supported by King Mongkut's Institute of Technology Ladkrabang (KMITL), grant number A118-0261-010.

References

Akintokun, A. K., Akande, G. A., Akintokun, P. O., Popoola, T. O. S. and Babalola, A. O. (2007). Solubilization of insoluble phosphate by organic acid-producing fungi isolated from Nigerian soil. International Journal Soil Science, 2:301-307.

El-Azouni, I. M. (2008). Effect of phosphate solubilizing fungi on growth and nutrient uptake of soybean (*Glycine max* L.) plants. Journal of Applied Sciences Research, 4:592-598.

Etesami, H., Emami, S. and Alikhani, H. A. (2017). Potassium solubilizing bacteria (KSB): Mechanisms, promotion of plant growth, and future prospects-A review. Journal of Soil Science and Plant Nutrition, 17:897-911.

Gomezjurado, M. E. G., Abreu L. M., Marra, L. M., Pfenning, L. H. and Moreira, F. M. S. (2015). Phosphate solubilization by several genera of saprophytic fungi and its influence on corn and cowpea growth. Journal of Plant Nutrition, 38:675-686.

Havlin, J. L., Tisdale S. L., Beaton J. D. and Nelson W. L. (2005). Soil fetility and fertilizer: An introduction to nutrient management. New Jersey (US): Pearson Education.

Jabin, P. P. N. and Ismail, S. (2017). Solubilization of insoluble potassium by different microbial isolates *in vitro* condition. International Journal of Current Microbiology and Applied Sciences, 6:3600-3607.

Khan, M. S., Zaidi, A. and Wani, P. A. (2007). Role of phosphate-solubilizing microorganisms in sustainable agriculture – A review. Agronomy for Sustainable Development, 27:29-43.

Masood, S. and Bano, A. (2016). Mechanism of potassium solubilization in the agricultural soils by the help of soil microorganisms. In: Potassium Solubilizing Microorganisms for Sustainable Agriculture (Eds.) Vijay Singh Meena, Bihari Ram Maurya, Jay Prakash Verma and Ram Swaroop Meena), Springer India, New Delhi, pp. 137-147.

Naidu, L. G. K., Ramamurthy, V., Sidhu, G. S and Dipak, S. (2011). Emerging deficiency of potassium in soils and crops of India. Karnataka Journal of Agricultural Sciences, 24 :12-19.

Narnian, V. and Patel, H. H. (2000). *Aspergillus aculeatus* as rock phosphate solubilizers. Soil Biology and Biochemistry, 32:559-565.

Pratama, D., Anas, I. and Suwarno. (2016). Ability of Potassium-Solubilissing Microbes to Solubilise Feldspar and Their Effects on Sorghum Growth. Malaysian Journal of Soil Science, 20:163-175.

Sanders, E. and Knight, J. D. (2002). Efficacy of *Penicillium bilaiae* on fall seeded canola. Soil Science Department, University of Saskatchewan, Saskatoon, SK.

Singh, S. M., Yadav, L. S., Singh, S. K., Singh. P., Singh, P. N. and Ravindra, R. (2011). Phosphate solubilizing ability of two Arctic *Aspergillus niger* strains. Polar Reserch, 30:1-7.

(Received: 20 January 2019, accepted: 5 April 2019)