IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals

Human Journals
Research Article
October 2016 Vol.:4, Issue:4

Effect of Microbes Phosphate Solubilizing and Organic Matter to Status the Phosphate on Andisol Impacted by Mount Sinabung Eruption, North Sumatera

IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
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Submission: 3 October 2016
Accepted: 10 October 2016
Published: 25 October 2016

HUMAN JOURNALS

www.ijsrm.humanjournals.com

Keywords: Andisol, microbes phosphate solubilizing , Pavailable and organic matter

ABSTRACT

The amount of P available to plants is very less as compared to total soil P. Field study aimed to know the effect of microbes phosphate solubilizing and organic matter to status the phosphate on andisol impacted by mount Sinabung eruption, North Sumatera. In vitro screening of bacteria as and fungi from surrounding horticulture land, on their ability to dissolve phosphate, showed that *Burkholderia cepacia* was the best bacteria and *Talaromyces pinophilus* the best fungi. The research was conducted in Kutarayat, Namanteran, regency of Karo. The research applied randomized block design factorial with two treatment factor and three replications. Microbe factor were A0=control, A1= *Burkholderia cepacia* (30 mL), B2= *Talaromyces pinophilus* (30 mL) and organic matter factor were B0=control, B1= chicken feces organic matter (100 g/polybag),B2= Cow feces organic matter (100 g/polybag), B3= rice straw organic matter (100 g/polybag),B4= Wood sawdust (100 g/ polybag) and B5=Mixtures of vegetables. Parameter measured were soil pH, P-Al , P-Fe, available-P and Total P. Applications of Phosphate solubilizing microorganisms and organic matter increased P available (13,38-36,98%), when compare with control. Therefore, the best treatment was *Talaromyces pinophilus* 20 mL and Cow feces organic matter (100 g/polybag).

INTRODUCTION

Phosphorous (P) plays an important role in regulating the vital metabolism and concomitantly the health of plants. However, a greater part of soil P, approximately 95–99 %, is insoluble and, hence, cannot be utilized by the plants. The rapid fixation of P by soil constituents leads to soil P deficiency (Tisdal et al, 1995). The main source of P is rock, which is not renewable, making this resource limited. P is derived from the parent materials which are mostly insoluble, except in certain circumstances.

Andisol is one of the soil types that has problem with the availability of phosphate (Shoji and Takahashi, 2002) Karo plateau is a horticulture center in North Sumatra and the soil in this area is Andisol. It has volcanic ash and rich of minerals and contains Al and Fe in huge amount. The retention of P in Andisol soil in Kutarayat village, Karo plateau, or north of Mount Sinabung ranged from 95.04-99.44% (Mukhlis et al, 2014). According to Balitbangtan, the volcanic ash materials of Mount Sinabung contained such elements as S (0.05-0.32%) Fe (0.58-3.1%), and Pb (1.5-5.3%). Meanwhile, Cd, As, Ag and Ni were undetectable. The soil pH was 4.4-6.5 and the volcanic ash pH was 3.3-3.5, with pH thereby causing the availability of P to below (Balitbangtan, 2014).

The P of land becomes available through the secretion of organic acids produce by roots or microbes. In this regard, P supply through biological systems is considered a viable alternative, and inoculation of P-solubilizing microorganisms, especially fungi to soil, is a reliable source for increasing soluble P in soil. Phosphate solubilizing microorganisms have been reported from different ecological. Following inoculation, microorganisms have proved to improve the growth of horticultural crop (Sahoo and Gupta, 2014). Therefore, the objective of this study was to measure the potential of the microbes phosphate solubilizing at various doses of organic matter in improving the P availability in the Andisol soil impacted by the eruption of Mount Sinabung.

MATERIALS AND METHODS

The research was conducted in Kutarayat Village, Naman Teran District, Karo Regency (North of Mount Sinabung) in April – Juli 2016, and the following characteristics: pH H_2O 4.29, C 5.74%, N 0.56%, P total 2538.76 mg/kg, P available 81.49 mg/kg, 0.4%K, and CEC 46.29 me/kg.

2.1. Experimental Design

This study used Factorial Randomized Block Design with two factors and 3 replications. Factor I was Phosphate solubilizing microorganisms , consisting of treatments Microbe factor were A0=control, A1= *Burkholderia cepacia* (20 mL),A2= *Talaromyces pinophilus* (20 mL) and organic matter factor were B0=control, B1= chicken feces organic matter (100 g/polybag),B2= Cow feces organic matter (100 g/polybag), B3= rice straw organic matter (100 g/polybag),B4= Wood sawdust (100 g polybag) and B5=Mixtures of vegetables. Inoculation of *B. Cepacia* with population 8 x 10^8 and T. pinophilus 7x10^8. Soil samples were taken at the age 45 days incubation on the 5 kg soil/polybag. The application Phosphate solubilizing microorganisms and organic matter start in the beginning of the research. The parameters measured were soil pH, P-Al , P-Fe. P-Available and Total P

3. RESULTS AND DISCUSSION

The statistical analysis showed that application of Phosphate solubilizing microorganisms affected P availability Soil significantly. Application of organic matter significant effected on P availability (Table 1)

Table 1. The mean of pH, available PP-Fe, P-Al and P Total

Treatment	pH Soil	P-Al (ppm)	P-Fe (ppm)	P- available (ppm)	P Total (%)
Phosphate solubilizing microorganisms					
A0=control	4,23	2424,7	638,6	90,76a	0,363
A1= *B.cepacia* 20 mL	4,40	2259,8	623,3	123,46b	0,368
A2=*T.pinophilus* 20 mL	4,57	2429,6	609,6	137,60ab	0,382
Organic matter					
B0=control	4,03	2435,7	637,46	103,41a	0,361
B1= chicken feces	4,56	2399,4	661,81	121,15ab	0,385
B2= Cow feces	4,35	2289,3	601,47	136,96bcdef	0,387
B3= rice straw	4,24	2428,7	635,83	132,06bc	0,378
B4= Wood sowdust	4,17	2321,2	610,25	132,56bcd	0,377
B5=Mixtures of vegetables	4,43	2321,3	632,22	118,25a	0,364

Note: Figures in rows and columns followed by lower case letters indicate a significant effect on the level of 5% according to LSD.

P –Al of treatment 20 mL *B.cepacia* inoculum/polybag was smaller compared to other treatments. It was 7,3% smaller compared to control. The P-Al of Cow feces organic matter (100 g/polybag) application was smaller compared to treatments. It was 6,01% smaller compared to control.P-Feof treatment 20 mL *T.pinophilus* inoculum/plant was smaller compared to other treatments. It was 4,5% higher compare to control. The P available of Cow feces organic matter (100 g/polybag) application was smaller5,6% compare to control.

Solubilization of Fe and Al by PSMs occurs via proton release accompanied by decrease in the negative charge of adsorbing surfaces to facilitate the sorption of negatively charged P ions. Carboxylic acids mainly solubilize Al-P and Fe-P (Khan et al. 2007; Henri et al. 2008) through direct dissolution of mineral P as a result of anion exchange of PO_4^{3-} by acid anion or by chelation of both Fe and Al ions associated with phosphate (Omar, 1998).

P Total of treatment 20 mL *T.pinophilus* inoculum/polybag was higher compared to other treatments. It was 13.57% higher compare to control. The P available of *T.pinophilus* application increased P available higher compared to control. Whereas application of *T.pinophilus* 20 mL, caused P available (137,6 ppm) or 34.04% higher than control. The P available of Cow feces organic matter (100 g/ polybag) application increased P available (24,49%) higher compare to control. Phosphate solubilizing microorganisms generates organic acids such as citric acid, malate, fumarate, glutamate, succinate, lactate, oxalate and beta - ketobutyrate acid capable of dissolving P. Mechanisms of P dissolution are by releasing organic acids and chelate Al, Fe, Ca and Mg cause P available for up taking by plant (SubbaRao, 1999).

Interaction of Phosphate solubilizing microorganisms treatment and organic matter increased The pH soil on treatment of *T. pinophilus* 20 mL and Cow feces organic matter (100 g/polybag)was the highest compared to other,(Figure 1). The P Total Treatment *T. pinophilus* 20 mL and Cow feces organic matter (0.41%), and it also decreased with Cow feces organic matter increasing except for treatment microorganisms (Figure 2). P- Fe on treatment *T. pinophilus* 20 mL and Wood sawdust (100 g/polybag) 25.65% compare to control (Figure 3).P- Al on treatment *T. pinophilus* 20 mL and Mixtures of vegetables (100 g/polybag) 26.38

% compare to control (Figure 4).P available on treatment *T. pinophilus* 20 mL and Cow feces organic matter (100 g/polybag) (36.98%) compare to control (Figure 5). Sembiring et al (2015) found that the inoculation of *T. Pinophilus* increased P available (14.78-64.79%) on Andisol impacted by mount Sinabung eruption

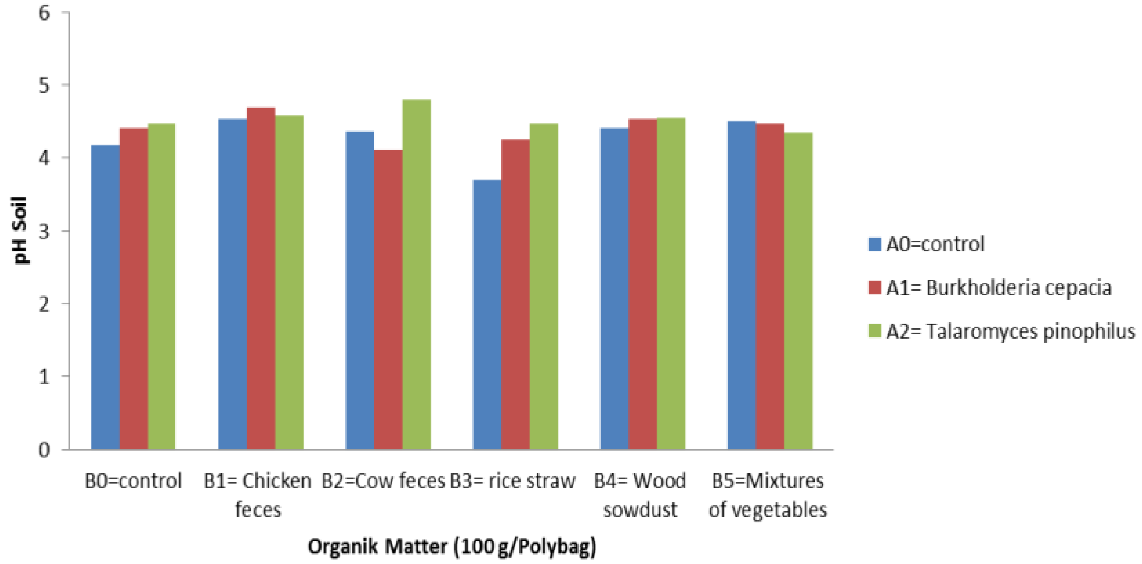

Fig.1. The relationship between Phosphate solubilizing microorganisms treatment and organic matter on pH Soil

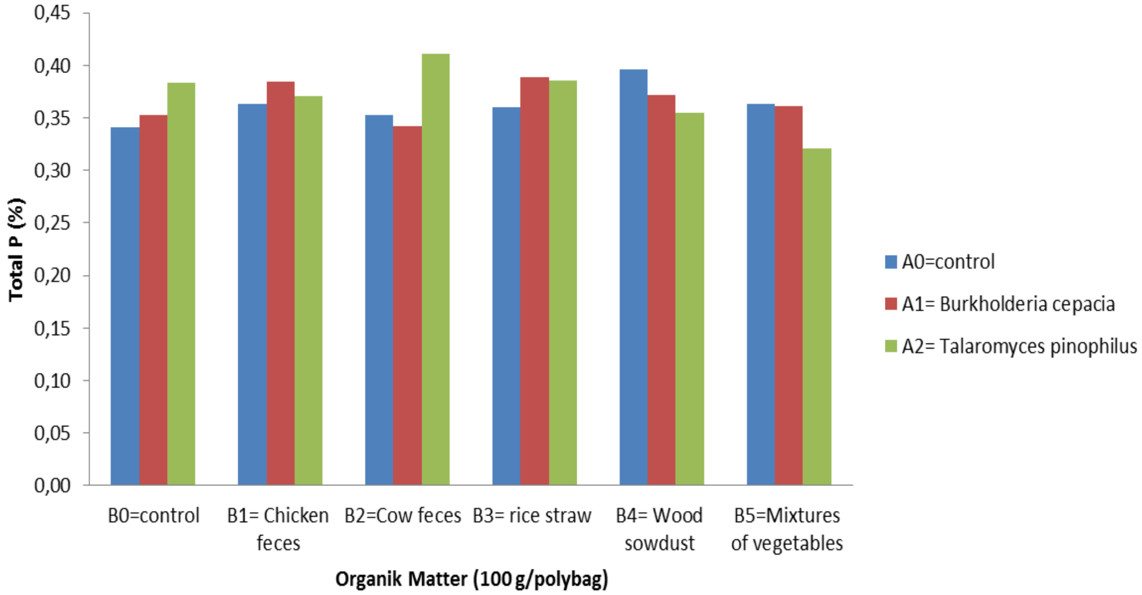

Fig.2. The relationship between Phosphate solubilizing microorganisms treatment and organic matter on P Total Soil (%)

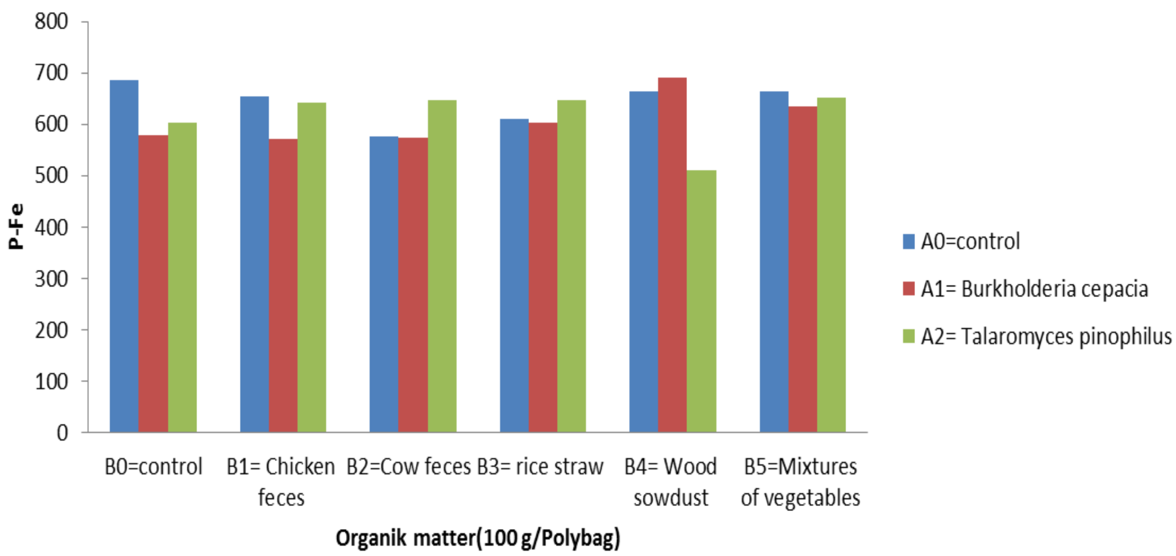

Fig.3. The relationship between Phosphate solubilizing microorganisms treatment and organic matter on P- Fe (ppm)

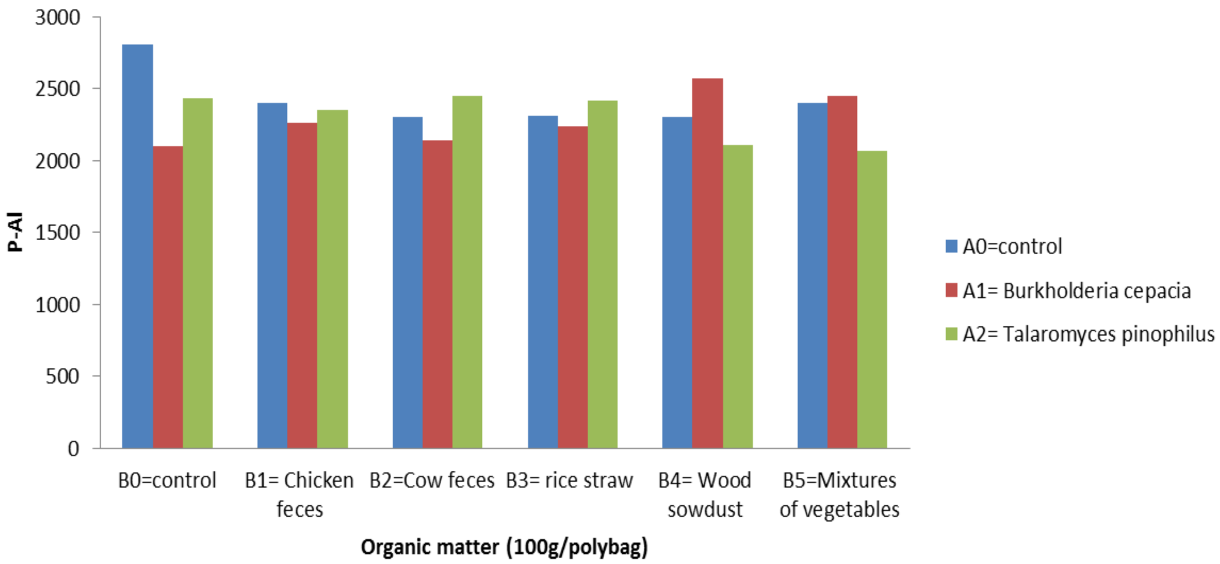

Fig.4. The relationship between Phosphate solubilizing microorganisms treatment and organic matter on P- Al (ppm)

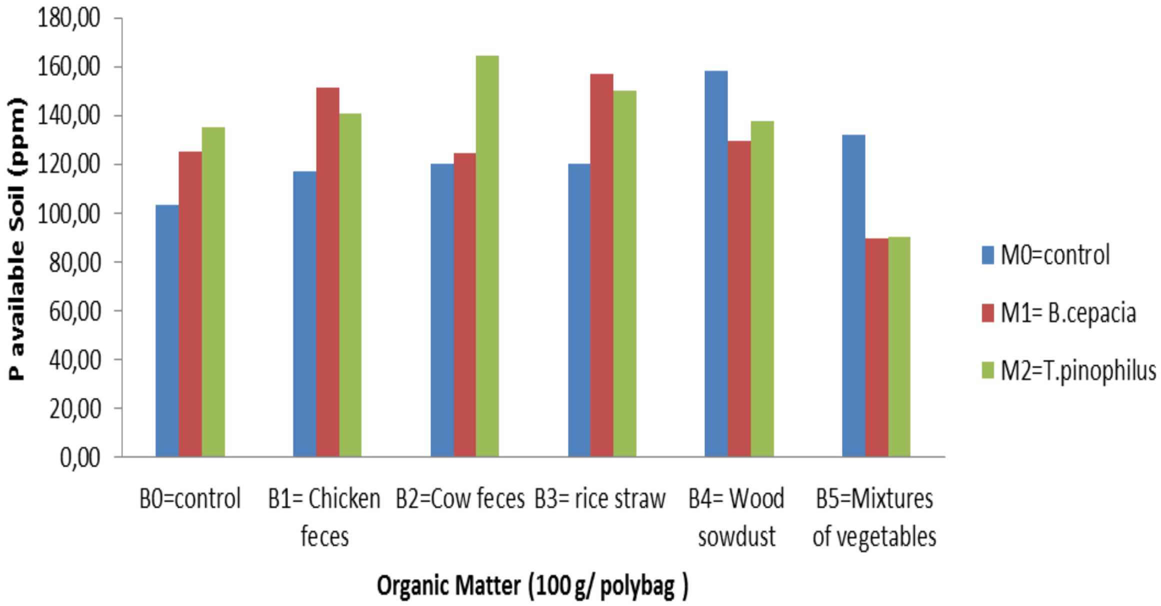

Fig.5. The relationship between Phosphate solubilizing microorganisms treatment and organic matter on P Available (ppm)

CONCLUSION

Applications of Phosphate solubilizing microorganisms and organic matter increased P available (13.38-36.98%), when compare with control. Therefore, the best treatment was *Talaromyces pinophilus* 20 mL and Cow feces organic matter (100 g/polybag) on Andisol impacted by mount Sinabung eruption.

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