

**PROCEEDING**

# **INTERNATIONAL SEMINAR ON SCIENCE AND TECHNOLOGY 2014**

**October 23, 2014**

Tegalboto Campus, University of Jember  
Jember, Indonesia

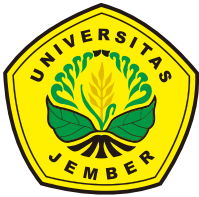


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## Proceeding of The International Seminar on Science & Technology 2014 (ISOSTECH '14)

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The editing of this proceeding has been carried out by **Siswoyo & B. Kuswandi** with assisted by the Scientific Committee of ISOSTECH'14.

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## Foreword by Organising Committee

Assalamu'alaikum Wr. Wb.

Distinguished guests and delegates

On behalf of the organizing committee, I am deeply grateful to your present in the International Seminar on Science & Technology 2014 (**ISOSTECH '14**) that already held in Universitas Jember, Jember Indonesia on thursday, 23 October 2014.

The **ISOSTECH '14** is jointly seminar between University of Jember (UNEJ), Indonesia and Universiti Sains Islam Malaysia (USIM), it was arranged with substantive elements such as seminar pertaining to current advance on science and technology together with posters.

The seminar was provide an excellent platform for knowledge exchange between the academicians, researchers, scientists and engineers working in areas of mathematic and basic sciences, agricultural and food Technology, health sciences and enggineering as well as information technology. In addition, it provides an opportunity for the participants from Indonesia, Malaysia and Philipine to share research findings, to establish networking and to encourage academic and student exchange and other participation in this exciting seminar.

We also would like to express our deep appreciation to the all organising committee members and steering committee, especially Dr. Zulfikar, on behalf of Rector, as Vice Rector of UNEJ who officially opens this seminar. Last but not least our appreciation to all participants especially delegate from USIM, IIU Malaysia and San Carlos University, Philipines. We convey our great gratitude for your scientific speech and contribution. We do hope that all these research results are useful for further research progress and development in these fields.

Enjoy the conference proceeding and hope it will give inpiration on your research projects.

Wassalamu'alaikum Wr. Wb.

**Mrs. L. Wulandary**  
Chairperson  
University of Jember

## Preface

The first International Seminar On Science & Technology 2014 (**ISOSTECH '14**), took place in University of Jember, Jember East Java Indonesia on 23 October 2014. This first seminar series is focused on all aspects related to recent advance in science and technology.

This proceeding contains papers that have been presented at **ISOSTECH '14** as plenary lectures, invited, oral and poster presentations. About 100 participants attended the conference, with 4 plenary lectures, 35 oral and 24 poster presentations. The proceeding of **ISOSTECH '14** has been published in electronic form as \*.pdf file for simple and easy publication and to avoid heavy book of proceeding. We hope that this publication can be easily read, handled and transferred to other form. Furthermore, this paperless proceeding can be fruitful for all participants of the conference.

My sincerely thanks go to all the members of Scientific Committee for their valuable help in the review of the submitted papers, and also to the authors for their collaborative attitude. A special mention must go to **Mrs. L Wulandary**, our Conference Chairperson, who has put in a terrific amount of effort not only in general conference matter but also in the assembly of the papers for this proceeding. Finally, I congratulate the authors of all papers for producing the new and novel idea for research on mathematic and basic sciences, agricultural and food Technology, health sciences and engineering as well as information technology.

Jember, October 2014

**Siswoyo & B. Kuswandi**  
Editors

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## The Changes of Phosphate Fraction in Andisol and Oxisol by Organic Matter Application

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**Abstract** - Soil phosphate (P) exists in various chemical forms, including inorganic P (Pi) and organic P (Po), which differ widely in their behavior and fate in soils. Some fractions of soil P are insoluble forms and each concentration depends on soil types. The problem of P deficiency in Andisol and Oxisol can potentially be solved by the progressive return of organic materials to soil. However, the quantity, quality, and management of this practice are fundamental factors that affect the availability of P from residues. The objectives of this research are to evaluate: (1) the changes of fractions of soil P in Andisol and Oxisol by adding organic acid and organic matter, and (2) enhancement of available soil P in Andisol and Oxisol. Four treatments have been done i.e: (1) control, (2) citric acid, (3) oxalic acid, and (4) soybean biomass. Soil was incubated for 30 days. The results show that application of soybean biomass increases the total P-and the availability of P in both soil types. Furthermore, model of changes of soil P fractionation are different between Andisol and Oxisol. In addition, 30 days incubation does not influence the decreased of P retention in Andisol; it shows that adsorption site of Andisol is higher than Oxisol.

*Key word: Andisol, Oxisol, soil phosphate fraction*

### 1. Introduction

Phosphorus is an essential nutrient. In spite of its wide distribution in nature, P is a limited resource and it is deficient in most soils. Soil P exists in various chemical forms, including inorganic P (Pi) and organic P (Po), which differ widely in their behavior and fate in soils, specifically in relation to bioavailability, as various forms can undergo cycling at different rates, being retained in soils or made available to plants.

In general, Andisols are predominated by amorphous materials such as Al-oxides, Fe-oxides, allophane, and imogolite. These soils have a high P-sorption capacity due to the very high surface area of allophanic, amorphous minerals, and Humus-Fe complexes [1]. Andisol has a high P-sorption capacity about 8000 – 15000 ppm [2]. However in acid soil such as Oxisol and Ultisol, orthophosphate anion will

react with Al and Fe fraction to create undissolve  $AlPO_4$  and  $FePO_4$  (precipitated).

The variable charge mineral constituents ( $\equiv Al-OH$  and  $\equiv Fe-OH$ ) have an important role in adsorbing some oxyanions. Due to their high surface area and reactivity, they strongly retain anions such as phosphate, borate, carboxylate acids (acetate, oxalate, citrate), molybdate, silicate, sulphate, and organic matter and either as adsorbed species or as a reaction products. The principal sorption mechanism is ligand exchange involving the formation of inner-sphere surface complexes.

Fractionation of P in soil influences the availability of P. The occurrence of such fraction is affected by the presence of other anions that able to bind with metal and compete with phosphate, among others are organic anions. These anions could be produced by microbes and roots activities as well as decomposition of organic materials.

Organic materials not only serve as source of macro and micro nutrients for plants, but also closely related to the population and the activities of soil biology. Organic acids, as results of the decomposition of organic materials, have an ability to bind cations through chelation bond. They are also able to envelop the positively charged colloidal. Returns of crop residues into the soil give the change in the P-labile, total P-organic, and P fractions. Moreover, such a process is able to extract the increase in P. However, [3]Dahgreen and Drisscoll (1994) reported that the change of  $H_2PO_4$  concentration in the soil solution is not real. It seems that the change of P in the soil, after the addition of organic matter, is inconsistent. The change of P could be influenced by several factors, among others: the level of addition of materials, the quality of materials, the analyzed P, the status of P in the soil, and the characteristics of each soil type.

Generally, different soil characteristics lead to the different pattern of its fractionation. The addition of organic matter will affect the pattern of fractionation, but how big and how the pattern changes are still not much investigated yet until now.

Organic ligands such as tartaric acid, oxalate, malic and citric containing carboxyl group (COOH), aliphatic phenolic-OH, hydroxyl are very effective in

dissolving minerals and the formation of the elements Al, chelat Fe, Ca as well as other elements and lowers the pH of the medium [4].

The effect of carboxylic groups (e.g. citric, malic, oxalate) as an exudates component generated by root or microbes is able to mobilize the form of P-organic (Po) and the P-inorganic (Pi) due to the formation of metal-cation complexes that bind and move P from soil matrix with ligand exchange.

This study was set up to evaluate the changes of fractions of soil P and enhancement of available soil P in Andisol and Oxisol by adding organic acid and organic matter. Results of the study will assist in the development of long-term P management strategies for improved soil fertility especially in soil phosphate status.

## 2. Method

Research was conducted at Soil chemistry Laboratory Faculty of Agriculture University of Jember. Research was done by factorial Randomized Complete design (three replicate) with the following factors.

Factor-1: Soil type: 1. Andisol (from Batu East Java)  
2. Oxisol (from Depok West Java)

Factor-2: Organic compound: 1. Control;  
2. Citric acid (1M); 3. Oxalic acid (1M)  
4. Organic matter (soybean biomass)

### 2.1 Material Preparation

Andisol samples were taken from Batu East Java, while Oxisol samples were taken from Depok West Java. Samples were collected at the <15 cm depth only. Soil samples were placed in plastic bags. Soils were air-dried and then sieved through a 2mm mesh screen. Approximately 5000 g.pot<sup>-1</sup> of each soil was prepared as medium with 80% field capacity condition. Initial analysis was soil pH, texture, organic carbon, total and available phosphate, Nitrogen total and fractionation of phosphate. Artificial citric and oxalic acid are applied to compare the effectiveness of increasing the availability of phosphate and soybean biomass. Shoot of soybean biomass was decomposed naturally about thirty days. Then the results were analysed on organic acid (citric, oxalic, fumaric, acetic acid).

### 2.2 Application

Each soil types added by 100 ml.pot<sup>-1</sup> organic acid for organic acid treatment, and 70 g soybean biomass was incubated for thirty days on 80% field capacity conditions. Analysis of pH, total-P (HCL 25%) and available-P (Bray) was done regularly (every ten days), while fractionation-P (Hesse, 1972) was measured at the end of incubation.

### 2.3 Material Preparation

Andisol samples were taken from Batu East Java, while Oxisol samples were taken from Depok West Java. Samples were collected at the <15 cm depth only. Soil samples were placed in plastic bags. Soils were air-dried and then sieved through a 2mm mesh screen. Approximately 5000 g.pot<sup>-1</sup> of each soil was prepared as medium with 80% field capacity condition. Initial analysis was soil pH, texture, organic carbon, total and available phosphate, Nitrogen total and fractionation of phosphate. Using artificial citric and oxalic acid are compare the effectiveness increasing availability of phosphate with soybean biomass.

Shoot of soybean biomass was decomposed naturally about thirty days. After that, these product of decomposition were analysed on organic acid (citric, oxalic, fumaric, acetic acid).

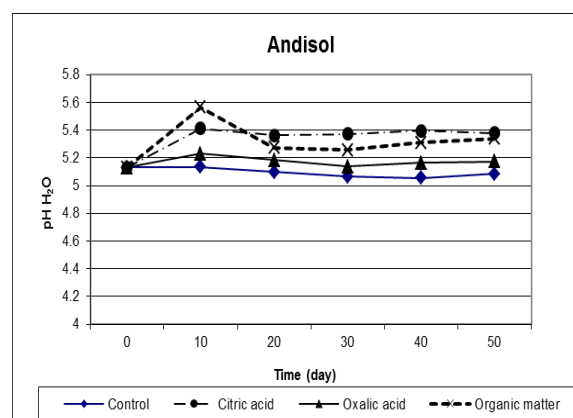
### Application

In each soil added by organic acid (100 ml.pot<sup>-1</sup>) and 70 g biomass. Incubate for thirty days on 80% field capacity conditions. Analysis of pH, total-P (HCL 25%) and available-P (Bray) was done regularly (every ten days), and fractionation-P (Hesse, 1972) at the end of incubation.

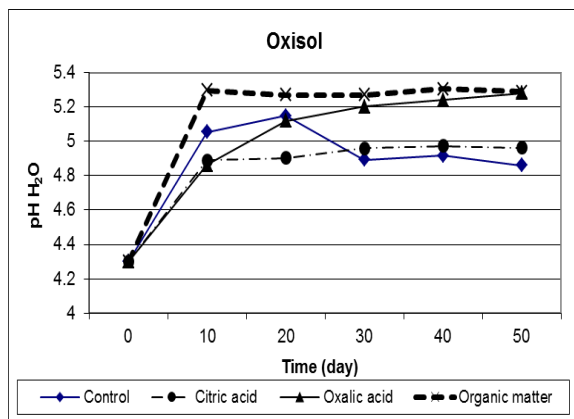
## 3. Result and Discussion

### 3.1 Soil Reaction (pH)

The addition of artificial organic acid and organic matter (soybean biomass) changes the soil acidity on both soil types as shown by Figures 1a and 1b. It can be seen from those figures that in Oxisol, all treatment increased soil pH. In contrast, the increase of soil pH on Andisol was only taken place till D-10 and then subsequently decreased. It can be observed that for Andisol, soil pH was higher than the initial soil pH except for control.



(a)



(b)

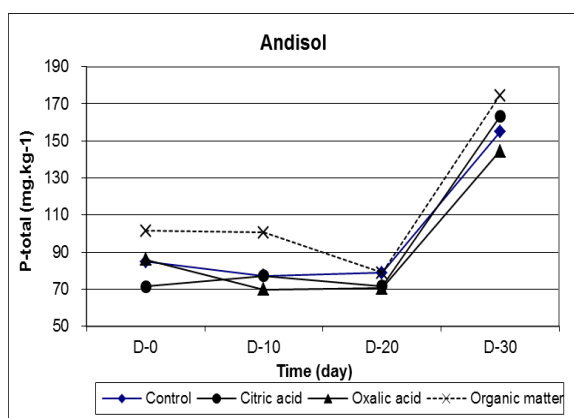
Figure 1. Changes of pH on Andisol (a) and Oxisol (b)

The increase of pH occurred due to ionization of functional groups of organic matters, i.e. carboxyl (-COOH), phenol (-OH), enol (-OH), quinon and amide [5] that causes high phenolic groups concentrations in the soil solution, leading to the increasing soil pH. In addition, organic matter has ability as a *buffering capacity* of soil pH by binding or release  $H^+$  ions, resulting in a pH close to neutral [6].

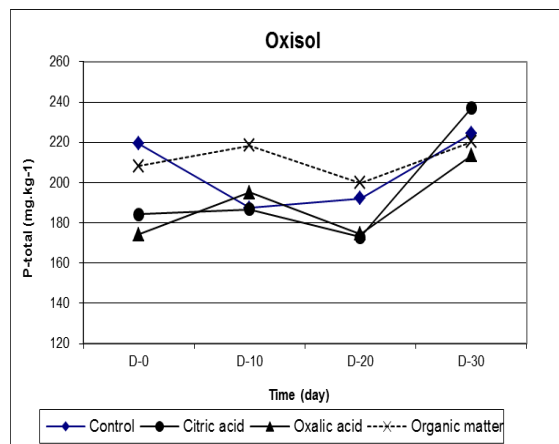
### 3.2 P-total (HCl 25%) and P-available (Bray II)

Figures 2a and 2b shown the behaviour of P-total (HCl 25%) in Andisol and Oxisol for different treatments. It can be seen that both soil types had similar trend, i.e. P-total was tend to decrease until D-20, and then sharply increased after D-20. Compared to other treatments, the addition of organic materials resulted in highest concentration of P-total.

The addition of organic materials also produced highest P-available soil (Figures 3a and 3b). The decomposition of organic material will increase P-organic form such as phospholipida, nucleic acids and inositol phosphates.



(a)

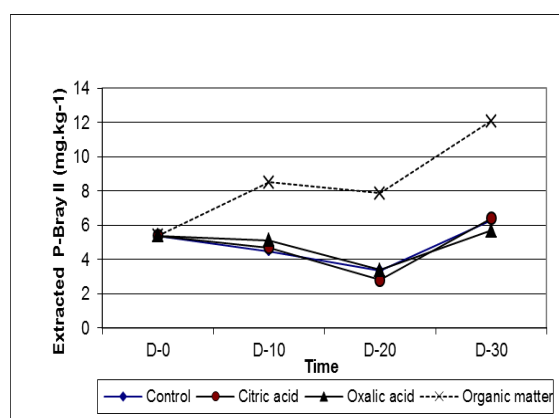


(b)

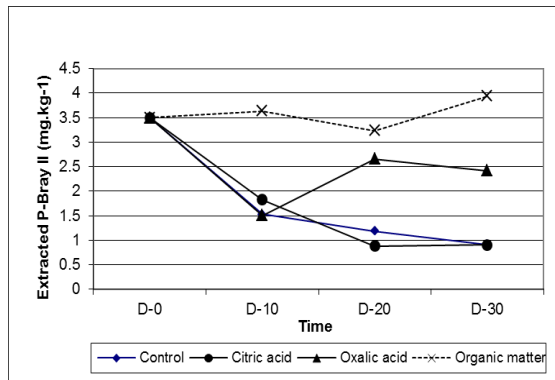
Figure 2. Changes of P-total (HCl) on Andisol (a) and Oxisol (b)

The changes of P-available (Bray II) by addition of organic matter was due to the process of mineralized organic-P to P-inorganic form. Phosphate mineralized from soybean biomass occurred due to the ratio of C/P is less than 200. Based on initial analysis, C/P of soybean biomass was 102. The changes also took place due to the competition of adsorption site between organic anion and orthophosphate anion. If the concentration of organic anion in soil solution was higher than orthophosphate anion, it will replace the orthophosphate anion in adsorption site, so the concentration of the orthophosphate anion in the soil solution increased.

It can also be observed from Figures 3a and 3b that the effect of additional organic matter to the increase of concentration of soil P-available in Andisol was larger than in Oxisol for the whole periode of incubation. Decomposition of organic matter produces organic acid continuously, so that the concentration of organic anions that compete with phosphate anions in soil was much bigger. It could produce metal-organic forms by chelation mechanisms.



(a)



(b)  
Figure 3. Changes of P-available (Bray II) in Andisol (a) and Oxisol (b)

Andisol formed from the ashes of Vulcan materials with the dominance of amorphous materials (allophane, imogolite and humus fraction) that has a large specific surface area, so adsorption from Andisol is also great. The large P retention on Andisol cause release P from adsorption site of allophane and organic matter. Research results [7] on the Andisol soil treated with the addition of fertilizer P increases the concentration of P-in organic, but not P-organic.

The existence of a large P retention in Andisol also led to a release of P from the sorption of allophane and organic matter. Andisol formed from volcanic ash materials with the dominance of amorphous materials (allophane, imogolite and humus fraction) having an extensive specific surface. Early research [7] reported that in Andisol treated with the addition of P fertilizer increased the concentration of P in organic, but not P-organic.

### 3.3 The Changes of P Fraction

The pattern of the change in the fraction of P in Andisol and Oxisol was significantly different as shown in Tables 2 and 3. The data in Table shown that in Oxisol, total concentration of P fraction for all soil types decreased compared to control soil. In contrast, total concentration of P fraction in Andisol increased compare with control soil.

The increase of total fraction in Andisol was higher than in Oxisol. Such a result is due to Andisol has large adsorption capacity. P retention in Andisol before treatment was 94.9%, while P retention in Oxisol was only 60.3%. After 1 month incubated, adsorption site of Andisol was still high, consequently the amount of total P fraction increased over control.

Table 2. The changes of soil P-fraction concentration at 30 days

Treatment	Soluble - P	Al-P	Fe -P	Ca-P	Red-P	Occ-P	total
	mg.kg <sup>-1</sup>						
<b>Andisol</b>							
Control	0.54	0.70	-	5.18	5.97	2.83	15.21
Citric acid	0.35	1.43	-	5.35	10.47	4.53	22.13
Oxalic acid	0.67	0.81	-	5.45	15.70	3.82	26.44
Organic matter	0.67	0.88	-	5.55	23.27	3.19	33.56
<b>Oxisol</b>							
Control	0.70	0.40	12.69	4.15	3.33	2.99	24.27
Citric acid	0.37	1.36	7.05	3.85	5.88	2.39	20.89
Oxalic acid	1.03	0.81	7.79	3.80	4.16	2.00	19.59
Organic matter	0.39	0.70	10.29	5.68	1.67	1.34	20.05

Addition of citric acid, oxalic acid, and organic materials had different results in the changes of P-fraction in Oxisol as well as in Andisol. In Oxisol, organic matter decreased all of P-fraction except Al-P and Ca-P, but in Andisol all P-fraction increased having added by organic matter. Basically organic material has the ability to release P into the soil solution, but the organic material itself has component which able to serve as new adsorption site, so that P that has been released can be adsorped again.

Conversely, the artificial organic acid (citric and oxalic acid) do not have adsorption site which can adsorb or discharge of P, only dissociation of organic anion. Then anion organic compete with orthophosphate ion to build organic-anion complexes.

From Table 3, it is observed that organic matter significantly decreased undissolve phosphate in Oxisol i.e occluded-P, reductant-P and Fe-P. It dominated fix by iron or Fe-oxide. In Oxisol, ferrous oxide was high, as recorded in initial data (appendix 1), ratio of Feo/Fed was low (0.23 - 0.38).

Table 3. Percentage of soil P-fraction at 30 days

Treatment	Soluble - P	Al-P	Fe -P	Ca-P	Red-P	Occ-P	total
	%						
<b>Andisol</b>							
Control	3.57	4.58	-	34.03	39.24	18.59	100.00
Citric acid	2.30	9.40	-	35.18	68.83	29.81	145.52
Oxalic acid	4.37	5.30	-	35.84	103.24	25.10	173.85
Organic matter	4.37	5.79	-	36.50	152.99	21.00	220.65
<b>Oxisol</b>							
Control	2.88	1.66	52.30	17.10	13.73	12.32	100.00

Citric acid	1.51	5.59	29.04	15.86	24.24	9.83	86.08
Oxalic acid	4.25	3.32	32.10	15.66	17.13	8.23	80.70
Organic matter	1.59	2.87	42.41	23.38	6.87	5.50	82.62

High organic matter concentration in Andisol affected P-fractionation model. Andisol has big capability to adsorb phosphate, strong and very slow ability to desorb; as a result, percentage of P was still large until D-30. However, P fixation in Oxisol was weak, so that P could be changed to other P form. Organic matter from soybean biomass significantly decreased insoluble P fraction in Oxisol such as occluded-P, reductan-P and Fe-P. Previous research by [8] shown that Andisol has higher capacity to P adsorb than Latosol. In addition the adsorption curve in Andisol linearly increased until 3 months incubated.

#### 4. Conclusion

1. The changes of P fraction in Andisol and Oxisol have different patterns.
2. In Andisol all P-fraction increase, except for soluble-P, but in Oxisol the treatments decrease Fe-P, reductan-P and occluded-P.
3. All of treatments can increase the availability of P concentration, at which the addition of organic matter serves the biggest effect.

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