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Utilization of Palm Oil Mill Effluent and Zeolite on Corn in Potential Acid Sulphate Soil

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***Abstract* – Acid sulphate soil is soil with low fertility rates. To improve the potential acid sulphate soil fertility in order to support the growth of corn plants required ingredients that act as fertilizers and ameliorant the combination of Palm Oil Mill Effluent (POME) and zeolite. The study aims to determine the growth of corn plants in acid sulfate soil potential given POME and zeolite. Implementation research in Ulu Lagan Village, East Tanjung Jabung, Jambi Province, using a randomized block design experiment with 3 treatments and 3 groups. Treatment factor: without POME, POME secondary anaerobic pond I, and the combination of POME acidification pond and zeolite 10%. The treatment given to the hybridcorn Bisi 2 in acid sulphate soil potential. The results showed that the zeolite POME and significant effect on total-N, P-Bray I, soil CEC, pH, canopy dry weight, root dry weight, leaf N content, P content of leaves, and leaf K content of corn plants. In general it can be concluded that the acidification pond POME and 10% zeolite can better promote plant growth of corn in acid sulphate soil.**

***Keywords* – Acid Sulphate Soil, POME, Zeolite, Corn.**

I. Introduction

Palm oil mill effluent (POME) can not be directly used as an organic fertilizer due to the high contents of both Biological Oxigen Demand (BOD) and Chemical Oxigen Demand (COD), in the other hand, it's organic material shows not perfectly degradation yet, beside there is no a maximum of microorganism activity, moreover it will decrease both water and environment quality if it directly wasted to the water flow so that it should not be recommended to be applied in agriculture land. This POME needs a hidrolisis duration by 150 to 220 days in its processing activity. This processing shows several weakness e.g. producing unpleasant odor, contaminating the soil around the pool, it needs wide area of pool, by product which produced such like metan gases, need periodic maintain to reduce mud in the bottom of the pool, moreover there is a nutrient decreasing [14].

Palm oil mill effluent was able to be transformed as high quality organic fertilizer by zeolit addition. Compounding 10% of zeolite incubated in two weeks duration in acidulating pool and 5% of zeolite incubated in two weeks duration in secondary anaerobic pool I produced a better content of N, P, K, Fe, Al with BOD and pH that matched with waste quality standard [11].

The zeolite utilization on POME combined with the hydrolysis duration would produce better N, P, K, Al, Fe, BOD and pH than that the zeolite utilization with without zeolite.

The zeolite utilization sould be able to absorb the heavy metal e.g. Pb, Hg, and Cd [17]. Zeolite also able to absorb CO_2, H_2S and NH_3 beside it able to inhibit the relies of soil nitrogen. All the time the utilization of zeolite in agricultural are: as a raw material to increase the quality of organic fertilizer and slow release fertilizer processing, soil conditioner and stock water controller. The further statement the zeolite utilization should be combined with organic fertilizer [8]. Zeolite 5% on the sands has increased the population of bacteria and fungi [3]. 10% zeolite on the mining mud which incubated during 6 weeks show be able to decrease 40% Zn, contained 23.18% oil and 14.16% polyaromatic hydrocarbon, and it effects to the bacterial and fungi quantity [4]. Zeolite minerals are capable to increase the phosphate concentration, and inhibits the compost phosphate removal, for having the P retention capacity, as an absorbent and nutrition slow release [7]. Urine with 20% zeolite acts to decrease the N removal, due to 21.27 mg l^{-1} N (ammonium) has been absorbed by zeolite, furthermore the N will be slowly released. Zeolite capable to reduce a bad aromatic and reduce the urine ammoniac concentration [15]. Palm oil mill effluent had found that POME in 1000 ml acidulating pool that give 10 % zeolit with two weeks incubated was increase the fertilation of potential achidity sulphate soil higher. It was indicated by seeing both parameter of physical and chemistry karacteristic. While generally POME treatment without zeolit was better on 1000 ml POME with 4 weeks incubation [12].

Palm oil mill effluent is able to increse fress fruit bunch up to 60 % and has fertilizer saving by 70%. Beside it contains N, P, K, Na, Ca, Mg and various microorganism which has a rule to prepare nutrient available and do a soil conservation.

Application of POME as a fertilizer can also increase the soil acidity, total N, available P, K and Mg [18]. POME Application of 740 ml doses per polybag, incubated for two weeks without anorganic fertilizer showed highly significan than without POME Application [10]. Acid mineral soil can be upgraded by zeolit application. There is no break down for zeolit and it isn't give acid condition, beside it has still stabil number in soil to retention the soil nutrition [8]. 15% zeolit aplication on sandy soil can increase the soil water keeping [1]. It has the same cases as mumpton in [16] find that zeolit has an ability on water absorption, water release and kation exchange without change its crystal structure.

Increasing of food production espacially corn (*Zea mays L*) is the aim of agriculture sector. Indonesia doesn't able to be self-sufficient yet, even corns was huge imported to fullfil food and feed requirement.

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II. Material and Method

This research was conducted at potentialy acid sulphate land in Lagan Ulu Village Geragai District Janjung Jabung Timur Regency Jambi Province which is has geographycal coordinate as 1°11'58.66 and 103°44'6.19". The research has been held in 5 month.

The bloking randomized design was used with three treatmens and three cluster). Treatments are L_o = without POME, L_1 = POME in secondary anaerobic pool I (0% zeolit, 4 weeks incubation) 1000 ml doses, L_2 = POME in acidity pool (0% zeolit, 2 weeks incubation) 1000 ml doses. There are three time replication of each treament so it has 9 units experiment.

Pyrite thickness was measured before preparing a land. There was 4 locations centre as a soil sample with 20, 30, 40, 50, and 60 cm of thickness. Plot size 20 m x 9.8 m was decided suitable with experiment layout. Hence 375 Kg Ha^{-1} of lime was given to the land a week before planting. Planting was started by dibbling with a pointed stick in order to sow seeds, with a distance 70 x 25 cm. there were 12 crops each treatment so there were 12 x 9 = 108 number of crops. Basic fertilizing of 25% doses was recomended to be done in the same time in planting.

There are 3 times of Pome application e.g. in planting time, 15 days after planting and 35 days after planting. POME added by zeolit (0.25% N, 0.09% P, 0.10 % K, 4700 ml L^{-1} BOD and pH = 6.89) and POME without Zeolit (0.11% N, 0.05% P, 0.06 % K, 5700 ml L^{-1} BOD and pH = 6.89) are smoothtly spraied to the soil. The observated parameters consist of crown dry weigh (g), root dry weigh (g), containing of leaf N, P and K. Electrometric method are used to analyse the soil after experiment of available P (Bray-I), total N (Kjeldahl), CEC (NH_4Oac.pH 7) and pH H_2O (1:1).

The observed data were analyzed using the analysis of variance by using Statistical Analysis System Version 17. To compare each variable mean, the Duncan Multiple Range Test (DMRT) was used (α = 5%). Furthermore, the correlation test was also used to determine the level of relationship between independent and dependent variables.

III. Results and Discussion

Response of Corn Growth of that Treated by POME Plus Zeolite.

The result of statistical analysis showed that the application of POME plus zeolit was significantly affected all plant growth variables (Table 1).

Table 1. Effect of POME Plus Zeolite Application on Dry Weight of Both Crown and Root

POME	Dry Weigh (g)		N	Contain (%) P	K
	Crown	Root			
Without POME (L_0)	89.36 a	24.35 a	1.66 a	0.25 a	0.99 a
POME Without zeolit(L_1)	110.81 b	61.19 b	2.27 b	0.33 b	1.27 b
POME plus zeolit (L_2)	125.52 c	64.72 b	2.64 c	0.35 b	1.57 c

The numbers followed by the same small letters on each column mean not significantly different (DMRT Test α = 0.05).

Fig. 1. Respon of maize crops growth upon the provision of POME plus zeolite to potential acid sulphate soils.

Fig. 2. The Respon of corn crops growth without POME on potential acid sulfate soils.

POME plus zeolite has a role to increase the growth of corn crops as seen in all variables of morphology, and physiology corn crops (Figures 1 and 2). This is due to the role of POME plus zeolite in the soil as an organic fertilizer that provides plant nutrients (content of POME plus zeolite: N 0.29%, P 0.09% and K 0.1%) and can increase the capacity of groundwater holding and reduce speed of water loss. Palm oil mill effluent plus zeolite increased soil macroagregate stability and groundwater holding capacity of potential acid sulphate soils by 22.59% and 26.09%, respectively [11]. Furthermore [3] explains that giving of material organic and zeolite can reduce the speed of water loss in sandy soil.

Plants given POME plus zeolite showed higher capacity in maintaining leaf nutrient content. Larger capacity in up -take and transport of nutrient from root to crown is associ -ated with increasing of root activity. Plants given POME plus zeolite give higher dry weight of root than without POME and POME without zeolite. The Increasing of dry weight of roots means that there are more roots that can absorb water and nutrients, so it can meet the needs of pla -nt water for physiological activity.

Effect of POME Plus Zeolite on Some Chemical Caracteristic of Potential Acid Sulphate Soil of Corn.

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The result of statistical analysis, showed that giving POMEplus zeolite had a very significant effect on N-total, P Bray I, CEC, and pH. POME plus zeolite giving can increase N-total, Bray I, pH, and CECof soil. N-total increased from low to high criterion, P availibility from medium to high, pH from low (acid) to moderate (slightly acid), soil CEC from low to high (Table 2).

Table 2. The main effects of POME plus zeolite on N-total (%), P Bray I (mg kg-1), CEC (cmol (+) kg-1) and pH.

POME	N-total	P Bray I	pH	CEC
Without POME(L0)	0.15 r	16.77 s	5.22 r	16.14 r
POME without zeolit(L1)	0.23 s	22.79 s	5.70 s	26.42 t
POME plus zeolit (L2)	0.49 t	32.38 t	6.40 s	31.11 t

The small letters in each column indicate the criterion of soil characteristic (LPT, 1983) r = low, s = medium, t = high, st = very high.

Soil observations of 20, 30, 40, 50, and 60 cm depths of massive soil, unstructured soil, pale gray to dark gray soil, groundwater surface -100 cm, and there are pyrite at 30, 40, 50 and 60 cm depths respectively of 0.08, 0.12, 0.13, 0.15 and 0.21%. Based on the soil analysis (Table 3) it was found that the soil was clasified as clay soil texture, the cation exchange has low capacity, the soil reaction was very acidic and the available P concentration extracted with Bray I was low as well as low N-total.

Table 3. the Initial analysis Results of acid sulphate soils before treatment

No	Varianous of Analysis	value	Criteria *)
1	pH H2O (1:1)	4.10	very
2	pH KCl (1:1)	3.40	acidic
3	EC (mS Cm^{-1})	0.18	
4	Organic C (%)	1.76	no salt
5	total N (%)	0.18	low
6	C/N	9.78	low
7	P Bray I (mg kg^{-1})	14.30	low
8	K-total (mg kg^{-1})	43	low
9	Ca-dd ($cmol_{(+)}kg^{-1}$)	1.08	high
10	Mg-dd ($cmol_{(+)}kg^{-1}$)	1.30	very low
11	Na-dd ($cmol_{(+)}kg^{-1}$)	0.98	moderate
12	K-dd ($cmol_{(+)}kg^{-1}$)	0.47	high
13	H-dd ($cmol_{(+)}kg^{-1}$)	1.38	moderate
14	KTK ($cmol_{(+)}kg^{-1}$)	15.24	low
15	Al-dd ($cmol_{(+)}kg^{-1}$)	4.34	low
16	Al Saturation (%)	45.45	
17	Alkaline Saturation	25.13	high
18	(%)	1.61	low
19	Fe (%)	0.15	
21	S (%)	0.34	
	Sand Fraction (%)	39.07	
	Dust Fraction (%)	60.59	
22	Clay Fraction (%)	Clay	
	Texture		

Description: *) based on criteria of Soil Research Center 1983

Multi-correlation analysis of N-total, P Bray I and CEC as a treatment effect of drought stress and POME plus zeolite showed that the increase of N-total, Bray I and CEC of soil will be followed by the increasing of crown dry weight, root dry weight, N and P leaf content (Table 4).

Table 4. Correlation between N-total variables, Bray I, CEC soil and leaf N content, leaf P content, dry weight of crown, root dry weight as the effect of POME plus zeolite treatment

Variabel	Coefisient of Corelation		
	total N	P Bray I	CEC
dry weight of crown	+0.90**	+0.86**	+0.81**
dry weight of root	+0.77**	+0.85**	+0.91**
leaf N content	+0.83**	+0.83**	+0.82**
leaf P content	+0.83**	+0.82**	+0.81**

Description: * * highly significant α = 0.01.

An increase in pH by zeolites is possible because the alkaline kation in zeolites such as Ca K and Mg can be interchanged with H + and Al3 + ions. Zeolite can support soil acitity (pH), acid soil can be neutralized by the zeolite because its pH = 7.2 and it can adsorb Al and Fe that cause soil acidity and release cations like Ca, Mg and K. Zeolite Is a mineral that can neutralize the soil acidity [5]. $Ca2^{+}$, $Mg2^{+}$, K^{+} ions in the soil will hydrolise which produces hydroxide compounds and it reacts with soluble Aluminum ions produce insoluble $Al(OH)_3$ [2].

The Increasing of nutrient content such as total N and available P are, was derived from mineralization processes that release these elements to the soil. Beside nutrient content comes from the decomposition of POME and elements adsorbed by zeolites. N content in the soil solution is less then the N adsorbed by the zeolite will be released slowly. POME contains dissolved organic compounds which may play a role in increasing solubility of the soluble P compounds which dificult to fuse in acidic soils such as A1-P and Fe-P [17]. Organic acids giving (humic, oxalate and citrate) can increase available P and total P in the soil [6].

The addition of organic material can increase the cation exchange capacity, soil acidity and contribute a number of both macro and micro nutrients through the mineralization process. It is also explained that the function of organic materials in improving chemical fertility is also due to the decrease of nutrient losses by pelindian because of the organic material binding ions and immobilization of N, P and S and as a solvents of nutrients, especially phosphates and minerals by organic acids [19].

Zeolites have a high CEC for 154.17 cmol (+) kg^{-1}. The exchange of zeolite cations is bacsiclly a function of the degree of silica substitution by aluminum in the structure of zeolite crystals [9] . The more the amount of aluminum replaces the silca position so it also more produced negative charge, so the zeolite CEC will be higher. Potentially acid sulphate soils have variable charge, if the pH rises above of neutral it will produce a negative charge. Negative charges are formed by the high absrption of OH^- ions in the colloidal surface. Negative charges on the colloidal surface will be able to absorb the cations.

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IV. Conclusion

POME of acidity pool and 10% zeolite ponds can be better, compared with to add the POME without zeolite and without the application of POME will increase the growth of corn crops and it can improve the fertility of potential acid sulphate soil.

References

[1] Abdoellah.S. dan Fitri. M.Z. 2004. Application of zeolites to improve the efficiency of water use in theobroma cacao seeds on sandy soil. Pelita Perkebunan. 20 (3): 123-131.

[2] Ano. A.O. and C.I.Ubochi. 2007. Neutralization of soil acidity by animal manures: mechanism of reaktionn. Africa Journal Biotechnol. 6(4): 364-368.

[3] Djajadi. Helianto. B dan Hidayah, N. 2010. Influence of planting media and frequency of water to physical, chemical and biological characteristics of soil and growth of Jatropha curcas. Jurnal Littri. 16(2):64-69.

[4] Dhayat,N.R. 2011. Bioremediation of petroleum sludge with zeolites and microorganisms and their testing of sengon plants (*Paraserianthes falcataria*). http://www.google.com. (diakses 23 Desember 2011).

[5] Endro.K. 2008. Optimization of utilization of natural zeolite from kidul volcano to reduce cesium content in radioactive waste. Proceedings of the National Seminar on Research and Management of Nuclear Devices, Batan, Yogyakarta.

[6] Ermadani dan Arsyad.A.R. 2007. Improvement of some chemical properties of acid mineral soils by utilization of palm oil mill effluent. J. Research Institute of Jambi University Science Series. 09(2): 99 - 105

[7] Gu.Z, Buyuksonmez.F, Gajaraj.S, and Edward.N.2 011. Adsorption of phosphate by goethite and zeolite: effects of humic substances from green waste compost. ProQuest Agriculture Journals. 19(3):197-204.

[8] Jabri.A. 2008. The study of zeolite cation exchange rate setting method as a soil enhancer for degraded agricultural land. Jurnal Standardisasi. 10(2): 56-69.

[9] Li. Z, Allesi. D dan Allen. L. 2000. Influence of quartenary ammonium of sorption of selected metal cations onto clinoptilolite zeolite. Journal of Environmental Quality. 31: 1106- 1114.

[10] Muzar.A. 2008. Application of palm oil mill effluent to ultisol soil and its effect on soybean crop. Jurnal Agrivigor. 8(1):24-32.

[11] Nursanti.I, Dedik.B, Napoleon.A dan Parto.Y. 2014. Zeolite utilization as a catalyst and nutrient absorbent in an organic fertilizer processing derived from palm oil mill effluent as a raw material. Journal of Tropical Soil. ISSN 0852-257X. Vol. 18. No. 3. September 2013. Pp.177-184

[12] Nursanti.I, Dedik.B, Napoleon.A dan Parto.Y. Improved soil sulphate fertility potential through the provision of liquid wastes of palm oil mill and zeolite of various doses. Prosiding Semnas Lahan Suboptimal 2013, ISBN 979-587-501-9. Hal. 297-305

[13] Oste.L.A, Lexmond.T.M, and Riemsdijk.V. 2002. Metal immobilization in soils using synthetic zeolites. Journal of Environmental quality. Proquest Research Library. 31: 813-821.

[14] Raharjo.P.N. 2006. The ideal liquid waste management technology for palm oil mills. Jurnal Agronomi Indonesia. 2(1): 66-72.

[15] Sumarlin.L.O, Muharam.S dan Vitaria.A. 2008. Absorption of ammonium (NH4 +) from urine with zeolites in various urine concentrations. Jurnal Valensi. 1(3): 110-117.

[16] Suwardi. 2000. Utilization of zeolite as a medium for growing horticultural crops. Department of Land, Faculty of Agriculture IPB, Prosiding. Temu Ilmiah IV. PPI. Tokyo, Jepang.

[17] Vaulina. E. 2002. The potential of natural zeolite as an adsorbent of heavy metals in aquatic waste. Majalah Ilmiah Universitas Jenderal soedirman. Purwokerto. 2(28): 1-8.

[18] Widiastuti.R, Suryanto.D, Mukhlis dan Wahyuningsih.H. 2006. Influence the utilization of liquid waste of palm oil processing plant as fertilizer to soil biodiversity. Faculty of Agriculture Universitas Sumatera Utara. http://www.google.com. (diakses 13 Desember 2011).

[19] Wolf. B and G.H.Snyder. 2003. Sustainable soils; the place organic matter in sustainable soils and their productivity .E-Books. Food Products Press. New York-London-Oxford.

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