The Changing of Soil Reaction and Exchangeable Aluminum on two Different Soil Order due to Dolomite Application

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Abstract— *The objective of the experiment was to know the effect of Dolomite application on soil reaction and exchangeable Aluminum in two different soil orders. The method was experimental using Factorial Randomized Block Design, which consists of two Factors. The First factor were soil orders consist two levels, i.e. T1= Ultisols Kentrong, dan T2 = Inseptisols Jatinangor, while the second were dolomite dosages, consist four levels, i.e. dO = 0 ton ha^{-1}, d1 = 1 ton ha^{-1}, d2 = 2 ton ha^{-1}, d3 = 3 ton ha^{-1}, d4 = 4 ton ha^{-1}.The result of the experiment showed that on Ultisols Kentrong, dolomite applications significantly increased the value of soil reaction (pH) after two weeks incubation. The treatment of 3 ton/ha showed pH 4.73 or 8 % higher that control. Otherwise, the applications of dolomite also decreased the exchangeable Aluminum. The treatment of 3 ton/ha showed value 7.01 of exchangeable aluminum or 21 % lower than control. In Inceptisols Jatinangor, dolomite applications increased the value of soil reaction (pH) after two weeks incubation and the treatment of 3 tonha^{-1}showed pH 5.83 or 11 % higher than control. Otherwise, the application of dolomite decreased the exchangeable aluminum although were not significantly different for that parameters in this soil order. Based on statistical analysis, it proved that liming unable applied effectively on whole soil types or orders due to its relation with the level of soil acidity.*

Keywords— ***Soil Reaction, Exchangeable Aluminum, Ultisols Kentrong, Inceptisols Jatinangor.***

I. INTRODUCTION

The soil productivity is one of the serious problems in agriculture production, because we need to increase the food availability to represent a rapid growth of population. In fact, Indonesia has great opportunities to increase of agriculture production due to availability of land resources, although there are many limit factors in its development. Soil acidity is one of the limit factors in tropical land development. High rainfall leach out the basic minerals in soils. Fertilizers and organic matter from manure and compost tend to accelerate this acidulation process (Tan, 2000). The results of long-term experiments in many countries of the world show that regular application of farmyard manure limits soil acidification and intensive mineral fertilization; especially with nitrogen and potassium, it results in a decrease in pH value, and even in soil degradation (Gomonova et al. 2007, Shahid et al. 2013).Liming is helpful because it neutralizes active protons (H +) in the soil solution, alters the exchangeability and potential acidity associated with the presence of toxic Al and Mn (Raijet al., 1977) in soil solution.

Soil acidity is commonly indexed by the soil reaction; the index is used together with other soil characteristics such as texture, organic matter, and clay mineralogy to estimate the degree of soil acidity and the effect of soil acidity on plant behavior (Kidder, 2003). One of the primary factor that effect on plant growth environment is soil reaction due to its effect to plant nutrients availability. In base soil reaction, the availability of K, Ca, Mg and N are very high while Fe and Mn are low, otherwise in acidic soil reaction, the availability of P and Alis optimum, while micro nutrients are dissolved (Foth, 1994).

Ultisols and inceptisols are the acidic soil, the soils widely distributed in Indonesia, approximately 42, 27 % for Inceptisols and 20, 25 % for Ultisols, or about 119.389.914 ha for both, a great number of land resources. Both Ultisols and Inceptisols may develop from similar parent material but strongly distinguished by the climate, vegetation, and age (Buol, et al, 1990).

Inceptisols develop on fairly steep slopes, young geomorphic surfaces, and on resistant parent materials, there is no Fe or aluminum oxide formation indicated soil acidity, while ultisols develops in warm, humid temperate, typically on old and stable landscapes. They have an acidic argillic horizon due to the formation of Fe oxides with less than 35% base saturation. It indicate that ultisols has a higher acidity than Inceptisols. Liming aim to reduces soil acidity, by increase of pH value. This is the primary reason for applying lime to acidic soil such as Ultisols and Inceptisols (Kidder, 2003).

II. MATERIAL AND METHOD

The incubation experiment was conducted at the greenhouse. The method was experimental using factorial randomized block design that consists of two factors. The first factors was soil types consist two levels, i.e. T1= Ultisols Kentrong, and T2 = Inceptisols Jatinangor, while the second was dolomite dosages, consist four level, i.e. d0 = 0 ton ha^{-1}, d1 = 1 $tonha^{-1}$, d2 = 2 $tonha^{-1}$, d3 = 3 $tonha^{-1}$, d4 = 4 $tonha^{-1}$.

Air dried soil of ultisols and inseptisols with amount of 12 kg sieved by 2 mm mess and applied the treatment of dolomite dosages get into the polybags then given the watered reach to field capacity condition. The soil in polybags was incubated for 2 weeks and soil reaction (pH) and exchangeable aluminum were analyzed pre and post treatments from unit of soil sample. Completed data was statistically analyzed, followed by mean separation with Duncan's New Multiple Range Test.

III. RESULT AND DISCUSSION

3.1 Soil Reaction (pH)

The result shows that dolomite applications significantly increased the soil reaction on Ultisols Kentrong after two weeks incubation. The treatment of 3 ton/ha showed pH 4.73 or8% higher than control, while on Inceptisols Jatinangor the dolomite applications insignificantly increased the soil reaction. The treatment of 3 ton/ha showed pH 5.83 or 11% higher than control.

The increasing of soil pH due to the increasing of Ca^{2+}sourced from dolomite applications. Dolomite applications increase the availability of calcium that created neutralization effect due to substitution reaction between H^{+} and Ca^{2+} (Tisdale, 1993).Liming increase bases caution dan soil pH.Alsolubility is strongly influenced by soil pH. Increase soil pH will decrease of Al solubility in soil (Ritchie, 1995).

Liming soil also modifies the distribution of charges in the soil particles, especially in the juvenile soil class (Inceptisols), which shows a predominance of electrical charges (positive or negative) depending on pH or variable charges associated with the ferrol, aluminol and silanol surfaces complex groups on the surface of minerals and the carboxylic and phenolic surface complex groups on the surfaces of soil organic matter (Sposito, 2008).

TABLE 1.
EFFECT OF DOLOMITE APPLICATIONS ON SOIL REACTION OF ULTISOLS KENTRONG AND INCEPTISOLS JATINANGOR

Treatments	Soil Reaction (pH)	
	Ultisols Kentrong	Inceptisols Jatinangor
d_o= Control	4.36 a	5.23 a
d_1 = 1.0 ton ha^{-1}	4.54 b	5.43 a
d_2 = 2.0 ton ha^{-1}	4.67 b	5.62 a
d_3 = 3.0 ton ha^{-1}	4.73 c	5.83 a
d_4 = 4.0 ton ha^{-1}	4.90 c	5.83 a

Note: same letters represent insignificant values at 5 % level by Duncan's Multiple Range Test.

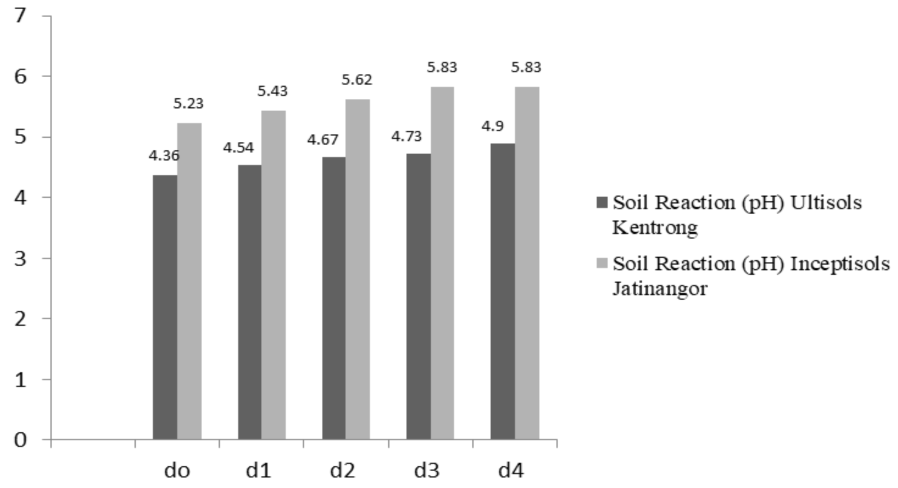

FIGURE 1: EFFECT OF DOLOMITE APPLICATIONS ON SOIL REACTION OF ULTISOLS KENTRONG AND INCEPTISOLS JATINANGOR

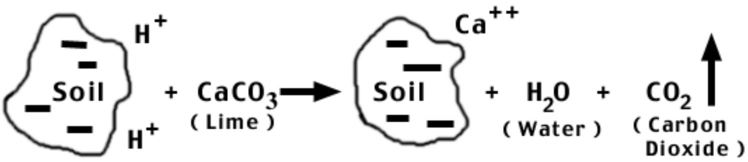

FIGURE 2: CHEMICAL ILLUSTRATION OF LIMING PROCESS

3.2 Exchangeable Aluminum

The result showed that the dolomite applications significantly decreased exchangeable aluminum on Ultisols Kentrong after two weeks incubation. The treatment of 3 ton/ha showed value 7.01 or 21% lower than control, while on Inceptisols Jatinangor the treatments insignificantly decreased the exchangeable aluminum.

The decreasing of exchangeable aluminum due to liming application that increase soil reaction (pH) and sediment of exchangeable aluminum as $Al(OH)_3$ (Tan, 2000). Liming process equivalent to 2.25 t ha^{-1} on acid soil (pH 4.5) decreased Al-exchangeable (Costa and Rosolem, 2007). Furthermore, the study showed that liming increased Ca concentration and reduced Al exchangeable and Al saturation at 20 cm and 40 cm soil depth after 9 months and two years of application, respectively (Caires et al., 2008). Although it takes a long time, the movement of lime into the deeper layers may occur through (1) the process complexes formation of Ca or Mg with soluble organic matter so that it can move to deeper soil layers, (2) the activity of organism, especially macro fauna and (3) lime with a micro size is relatively soluble (Miyazawa et al., 2002; Chan, 2003).In electronegative soils, pH decreases with increasing soil solution salt concentration, due to ion exchange between salt cautions and the H^+ and Al^{3+} ions of the exchange complex (Sousa et al., 2007).

TABLE 2
EFFECT OF DOLOMITE APPLICATIONS OH EXCHANGEABLE ALUMINUM OF ULTISOLS KENTRONG AND INCEPTISOLS JATINANGOR

Treatments	Exchangeable Aluminum (cmol/kg)	
	Ultisols Kentrong	Inceptisols Jatinangor
d_o= Control	8.83 a	0.81 a
d_1 = 1.0 ton ha^{-1}	7.68 b	0.78 a
d_2 = 2.0 ton ha^{-1}	7.38 b	0.76 a
d_3 = 3.0 ton ha^{-1}	7.01 bc	0.74 a
d_4 = 4.0 ton ha^{-1}	6.78 c	0.73 a

Note: same letters represent insignificant values at 5 % level by Duncan's Multiple Range Test.

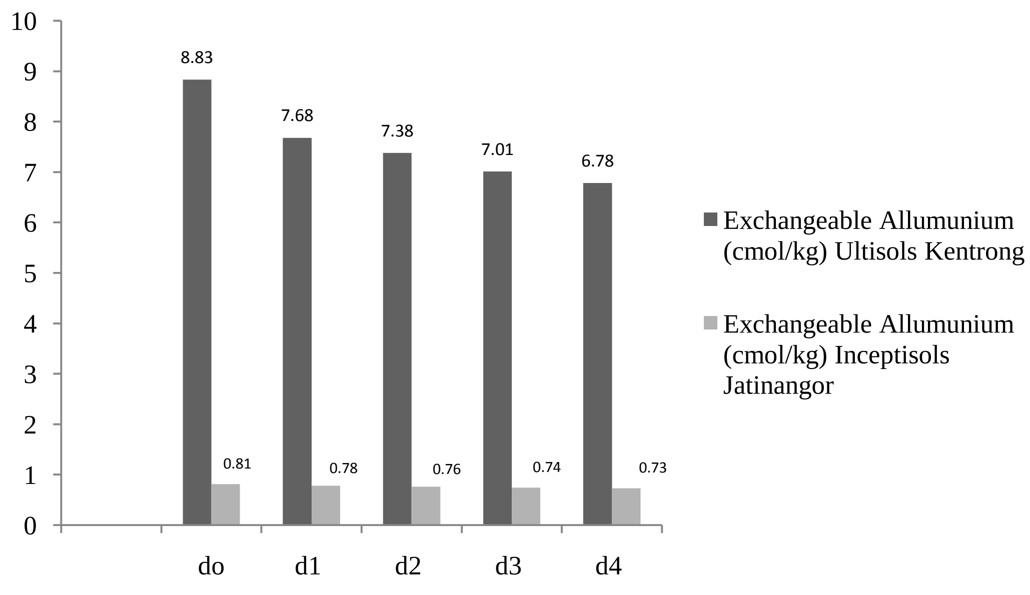

FIGURE 2: EFFECT OF DOLOMITE APPLICATIONS OH EXCHANGEABLE ALUMINUM OF ULTISOLS KENTRONG AND INCEPTISOLS JATINANGOR

IV. CONCLUSION

The Dolomite applications showed the changing on soil reaction and exchangeable aluminum in two different soil orders, both Ultisol Kentrong and Inceptisols Jatinangor, by the different responses. Ultisols Kentrong showed significant responses both on soil reaction and exchangeable aluminum, while Inceptisols Jatinangor showed insignificant responses on that soil reaction and exchangeable aluminum. It concluded that liming process unable applied effectively on the whole soil order due to it relation with the level of soil acidity.

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