EFFECTS OF STEEL SLAG AND BOKASHI ON PHYSICAL PROPERTIES OF VOLCANIC ASH SOILS

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EFFECTS OF STEEL SLAG AND BOKASHI ON PHYSICAL PROPERTIES OF VOLCANIC ASH SOILS

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INTRODUCTION

Volcanic ash soils have P retention that 85% or more, made the P availabity is one of the main problem of this soils. Ameliorants iSteel slag as silicate material has a high negative charge can be given to volcanic ash soils to and bokashi of husk were combined to be given to volcanic ash soils to

Volcanic ash soil can refer to any soil that was derived from tephras or other pyroclastics materials (The Third Division of Soils, 1973). Further, Soil Survey Staff (1990) classified it as Andisol if fulfills the requirements of andic soil properties: the organic carbon is less than 25%, bulk density is than 0.9 gcm^{-3} or less, phosphate retention / P-retention is 85% or more, and Al + ½ Fe with ammonium oxalate 2% or more. Among these properties, the phosphate retention that more than 85% is a serious problem. Phosphorus availablity is therefore very limited. Fertilization of P will never be effective due to the P fertilizer will immediately be retained by soil. Egawa (1977) informed that only ten percent of P fertilezer will be available for plants.

Volcanic ash soil actually is one of the most productive soil in the world, due to its high potentiality for serving nutrients from rapid weathering of pyroclastic materials. Further, it has an excellent soil physical characteristics like low bulk density range from 0.4 – 0.9 g cm^{-3} and high porosity (Bielders *et al*., 1990), high water holding capacity in soil pores which can hold hygroscopic water of 35-36%, capilary water of 21-27%, gravitional water of 36-40% (Saguisa *et al*., 1987) and high water permeability of $10^{-3}$to 10^{-4} cm sec^{-1}. This high permeability allows farmer do field work just the next day after rain. These are the natural excellent characteristics of the soils againt the erosion.

However in contrast to some distinguish chemical and physical characteristics, volcanic ash soils have high phosphate retention which considered as a factor to impoverish this soil (Nanzyo *et al.*, 1993). Meanwhile, volcanic ash soil has high human carrying capacity in serving food, fiber and forage, therefore should be preserved and resqued. Overcome the problem of P-retention to maintain its productivities properly is one of the the goal in improving the productivity of volcanic ash soil, that can be done by adding the silicate and organic matter. Steel slag and bokashi of husk can be used as silicate and organic matter in releasing the P retention in volcanic ash soils.

The main purpose of application steel slag and bokashi of husk is to maintain the soil chemical characteristics like reducing P-retention and increasing available P. Meanwhile, the soil physical characteristics like bulk density, permeability, and aggregate stability are somewhat shadowed from the effect of those applications. There was not much research considered the effect of chemical application to the soil physical characteristics. Whereas, those physical characteristics are the excellence hallmark of volcanic ash soil that must be protected due to allow the optimization of roots penetration, aerase condition and soil resistance against erosion. Application of steel slag is worried not only improve the soil chemical characteristics in one side, but aggravate the soil physical characteristics in another side Steel slag has a high bulk density (1.7 g cm^{-3}) meanwhile volcanic ash soil has a low bulk density ($\leq$ 0.9 g cm^{-3}). Applying the steel slag to volcanic ash soil is considered to tamp the soil and increase the bulk density.

This paper is to discuss the physical properties of volcanic ash soil after be treated with steel slag (as silicate) and bokashi (as organic matter).

2. Materials and methods

The soils for this research were collected from the agricultural field of Balai Penelitian Tanaman Sayuran (Balitsa) in Lembang, West Java. Maps of soil, geology, topography, land use, climate, and administrative were used for guidance in determining the location of the sample site. The experimental soil samples were acquired from several points in the research land on the depth of 0-20 cm. The soil were compositely mixed before preparing for the treatments. The physiographic field data were recorded include the geology (parent materials), climate (rainfall, temperature, humidity), drainage, land use and vegetation. Soil profile was made and soils were sampled and described in every identifiable horizons, followed National Soil Survey Center (2002). The chemical and physical analyses were done for soils from the identifiable horizons. Undisturbed soil samples taken with ring samples were used for measuring the bulk density. Soil classification were done base on the field and laboratory result followed the Keys to Soil Taxonomy (Soil Survey Staff, 2010).

The experimental research was conducted in laboratory with the relative humidity of 80% and average temperature of 26 ^{0}C. Before treatments, the soils were crushed to pass 5 mm sieve and measured its water content. Randomized designed in factorial with two factors were used in the experimental polybags. The first factor was steel slag and the second factor was bokashi of husk with four levels: 0, 2.5, 5.0 and 7.5% of soil on weight/weight (w/w) basis respectively, by considering the bulk density and water content. The treatments were repeated two times, gave a total 4x4x2 = 32 polybags. Steel slag was obtained from PT. Krakatau Steel Indonesia and have been grinded by PT. Purna Baja Heckett to pass the diameter sieve of 0.5 mm. This grinded steel slag were crushed again in the Laboratorium Teknologi Mineral dan Batubara (Tekmira) Bandung to the size of 200 mesh. Bokashi of husk were made by fermented the husk by the addition the microorganisms for 4 weeks.

The soils were mixed thoroughly with steel slag and bokashi of husk according to the treatments. The control soils without treatments was also mixed itself in order to reduce experimental errors. The mixtures of soil with defined treatments were then filled into 32 polybags (diameters of 15 cm to a depth of 20 cm), and added the water to field capacity. The polybags were tighted to protect the soil moisture. The soils were incubated for four months at by adding water with 3 days intervals to keep the soil field capacity.

The analyses were done for soil from soil profile of every identifiable horizons to have the whole soil characteristics, include pH H_2O and KCl with glass electrode (Van Reeuwijk, 1992), orcanic carbon with Walkley and Black (Van Reeuwijk, 1992), bulk density (Blake and Hartge, 1986), P-retention **(**Blakemore et al., 1987**),** aluminum and iron with acid ammonium oxalate (Blakemore et al., 1987), CEC and cations with AAS (Van Reuwijk, 1992), available P (Van Reeuwijk, 1992).

The soil analyses before and after treatments covering P-retention, available P, bulk density, perneability (Klute and Dirksen, 1986), porosity, aggregate stability (Kemper and Rosenau, 1986), field capacity and wilting point in −0.033 MPa andn−1.5MPa pressures respectively using a membrane extractor (Cassel and Nielsen, 1986).

Analysis of variance (ANOVA) was performed by SPSS Statistical Package (SPSS 13.0, SPSS Science, Chicago, IL). The Duncan'sMultiple Range Test was used for testing the mean differences.

3. Results and Discussion

Based on the maps of soil, geology, topography, land use, climate, and administrative, the study area was volcanic ash soils (Badan Perencanaan Daerah, 2008 a), developed from andesitic brownish sandy tuffs, very coarse hornblend crystals and red-weathered lahar, lapilli layers and breccia of Mt. Dano and Mt. Tangkuban Parahu (Alzwar et al, 1976), in the elevation of 8% (Badan Perencanaan Daerah, 2008 b), with agricultural land (Badan Perencanaan Daerah, 2008 c), under A climate of Smidth Fergusson, in the 107°38’57.0” S - 06°47’07.7” E, in district of Bandung Regency District, West Java Province.

Based on the laboratory analyses, volcanic ash soils in this were fulfilled the requirements of Andisols due to fulfilled all of the requirements of andic soil properties: organic carbon was less than 25%, bulk density was less than 0.9 g cm^{-3}, P-retention was more than 85%, and Al + ½ Fe with ammonium oxalate was more than 2% in depth of 0-60 cm (Table 1). Soil morphology supported the determination of volcanic ash soils from dark colour of the soil profiles, crumb structures and the existance of 2 Ab horizons as the indications lithologic discontinuity (Table 2).

....Table 1 and Table 2.....................................

Application of steel slag and bokashi of husk had the significant effect on soil chemical characteristics like pH, P-retention, and available P presented in Table 3. Steel slag and bokashi of husk increase the soil pH up to **1.2** point. This increasing is an indication that there interaction of steel slag and bokashi of husk in increasing of soil pH. Organic matter as a variable material. Exchange reaction especially in soils with variable charge like volcanic ash soils is influenced by pH. There are a variety of soil components contributing to soil acidity, and in andic soils allophanic clays, organic matters are specially important. At very low organic matter content (3 % or less) and layer silicates, acidity is primarily attributable to the dissociation of protons from he broken edges of shor-range ordered alumnosilicats. At pH greater than 6.8, the SiOH dissociate to SiO^- and H^+ (Nanzyo et al., 1993). At organic content of more than 6% allophanic volcanic ash soils acidity is largely determined by the carboxyl group and is significantly influenced by the formation of Al-humus complexes. However, although the carboxyl group of humic acid are strongly acidic, many of them are blocked by complexation with Al, therefore only small fraction of the wakly acidic carboxyl groups contribute to the acidity. Nanzyo et al (993) noted that this volcanic ash soils have pH values between 5.0 to 5.7.

The pH value of this soils after treatments as presented in Table 3 indicate that the pH become moderately to slightly acid. The influence of the treetments......(look for the reference that support the increasing of pH due to the application of silicate and organic matter. How the function of them block the positif charge to increase the OH content for increasing the pH).

Application of steel slag and bokashi of husk also have the important effect on decreasing the P-retention. During the incubation periode a certain amount of negative charge from silicate and bokashi of husk block the postive charge of the mineral allophane, imogolite and ferrryhydrite.

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