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PROGRAM DESENTRALISASI

REMEDIATION OF VOLCANIC ASH SOILS IN MANAGING AND IMPROVING THEIR SUSTAINABLE PRODUCTIVITY IN THE AGRICULTURAL AREA

The second year of the two years plan

By :

Dr. Rina Devnita, Ir., M.S., M.Sc – NIDN 0022126309
Ridha Hudaya, Ir., M.S. – NIDN 0011025402
Ir. Mega Fatimah Rosana, M.Sc., Ph.D – NIDN 0005116604

and

Professor D.Sc. Hiroharu MATSUEDA
(HOKKAIDO UNIVERSITY – JAPAN)

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Chief researcher	:	
a. Full name	:	Dr. Rina Devnita, Ir. M.S., M.Sc
b. NIDN	:	0022126309
c. Academic rank	:	IV.a
d. Study program	:	Agroteknologi
e. Mobile phone	:	081394888163
f. e-mail	:	rinabursi@yahoo.com
Member of researcher (1)	:	
a. Full name	:	Ir. Ridha Hudaya, M.S
b. NIDN	:	0011025402
c. University	:	Padjadjaran University
Member of researcher (2)	:	
a. Full name	:	Ir. Mega Fatimah Rosana, M.Sc., Ph.D
b. NIDN	:	0005116604
c. University	:	Padjadjaran University
International partner	:	
a. Full name	:	Prof. Dr. Hiroharu Matsueda
b. Name of institution	:	Hokkaido University, Japan
c. Address of institution	:	Sapporo, 060-0810 JAPAN
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Approved,
Dean the Faculty of Agriculture

Prof. Dr. Benny Joy, Ir., M.S
NIP. 195207071985031002

Chief researcher

Dr. Rina Devnita, Ir., M.S., M.Sc
NIP. 196312221989012001

Approved,
Head of Research Institution

Prof. Dr. Wawan Hermawan, Ir., M.S
NIP. 196205271988011001

ABSTRACT

Volcanic ash soils considered as a fertile soils with variable charge which tend to impoverish due to be managed not as their natural behaviour. Remediation this soils with high negative charge materials like silicate and organic mattter aims block the positive charge, realease the P-retention, and increase their negative charge in managing them as their natural characteristics. The objectives of this research were to the influence of explore the slag steel (silicate) and bokashi of husk (organic matter) to some soils characteristics and their respons to corn, red chilly and broccoli. The treatments were arranged in Randomized Block Designed in factorial pattern, consisted of two factors. The first factor was steel slag, and the second factor was the bokashi of husk, consisted of four level : 0, 2.5, 5.0 and 7.5 % of soil weight percentage respectively, and be repeated twice, brought a combination of 4 x 4 x 2 treatments, and were incubated for four months. Three series of treatments were arranged for corn, red chilly and broccoli, made the whole treatments of 4 x 4 x 2 x 3. The soils in every treatments were analysed after incubation and after vegetative periodes. The result informed that the treatments interacted significantly in influencing the soil physical and chemical characteristics. The treatments also interacted significantly in the yields of corn, red chilly and broccoli. The treatments decreased the P retention and increased the P availability, pH, CEC, increased the stability aggregate, permeability, and water availability, and decreased the bulk desity. The best combination in increasing and decreasing the parameters were differerents, therefore further research is needed to fix the best combination to have the best result.

Key words: volcanic ash soils, steel slag, bokashi of husk, soil chemical characteristics, soil physical characteristics, corn, red chilly, broccoli

PREFACE

Research concerning the remediation of volcanic ash soils with steel slag and bokashi of husk and its nfluence to the soil characteristics and crop production has been done for two years. In the first years, the research was done in the Laboratory of Soil Physic, Faculty of Agriculture, Padjadjaran University for incubating the soils with steel slag and bokashi of husk in varying combination dosages for four months. The change of soil characteristics after incubation was analysed like pH, Δ pH. P retention, available P, CEC, bulk density and permeability. Soil analyses were done in the Laboratory of Soil Physic and Laboratory of Soil Chemisty of Faculty of Agriculture Padjadjaran University. The soil clay mineralogical characteristics were analysed in the Laboratory of Geology, Hokkaido University, Japan to have the soil mineralogy characteristics. Some soil chemical characteristics have improved, like decreasing of P retention and increasing of available P.

In the second year, the research was done in the field of Balai Penelitian Sayuran (Balitsa) Lembang, West Java. The soils were again incubated with steel slag and bokashi of husk with the same combination as in the laboratory in the first year, and then planted with corn, red chilly, and brocoly. The soil chemical and physical characteristics were analysed after incubation and after harvesting. The crop were weighed of dry weight of shoot and root.

Several students have been involved in this research. During the first year there were four students from Strata-1 namely: Ovin Syaiful M (150110080001), Esfen Girsang (150110080171), Andrino Alif D (150110080008), and Ichsan Damar R (150110080087). During the second year there were two sudents from Strata-2 namely Henly Yulina (150220120004) and Rimma Rakhmalia (150220120006); and eight students from Stata-1 namely Sekar Winang Sariti (150510090243), Agustin Betty Arumaswati (150510090152), Indra Maulana (Sutrisno 150510090139), Agung Abdurrahman Syah (150510090057), Yudhi Fermana Putra (150510090083), Akbar Saeful R (150510090060), Joevi Secondio K (150510090171), Andre Putra Perdana (150510090136).

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Finally the authors wish this report are useful to enrich the information of the development of agricultural science, especially the soil science.

Bandung, November 2013
Authors

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CHAPTER I.
INTRODUCTION

Volcanic ash soils are dominated by short-range-order minerals such as allophane, imogolite, metal-humus complexes and ferrihydrite. These minerals contribute to active Al and Fe, and give a significant effect on physical and chemical properties to the soils (Shoji et al, 1993). These minerals are also the genuine of variable charge, make the soil colloids largely depend on the pH and the electrolyte concentration on soil solution (Van Wambeke, 1992). Volcanic ash soils exhibit high point of zero charge and low nutrient holding capacity (Nanzyo et al, 1993). High rainfall and rolling topography in mountainous region also make the cations are easily leached out and soil fertility deteriorate faster.

Allophane is the most active component in volcanic ash soils, and it strongly retains phosphate (Van Ranst, 1995). The available P, applied as fertilizer is quickly decreased and only 10% could be utilized by crops (Egawa, 1977). This constraint can be alleviated by blocking the positive charge of allophane by adding the high negative charge materials. The high negative charge materials are functioned as inorganic or organic remediation. Silicate, phosphate, and organic matter with high negative charge can be used for blocking the positive charge of volcanic ash soils (Qafoku et al, 2004). Slag steel as silicate material and bokashi of husk as organic matter are the potential remediation materials.

The objectives of blocking the positive charge are for releasing the P-retention, and increasing the negative charge by decreasing the pHo or increasing the pH. Devnita (2010a) found that the addition of silicate, phosphate and organic matter can reduce the P retention from 99% to less than 90%. The reductions of pHo were also found in 0.4-0.8 point. Fiantis (2000) found that the addition of Ca-silicate from 2.5, 5.0, and 7.5% weight of soil in pot can reduce the pHo from 4,0 to 3.0. Boniao

(2000) found that the remediation with peat reduce the pHo up to 0.3 point, meanwhile remediation with Ca-silicate reduce the pHo to 0.5 point.

The reducing of pHo will increase the negative charge of the soils, for the P-retention can be reduced and available P can be increased. Devnita (2010b) found that the reducing of pHo increased the available P. Boniao (2000) found the the reducing oh pHo increased the height and biomass of corn.

CHAPTER II
LITERATURE REVIEW

Volcanic ash soils are distributed exclusively in regions where active and recently extinct volcanoes are located. The soils cover only 0.84 % of the world's land surface, but they represent a crucial land resource due to their productivity support the need of food, fiber and forage. This soils support 10 % of the world's population, including some of the highest human population densities attributed to their natural fertility. However, this is true only in part. This account addresses to the specific feature and genesis of the volcanic soil, and how they are abused in various global environmental settings.

The soils developed from volcanic ash are characterized by the accumulation of humus, fixation of phosphate, leaching of bases and formation of aggregates with micropores, which closely related to the nature and properties of the clay-size minerals, particularly the noncrystalline minerals like allophane, imogolite, ferryhydrite and metal-humus complexes. They either reflect the presence of volcanic ejecta such as ash, pumice cinders or lava in the soil, or they indicate the properties of amorphous clays that characterize volcanic ashes that weather rapidly in humid or perhumid climates.

The absence of well-defined crystallize minerals in the clay fraction typifies as a genuine variable charge soils, which the charge of soils colloids are largely dependent on the pH and the electrolyte concentration of the soil solution. The charges in volcanic ash soils are contributed by active Al, Si and Fe. Volcanic ash soils exhibit high point of zero charge and low nutrient holding capacity. The development of negative and positive charges on allophane and imogolite is influenced by pH, the nature and concentration of cations and anions in solutions and temperature. Consequently, they will have high pHo and low cation exchange capacity (CEC), resulting in a limited ability to retain cations and worst excessive losses of cations at certain soil pH.

Allophane is considered as the most active components in the volcanic ash soils. Since allophane has hollow structure and positive charge sites, it strongly retains phosphate and organic matter. The availability of soluble phosphorus applied as fertilizer to plants is quickly decreased and only 10 % of the applied phosphorus is utilized by most crops. Phosphorus deficiency is the most important agronomic problem in volcanic ash soils. This constraint can be relieved by blocking the positive charge and hollow site of the allophane. Theoritically, these losses of cations can be prevented according to the literature (Van Ranst, 1995, Qofaku et al, 2004) by developing negative surface charges and thus creating additional cation exchange capacity. This can be achieved either by raising the pH, increasing the electrolyte concentration in the soil solution, or lowering the pHo. Adding materials that mask or block the effect of positive adsorption sites does this. Among the most recommended materials in the literatures are silicate, phosphate and organic matter. Thus, this study was initiated taking into consideration these recommendations trough slag steel and bokashi of husk.

The surface charge also depends on the electrolyte concentration (η), the dielectric constant (ε), and the counterion valenze (z), The relationship between surface charge density (σ_0) and these parameters has been expressed mathematically by Gouy-Chapman and later by Nernst. Wann and Uehara (1978) combined these two equations as follow:

$$\sigma_0 = (2\,\eta\,\varepsilon\,K\,T / \pi)^{1/2} \sinh 1.15\, z\, (pH_0 - pH)$$

where pHo is the pH at which the net charge of the potential determining ions is zero. K is the Boltzman constant and T is the absolute temperature. The relationship shows that the surface charge density can be changed by varying several parameters such as η, ε, z or (pHo – pH), but it is the electrolyte concentration (η) and the difference between actual soil pH and pHo (pHo-pH) that can be practically manipulated in the field. The η value can be changed by applying fertilizer. The increasing of electrolyte concentration causes an increasing in surface charge. The (pHo-pH) can be made more negative by increasing the soil pH or by decreasing the pHo. Soil pH can be increasing by liming (Gilman, 1980). The pHo value can be reduced by introduction of high valency anions such as silicate, phosphate and organic matter, which will strongly bond to mineral surface (Hingston, 1972). It is therefore, reasonable to assume that applications of silicate material and organic matter to volcanic ash soil would have combined effect of raising pH and at the same time lowering the pHo.

Phosphate sorption capacity in volcanic ash is related to large specific areas of soil components. Although total amounts of native phosphorus are quite hugh in volcanic ash soils, their available forms are quite low. Phosphorus added as fertilizer is immediately sorbed onto metal oxide surfaces, rendering it less available to plants (Qafoku et al, 2004a). The affinity of the short range order minerals for phosphates is very strong because of the density of active aluminum on the colloidal fraction. The possibility of decreasing pHo and P fixation, and at the same time increasing the cation exchange capacity of volcanic ash soils are important factors to obtain optimal agricultural production (Qafku et al., 2004b).

The cation exchange capacity of the top soil is almost entirely attributable to organic matter. Thus the loss of organic matter trough oxidation when the soils are cultivated, or through erosion not only reduce the phosphorus availability but also its ability to retain cations in a ready available form.

CHAPTER III
PURPOSES AND BENEFITS OF THE RESEARCH

The information on the characteristics of volcanic ash soils, their main constraints on crop production, and the rational management for optimizing and increasing their productivity is practically the basic need to maintain their sustainable productivity. As one of most productive soils which serve food, fiber and forage, volcanic ash soils have always to be maintained properly. The lack of knowledge on soil characteristics, culminate in exploitation of this soils without gaining more additional yield. Giving an excessive fertilizer, especially phosphorus, will only result in frustration because instead of gaining the increasing yield, the production tends to leveling off. Therefore, understanding the characteristics of this soil is an important aspect to plan the rational management.

Blocking the positive charge is the idea in managing this soil. Giving the remediation with high negative charge anion, will firstly fulfill and cover all positive charge site and secondly built the negative charge site. Remediation material like silicate and organic matter is the ideal material due to their ability to contribute the negative charge in the soil.

Create the negative charge in this variable charge soils has some advantages in improving soil characteristics. Being a negative charge soil, the P-retention will be reduced in the significant amount. The cation exchange capacity will also increase, make the soil have more capability to retain nutrient like Ca, Mg, K and other cations. Losing of these cations to the subsurface horizon due to leaching therefore can be diminished. Increasing the availability of P, Ca, K, Mg and other micro elements will in turn improve the productivity of the soils.

CHAPTER IV
RESEARCH METHODOLOGY

First Year :

Environmental setting, sampling, and remediation and incubation

The volcanic ash soils for this research located in the agricultural area in Lembang, along the southern slope of Mt. Tangkuban Parahu. This is an area of volcanic ash soils (Arifin, 1994; Devnita et al, 2010a) developed from an andesit parent material from the Holocene age and is is made up of volcanic deposit of tuff, hornblende crystal, reddish weathered lahar, and layer of breccias and lapilli of Mt Dano and Mt. Tangkuba Parahu symbolized with Qyd (Silitonga, 2003). The soils has udic soil moisture regime, that never dry 90 days cumulatively every years. The rainfall is about 2637-5369 mm/year and has an isohyperthermic soil temperature regime, with the average of temperature between 18-22 ^{0}C and the difference between the highest and lowest temperatures are not more than 6 ^{0}C.

The area previously had been investigated for their physiographic and environmental setting. Soil profiles were made for having soil morphology data and for taking soil samples. Soil samples were taken from profiles, which been dug along the slope on lower, middle and upper slope respectively. Profile description followed the guidelines proposed by National Soil Survey Centre (2002), and the horizon designation followed the symbols given in Soil Taxonomy (Soil Survey Staff, 2010). From each profiles, the bulk samples for routine physic-chemical analyses were done. The undisturbed soil samples for bulk density were also taken.

The soil in every horizon be analyzed for pH, organic carbon, CEC, Alo and Feo, bulk density and P-retention. The pH be determined in deionized water (H_2O) and 1 M potassium chloride (KCl) in 1:2.5 solid/liquid ratio; the equation of Δ pH (pH KCl – pH H_2O) were used to characterize charge. The pH of NaF (sodium chloride) 1 M were determined in a suspension of 1 g soil in 50 mL NaF soutio after 1, 2, and 24 hour. The organic carbon be determined by Walkley and Black procedure. The CEC be determined with 1 M ammonium acetate at pH 7. The leachate be used to determine the exchangeable bases and be measured by using atomic absorption spectrophotometry (AAS) The adsorbed ammonium ion (NH_4^+) be displaced with acidified 1 M KCl and the NH_4^+ ions in the leachate be then measured to determine the CEC. The Alo and Feo be determined with some steps. An extraction of 0.1 M sodium pyrophosphate solution (1:100) be mixed during one night to estimate the aluminum (Alp) and iron (Fep). Oxalate-extractable Alo, Feo, and silicon (Sio) be determined by extraction with 0.2 M ammonium oxalate for 4 h at pH 3 (Van Reeuwijk, 1992). Mineralogical analyses of sand and silt fractions be conducted by using polarizing microscope. The sand and silt particles be mounted with Canada balsam on a glass slide and cover with a cover glass. The minerals were mounted according to the line method. The mineralogical analyses of clay and also silt fractions were conducted by using X-ray diffractometer of Philips X'pert System, Philips Analytical Inc., operating at at 40 kV using nickel (Ni) filtered copper (Cu)-Kα radiation, scanned from 3 to 45^o 2Θ at 1^o/min. range.

Soils on the surface horizon be taken compositely for using in the plastic bag experiment. This experiments were done for investigating the influence of slag steel and bokashi of husk as the remediation material in volcanic ash soils. A 4 x 4 factorial experiment in a completely randomized block designed in double replication were set up. The experiment consist of 4 levels of slag steel (t_0, t_1 , t_2, and t_3), and 4 levels of bokashi of husk (b_0, b_1, $b2_0$, and b_3). The rates for slag steel and bokashi of husk are 0, 5, 10 and 15% of weight of soil respectively. The complete treatments are presented in Table 1.

Tabel 1. The combination treatments of slag steel and bokashi of husk

Slag Steel	**Bokashi of Husk**			
	b_0	**b_1**	**b_2**	**b_3**
t_0	s_0b_0	s_0b_1	s_0b_2	s_0b_3
t_1	s_1b_0	s_1b_1	s_1b_2	s_1b_3
t_2	s_2b_0	s_2b_1	s_2b_2	s_2b_3
t_3	s_3b_0	s_3b_1	s_3b_2	s_3b_3

T = slag steel B = bokashi of husk

0 = without slag steel or bokashi of husk

1 = 2.5 % (weight of soils) slag steel or bokashi of husk

2 = 5.0 % (weight of soils) slag steel or bokashi of husk

3 = 7.5 % (weight of soils) slag steel or bokashi of husk

The slag steel and bokashi of husk were mixed with 200 g of volcanic ash soils in pot, and watered until reach the field capacity. The well mixed moist sample were stored on a sealed plastic bag to prevent drying out. Prior to incubation, the soils were analyzed for pH, pHo, CEC, P retention, available P and basic cation. After 4 months of incubation, some samples were taken and retained to determined soil pH, pHo, CEC, P-retention and available P.

The data were analysed with analyses of variance with SAS software. Duncan's multiple range test was used for mean separation when anova is significant ($P \leq 0.005$).

The laboratory analyses wre done in the Laboratory of Soil Science, Faculty of Agriculture, and Laboratory of Geology-Padjadjaran University. Mineralogy analyses of sand, silt and clay fraction were done in the Laboratory of Hokkaido University Museum, Japan.

The Second Year : (*THIS IS THE SECOND YEAR ONE*)

Experimental Design and Analyses

During the first year, the same treatments were done in another three series. The treatments are prepared for the following second year research related to the response of corn, broccoli and red chilly after incubation with remediation materials. The treatments were arranged in Randomized Block Designed in factorial pattern, consisted of two factors. The first factor is slag steel, and the second factor is bokashi of husk, consist of four level : 0, 2.5, 5.0 and 7.5 % of soil weight percentage respectively. The treatments are repeated twice, bring about a combination of 4 x 4 x

2 treatments. Three series of plastic bags with the treatments were arranged for corn, broccoli and red chilly, make the whole treatments series of 4 x 4 x 2 x 3. The soils with each remediated treatments materials were mixed thoroughly, keep in the plastic bags, and watered until the field capacity. They were incubated paralelly for four months. During the incubation periode, the plastic bags were closed tightly to prodect them from evaporting. Once the incubation periode ending, the media starts to be planted with corn, broccoli and red chilly. The parameters were the growth factors, total biomass and the production

The treatments and dosages are the same, but the soils used are 10 kg/pot. The duration of incubation is completely the same. During the incubation the plastic bags will also be close tightly and placed in dark room to prevent the evaporation. After incubation period, the plastic bags were placed in the field and be planted with corn, broccoli and red chilly. The fertilizers were applied as the recommendation dosage. The plants were kept until vegetative phase. Plant height, biomass, dry weight, and P absorption are among the parameters collected after the vegetative period. The data were analysed with analyses of variance (anova) with SAS software. Duncan's multiple range test was used for mean separation when anova is significant ($P \leq 0.005$).

The laboratory analyses were done in the Laboratory of Soil Science, Faculty of Agriculture, and Laboratory of Geology - Padjadjaran University. The analyses like analyses of elements in slag steel, phosphorus absorption by plant, were done in the Laboratory of Hokkaido University Museum, Japan.

CHAPTER V
Result

Soil Chemistry

P-retention

Bokashi of Husk	Steel Slag			
	0%	2,5%	5%	7,5%
	P retention (%)			
0%	90.96 (b) C	86.08 (ab) B	83.60 (a) A	85.10 (b) AB
2,5%	92.16 (b) C	86.85 (b) B	84.29 (ab) A	86.10 (b) B
5%	86.83 (a) B	85.19 (a) AB	85.99 (bc) B	84.05 (ab) A
7,5%	95.40 (c) D	92.16 (c) C	87.36 (c) B	83.09 (a) A

Note : Numerals followed by the same letter are not significantly different at 5% level test of DNMRT. Letters in parentheses are read vertically and letters without brackets are read horizontally.

P-available

Bokashi of Husk	Steel slag			
	0%	2,5%	5%	7,5%
	P available (ppm)			
0%	10.02 (a) A	57.87 (b) B	55.76 (a) B	56.21 (a) B
2,5%	34.24 (b) A	43.21 (a) B	65.51 (b) C	70.01 (c) C
5%	48.95 (d) A	57.34 (b) B	60.53 (ab) B	61.43 (ab) B
7,5%	41.34 (c) A	54.34 (b) B	58.18 (a) B	65.24 (bc) C

Note : Numerals followed by the same letter are not significantly different at 5% level test of DNMRT. Letters in parentheses are read vertically and letters without brackets are read horizontally.

Exchangeable H

Bokashi of Husk	Steel Slag			
	0%	2,5%	5%	7,5%
	Exchangeable H (Cmol kg^{-1})			
0%	2,82 (b) A	2,77 (b) A	3,72 (b) A	2,94 (ab) A
2,5%	4,86 (c) C	3,77 (b) B	2,61 (a) A	2,68 (a) A
5%	1,52 (a) A	1,69 (a) A	3,89 (b) B	3,72 (b) B
7,5%	3,44 (b) A	5,14 (c) B	3,49 (ab) A	4,80 (c) B

Note : Numerals followed by the same letter are not significantly different at 5% level test of DNMRT. Letters in parentheses are read vertically and letters without brackets are read horizontally.

Total Porosity

Aggregate Stability
(red chilly)

Steel Slag	Bokashi of husk			
	0%	2,5%	5%	7,5%
0%	7 (b) A	3 (a) A	2,5 (a) A	2 (a) A
2,5%	7 (b) A	3 (a) A	4 (b) B	2 (a) A
5%	7 (b) A	4,5 (b) b	2 (a) A	2 (a) A
7,5%	6,5 (b) A	5 (b) B	2 (a) A	2 (a) A

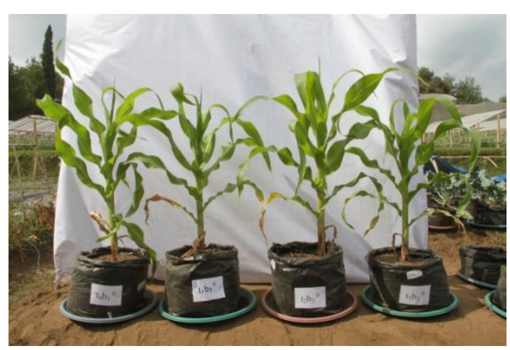
Note : Numerals followed by the same letter are not significantly different at 5% level test of DNMRT. Letters in parentheses are read vertically and letters without brackets are read horizontally

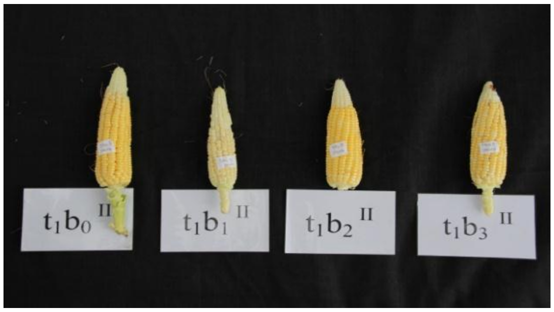
Soil Physic
Aggregate Stability(corn)

Steel slag	Bokashi of Husk			
	0%	2,5%	5%	7,5%
0%	2 (a) A	4 (b) B	2 (a) A	2 (a) A
2,5%	3,5 (a) A	2 (a) A	2 (a) A	2 (a) A
5%	3,5 (a) B	2 (a) A	2,5 (a) A	4 (b) B
7,5%	3 (a) A	3 (a) A	3 (a) A	2 (a) A

Note : Numerals followed by the same letter are not significantly different at 5% level test of DNMRT. Letters in parentheses are read vertically and letters without brackets are read horizontally

Crop Production
Corn

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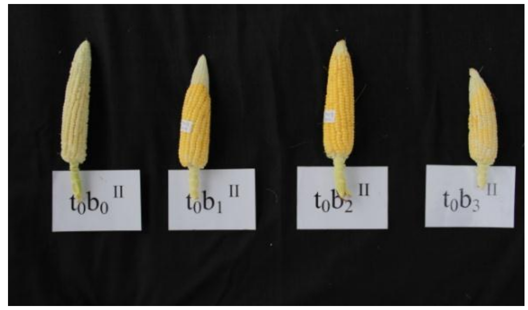
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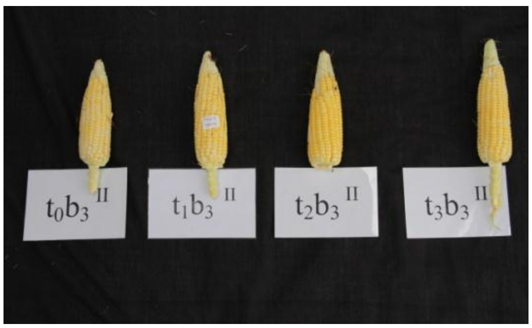
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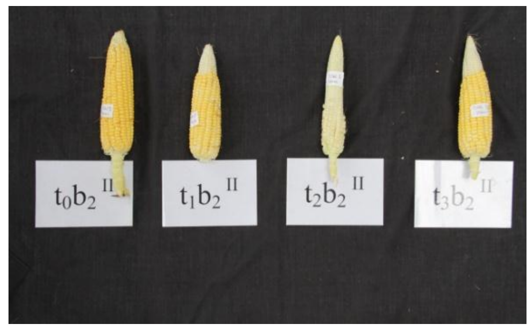
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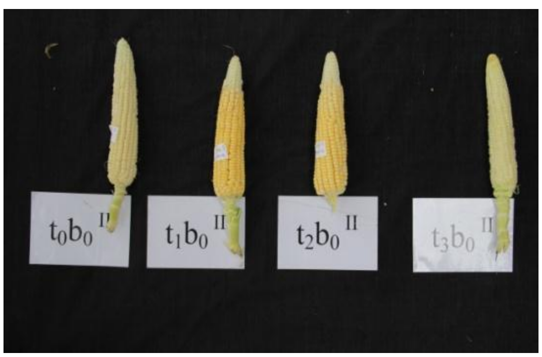
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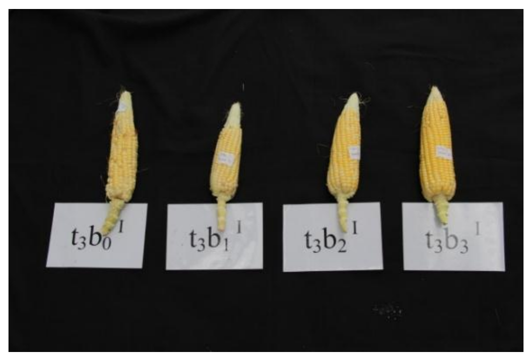
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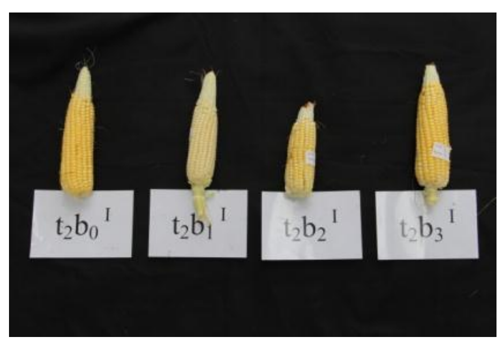
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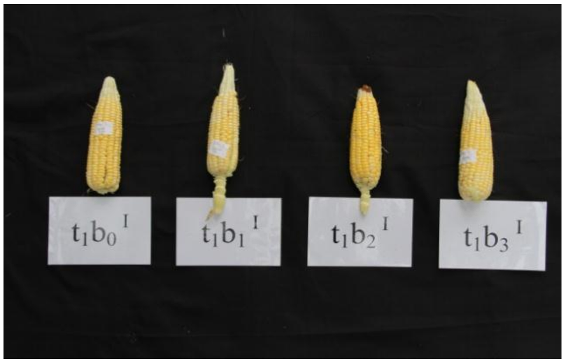
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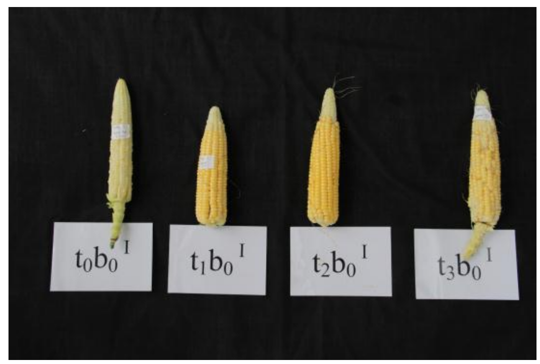
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t_3b_0 I

t2b0 I
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t2b2 I
t2b3 I

t0b0 I
t0b1 I
t0b2 I
t0b3 I

t0b0 I
t1b0 I
t2b0 I
t3b0 I

t3b0 II
t3b1 II
t3b2 II
t3b3 II

Red Chilly


t_1b_2 I
t_1b_3 I


t_2b_2 I
t_2b_3 I


t_3b_0 I
t_3b_1 I
t_3b_2 I
t_3b_3 I


t_3b_0 II
t_3b_1 II
t_3b_2 II
t_3b_3 II


t_0b_3 I
t_1b_3 I
t_2b_3 I
t_3b_3 I


t_0b_3 II
t_1b_3 II
t_2b_3 II
t_3b_3 II

Broccoli

$t_0b_0^{1}$
$t_0b_1^{1}$
$t_0b_2^{1}$
$t_0b_3^{1}$

$t_1b_0^{1}$
$t_1b_1^{1}$
$t_1b_2^{1}$
$t_1b_3^{1}$

$t_2b_0^{1}$
$t_2b_1^{1}$
$t_2b_2^{1}$
$t_2b_3^{1}$


t_3b_0 I
t_3b_1 I
t_3b_2 I
t_3b_3 I


t_0b_0 II
t_0b_1 II


t_2b_0 II
t_2b_1 II
t_2b_2 II
t_3b_2 II


t_3b_2 II
t_2b_2 II
t_2b_1 II
t_2b_0 II

VII. CONCLUSSION

The result informed that the treatments interacted significantly in influencing the soil physical and chemical characteristics. The treatments also interacted significantly in the yields of corn, red chilly and broccoli. The treatments decreased the P retention and increased the P availability, pH, CEC, increased the stability aggregate, permeability, and water availability, and decreased the bulk desity. The best combination in increasing and decreasing the parameters were differerents, therefore further research is needed to fix the best combination to have the best result.

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APPENDIX

Personalia of the Team

Principal Investigator

Full Name	:	**Dr. Rina Devnita, Ir., M.S., M.Sc**
NIP / NIDN	:	196312221989032001/ 0022126309
Place & Date of Birth	:	Padang, December 22, 1963
Gender	:	Female
Field	:	Soil Science
Affiliation	:	Faculty of Agriculture, Padjadjaran University
Office Address	:	Jl. Raya Bandung Sumedang, km 21 Jatinangor, City : Bandung, Post Code: 40600 Telp/Fax : 022-7796316 Email : dekanfaperta@unpad.ac.id
Home Address	:	Komp. Ujung Berung Indah Blok 14/15 City : Bandung, Post code 40611 Telp/Fax : 022-7805430 Email : rinabursi@yahoo.com
Mobile phone	:	081394888163

Education

No	University	City and State	Year	Field of Study
1	Andalas University	Padang, Indonesia	1987	Agriculture
2	Bogor Institute of Agricullture	Bogor, Indonesia	1991	Soil Science
3	Ghent University	Ghent, Belgium	1993	Soil Science
4	Padjadjaran University	Bandung, Indonesia	2010	Soil Science

Research Experience

No	Title of Research	Year
1.	Chemical and Mineralogical Characteristics of Andisols in West Java	2008
2.	Amelioration of some Andisols in West Java	2009
3.	Global Warming and Its effect to Characteristics and Productivities of Volcanic Soils in West Java	2010

Publications:

Devnita, R. 2010. Genesis and Karakteristik Tanah Abu Gunung Api. Unpad Press, 154 hal

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Member of the Research

Full Name	: **Ridha Hudaya, Ir., M.S**
NIP	: 19540211 198601 1 001
Place & Date of Birth	: Bandung, 2 February, 1954
Gender	: Male
Field	: Soil Science
Affiliation	: Faculty of Agriculture, Padjadjaran University
Office Address	: Jl. Raya Bandung Sumedang, km 21 Jatinangor, Sumedang, Jawa Barat
Phone./Fax.	: 022-7796316 / 022-7796316
Home Address	: Jl Giri Yudha no 11 Simpay Asih – Bandung 40611
Telp./Faks.	: 022-7801047
Mobile Phone	: 085721099200
e-mail	: ridhud11@gmail.com

Education

No	**University**	**City and State**	**Year**	**Field of Study**
1	Padjadjaran University	Bandung, Indonesia	1982	Agriculture
2	Padjadjaran University	Bandung, Indonesia	1999	Soil Science

Research Experience

No	Title of Research	Year
1.	Sellective Dissolution and Infra Red Method for Analyzing Short Range Order Minerals	2005
2.	Characteristics of Ap Horizon on Margins Land in Pasirwangi, Garut	2008
3.	Global Warming and Its effect to Characteristics and Productivities of Volcanic Soils in West Java	2010

Member of the Research

Full Name	:	**Ir., Mega Fatimah Rosana, M.Sc., Ph.D.**
NIP	:	19661105 199203 2 003
Place & Date of Birth	:	Tasikmalaya, 5 November 1966
Gender	:	Female
Field	:	Resource Geology
Affiliation	:	Faculty of Geology, University of Padjadjaran
Office Address	:	Jl. Raya Bandung Sumedang, km 21 Jatinangor, Sumedang, Jawa Barat
Phone./Fax.	:	62-22-7796545 / 62-22-7796545
Home Address	:	Jl. Karasak Baru No. 26 Moch Toha, Bandung 40243
Telp./Faks.	:	62-22-5202052
Mobile Phone	:	62-8172324211
e-mail	:	rosanamf@yahoo.com , mega_fr@unpad.ac.id

Education

Graduated	**Program**	**University**	**Field of Study**
2004	Doctor	Hokkaido University, Japan	Resource Geology
1997	Master	ITC, Netherlands	Mineral Exploration
1991	Undergraduate	University of Padjadjaran, Bandung	Geology

Research Experience

No	Title of Research	Year
1.	The Occurrences and characteristics of VMS/Kuroko type deposit in Sangkaropi and Kajong, Indonesia	2011
2.	Geochemistry Mapping of Jawa Island block Banten & West Java	2011
3.	Pembuatan Atlas Mineralogi Butir Indonesia	2011
4.	Characteristics of morphotectonic in relationship with the quantity of energy alternative in potensial natural hazard area	2010

ARTIKEL ILMIAH

EFFECTS OF STEEL SLAG AND BOKASHI ON PHYSICAL PROPERTIES OF VOLCANIC ASH SOIL AGAINTS EROSION

Rina Devnita*
Ridha Hudaya
Mega F Rosana

Department of Soil Science, Faculty of Agriculture, Padjadjaran University
Jl. Raya Bandung-Sumedang km 21, Bandung 40600
Email: devnitarina@unpad.ac.id, rinabursi@yahoo.com

INTRODUCTION

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, Andisols 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 (≤ 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 Andisols (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 Andisols from dark colour of the soil profiles, crumb structures and the existance of 2 Ab horizons as the indications lithologic discontinuity

Table 1. Investigation of Andisols through andic soil properties to volvanic ash soils in the site.

Profile	Horizon	Depth (cm)	Org.Carbon (%)	Alo + ½ Feo	Bulk Density (g cm^{-3})	P-retention (%)
Balitsa 1	Ap 1	0-14	8.42	5.3	0.58	99.20
	Ap 2	14 -22	4.71	3.4	0.61	99.70
	Ap 3	22 - 48	4.25	3.5	0.71	99.80
	BC	48 - 58	4.84	3.4	0.69	99.10
	2 Ab 1	58 - 87	9.28	3.5	0.63	99.60
	2 Ab 2	87 -110	9.45	3.9	0.69	99.50
	2 BA	110 -119	5.65	5.4	0.68	99.20
	2 Bw 1	119 -144	3.58	6.7	0.88	99.90
	2 Bw 2	144 - 162	2.62	5.8	0.71	99.80
	2 BC	162 - 200	1.62	5.7	0.76	99.50
Balitsa 2	Ap 1	0 - 14	8.97	2.3	0.78	97.38
	Ap 2	14 - 30	8.95	2.6	0.70	95.81
	Ap 3	30 - 45	8.19	4.5	0.69	95.75
	BA	45 - 62	5.62	3.9	0.87	95.71
	Bw 1	62 - 77	3.24	4.0	0.70	96.08
	Bw 2	77 - 90	6.94	4.7	0.67	96.08
	BC	90 - 105	6.49	5.3	0.74	95.85
	2 Ab 1	105 - 115	7.76	4.5	0.66	95.74
	2 Ab 2	115 - 147	8.97	4.2	0.61	95.66
	2 Ab 3	147 - 183	8.97	4.3	0.74	95.36
	2 Bwb	183 - 200	5.62	4.7	0.66	95.65

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 0,7 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 Andisols 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 Andisols have pH values between 5.0 to 5.7. The P retention of this soils after treatments as presented in Table 2 indicate that the treatments decreased the P retention.

Table 2. Influence of steel salg and bokashi of husk to te P-retention

Bokashi of Husk	Steel Slag			
	0%	2,5%	5%	7,5%
	P retention (%)			
0%	90.96 (b) C	86.08 (ab) B	83.60 (a) A	85.10 (b) AB
2,5%	92.16 (b) C	86.85 (b) B	84.29 (ab) A	86.10 (b) B
5%	86.83 (a) B	85.19 (a) AB	85.99 (bc) B	84.05 (ab) A
7,5%	95.40 (c) D	92.16 (c) C	87.36 (c) B	83.09 (a) A

Note : Numerals followed by the same letter are not significantly different at 5% level test of DNMRT. Letters in parentheses are read vertically and letters without brackets are read horizontally

Steel slag and bokashi of husk have improved soil chemical characteristic through the reduction of P reention. However, against the erosion the soil phisca characteristics are the main important. Aggregate stability is one of the parameters informed the strength of the soils in protecting them from the influence of rain. Table 3 indicate the interaction of steel slag and bokashi of husk to the aggregate stability.

Steel slag	Bokashi of Husk			
	0%	2,5%	5%	7,5%
0%	2 (a) A	4 (b) B	2 (a) A	2 (a) A
2,5%	3,5 (a) A	2 (a) A	2 (a) A	2 (a) A
5%	3,5 (a) B	2 (a) A	2,5 (a) A	4 (b) B
7,5%	3 (a) A	3 (a) A	3 (a) A	2 (a) A

Note : Numerals followed by the same letter are not significantly different at 5% level test of DNMRT. Letters in parentheses are read vertically and letters without brackets are read horizontally

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