Application of geo-organo granule fertilizer derived from volcanic ash and tithonia on corn production at oxisols

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Abstract. Volcanic ash material (Vam) can cover the surface of the farming land post volcano eruption. The covering process could be advantageous for soil fertility if it is thin enough, but it can be destructive for the crops if it is thick. The purpose of this research was to study the effect of the application of Geo-organo granules from volcanic ash and Tithonia (Tt) for the production of Baby Corn in Oxisol. The pot experiments design with six treatments (1AV:1Tt; 1AV:2Tt; 1AV:3Tt; 1AV:4Tt; 1AV:0Tt; 0AV:1Tt) three replications, and used Completely Randomized Design (CRD). The criteria test of compost standard used to test the benefit of these Geo-organo materials (PT Pusri, SNI, and Regulation from Agriculture Ministry, Republic of Indonesia). Corn growth was also measured for height and yield. Plant height and yield were analyzed using F-test and continued using HSD at a 5% level of significance. The results showed that Geo-organo granules be to improve soil chemical properties of Oxisol, and mass of cob of Baby corn.

1. Introduction
The material of volcanic ash which is highly produced during volcano eruption can damage agricultural land in a short time, however, it can benefit for environment hundreds of years later. Therefore, it is needed fundamental study on how the ash material could be utilized and the agricultural land impacted can be rehabilitated and produce some foods again. The volcanic ash needs a very long time to decompose because it contains primary minerals that can’t provide nutrients yet for plant growth. Based on Fiantis [1], volcanic ash materials will have a positive impact on the surface land covered during the eruption. The soil on the land will be fertile because the volcanic ash materials deriving from parent rock will be weathered into parent materials and then into soil releasing nutrients for plant growth.

On the other hand, Suriadikarta [2] stated that the negative impact of volcanic ash was the covered land could be cemented; therefore, it will bother plant growth if it is not soon reclaimed. The negative impact could be reduced by organic matter (OM) application. Fiantis et al [3] and Fiantis et al [4] explained that volcanic ash materials deposited on soil surface can be chemically decomposed by the aid of water and organic acids either contained in the soil or due to OM application. Naturally, the
weathering process takes a very long time. Anda and Wahdini [5] stated that volcanic ash contains some
minerals contributing macronutrients, especially Ca, Na, K, Mg, P, S, and micronutrients such as Fe, Mn,
Cu, Zn.

Dahlgren dan Ugolini [6] found that VA covered on top soil of Spodosol could contribute nutrients,
especially basic cations (K, Na, Ca, Mg) for 50% of the initial soil cations after 10 years. Based on
Wahyuni et al [7], Va materials contained 56% Al, 18% Si, 4% Ca. Tindaon and Tamputbolon [9]
reported that VAM contained 0.32% available Fe, 176.58 ppm S, 62.09 ppm Mn, 0.23 cmol/kg K, 10.76
cmol/kg Ca, 0.41 cmol/kg Na, 0.25 cmol/kg Mg, with pH 3.5-4.8. They also suggested that fertility
improvement of VA impacted land can be accelerated by applying compost and synthetic fertilizers.

Based on the above problem, it needs some efforts to increase the VAM weathering rate in order to
be utilized for rehabilitation of VAM impacted agricultural land. One of it suggested by Gusnidar et al
[9] was by composting the VAM mixed with titonia. They reported that organic acids contained in the
Tithonia could help in dissolving nutrients within VAM. Then, compost derived from VAM and
tithonia (Geo-organo) was granulated to avoid air pollution during the application.

The compost was utilized as ameliorant on Oxisol planted with baby corn. According to
Hardjowigeno [10] that Oxisol is an old soil having been exposed to weathering for a long time;
therefore, it contains high Fe oxides. This soil order can be found in wet tropical climate. This soil
contributes approximately 7.5% of the earth's surface area (9.8 million km²). This old soil was
potential for agricultural land if it is well managed. The physical properties of the soil is good, but it
has low chemical fertility. Therefore, it is needed technology to rehab the land to produce enough food
in future.

2. Materials and Methods

Volcanic ash material and Tt were composted using four different Vam:Tt compositions: A=1:1;
B=1:2; C=1:3; D=1:4; E=1:0; F=0:1. Compost resulted was granulated, and then analysed the water
content, the chemical properties especially Ctot (dry combustion), Ntot (Kjeldahl), Tot.-P, Tot.-K,
Tot.-Ca, Tot.-Mg, and Tot.-S (Murphy and Riley), pH H2O (1:2). Geoorgano granule fertilizer (5
ton/ha) was incubated to Oxisols for 3 weeks. Soil chemical properties were analyzed before and after
incubation for pH H2O (1:2), Avail.-P (Bray I), Tot.-N (Kjeldahl), Org.-C (Walkley and Black),
Ca-exch., Mg-exch., and Na-exch. (Leaching method using NH4OAc). Corn growth was also
measured for height and yield. Data of Geoorgano granule fertilizer resulted were standardized to PT
Pusri, SNI, and Regulation from Agriculture Ministry, Republic of Indonesia. Plant height and yield
were statistically analyzed the variance using F-test and continued using HSD at a 5% level of
significance.

3. Results and Discussion

Laboratory analyses of Geo-organo granules having the different composition (Table 1), showed that
compost containing tot.-C, tot.-N, tot.-P, total-P, tot.-Ca, tot.-Na, and tot.-Mg was showed the best result
from the application of VAM:Tt =0:1 (=100% titonia).

Application of Tithonia for composting VAM was able to dissolve the nutrient containing in the Vam;
therefore the mass of corn production increased. However, georgano granule fertilizer (Table 1) mixed
with Oxisols (Table 2) did not significantly affect corn growth and production (Table 3). As explained
by Fiantis et al. [3] that Vam deposited on soil surface would be chemically weathered as water, and
organic acids helped to decompose them. The organic acids resulted from tithonia decomposition [9].

| Table 1. Characteristics of Geo-organo granule at different composition |
|-------------------------------------------------------------|
| Geoorgano Granule Characteristics | Composition (Vam: Tt) |
|-----------------------------------|----------------------|
| Tot.-C (%)                       | 1:1  | 1:2  | 1:3  | 1:4  | 1:0  | 0:1  |
| 41.75 | c   | 43.37 | c   | 43.57 | c   | 45.94 | c   | 33.81 | c   | 64.23 | c   |
| Tot.-N (%)                       | 0.09 | 0.13 | 0.16 | 0.17  | 0.28 | 1.12 | b   |
| 473.38 | 345.87 | 268.12 | 278.27 | 120.75 | 57.35 |


Geo-organo granule compost applied to Oxisol (Table 2) was able to increase soil pH, P availability, especially from 1:1 of soil:VAM ratio after 3 weeks of incubation, even though it did not change the criteria yet. The same tendency was also found for OC, CEC, however, there was an indication of increasing exchangeable basic cations (K, Ca, Mg and Na). This phenomenon was in line with Fiantis [1] and Tindaon and Tampubolon [8], which stated that it needs time for weathering and nutrient release process from volcanic ash. Furthermore, Dahlgren dan Ugolini [6] found that volcanic ash could only increase basic cations by 50% after ten years.

Table 2. Oxisol characteristics before and after incubation with Geo-organo granule fertilizer for 3 weeks

| Parameters | Initial | Composition (Vam : Ti) |
|------------|---------|------------------------|
| pH (H₂O)   | 4.85    | 5.44 m                 |
| Avail-P ppm| 3.08 m  | 5.75 m 5.32 m 5.41 m 4.98 m 5.02 m |
| Tot.-N (%) | 0.11 r  | 0.11 r 0.11 r 0.11 r 0.11 r 0.11 r 0.12 r 0.12 r |
| Org.-C (%) | 0.97 sr | 1.17 r 1.12 r 1.25 r 1.13 r 0.97 sr 1.24 r |
| CEC cmol/kg| 10.75 r | 11.62 r 11.54 r 10.98 r 11.86 r 11.62 r 11.46 r |
| K_exch cmol/kg| 0.32 r | 0.86 t 0.99 t 0.86 t 1.06 t 1.29 t 1.54 st |
| Ca_exch cmol/kg| 2.67 r | 3.20 r 2.93 r 3.35 r 3.21 r 4.83 r 5.54 r |
| Mg_exch cmol/kg| 2.69 t | 2.98 t 3.27 t 3.41 t 3.18 t 4.13 t 4.04 t |
| Na_exch cmol/kg| 0.97 t | 1.15 st 1.26 st 1.30 st 1.02 st 1.92 st 1.99 st |

Note: m= acid; r=low; sr=very low; t=high; st=very high

Based on Gusnidar et al [9], organic acids resulted during the decomposition process of Tithonia were hoped to be able to release the plant nutrients from the ash to the soil. Therefore, Geo-organo granules could be applied to ameliorate acid soils, through its slow-release nutrients. Hopefully, in the long term, this volcanic ash could able to provide basic cations for tropical soils receiving high annual rainfall. It is because soil with high rainfall has leached basic cations from the root horizon into the deeper layer.
Table 3. Average of corn height and yield at several geoorgano granule fertilizer composition in Oxisol 72 days after sowing

| Vam : Tt | Plant Height (cm) | Mass of cob (g) |
|----------|-------------------|-----------------|
| 1:1      | 210.00            | 103.00 a        |
| 1:2      | 212.67            | 91.33 ab        |
| 1:3      | 206.67            | 107.67 a        |
| 1:4      | 198.33            | 114.00 a        |
| 1:0      | 204.00            | 43.00 b         |
| 0:1      | 202.00            | 103.67 a        |
| Control  | 199.33            | 103.00 a        |

Note: Numbers followed by the same small letters was not significantly different based on HSD at 5% level of significance.

The application of geo-organo granule fertilizer derived from VAM and tithonia (Table 3) was able to increase plant height and weight of baby-corn cob even though it was not statistically significant. This insignificance might be due to the nutrient release from the VAM that was still in progress.

4. Conclusion
Geoorgano granule fertilizer was able to improve the chemical characteristics of Oxisols and corn production, and even it was not yet significant.

Acknowledgments
Kemenristek Dikti funded this research through Universitas Andalas under Higher Education nominated Research Program contract no. 25/UN.16/UPT/LPPM/2016.

References
[1] Fiantis, D. 2006. Laju pelapukan kimia debu vulkanis G. Talang dan pengaruhnya terhadap proses pembentukan mineral liat non kristalin. Artikel ilmiah. Universitas Andalas. Padang. West Sumatra, Indonesia.
[2] Suriadikarta, D. A., A. Abbas Id., Sutono., D. Erfandi., E. Santoso, dan A. Kasno. 2010. Identifikasi sifat kimia abu vulkan, tanah dan air di lokasi dampak letusan gunung Merapi. BPT. Bogor.
[3] Fiantis, D., M. Nelson, J. Shamshuddin, T. B. Goh, and E. V. Rants. 2010. Leaching experiments in recent Tephra deposits from Talang Volcano (West Sumatra), Indonesia. J. Geoderma 156 (2010):161-172.
[4] Fiantis, D., M. Nelson., Shamshuddin, J., T. B. Goh., E. Van Ranst. 2011. Change in the chemical and mineralogical properties of Mt. Talang volcanic ash ini West Sumatra daring the initial weathering phase. Commun. Soil Sci. Plant Anal. 42: 569-585.
[5] Anda, M. dan Wahdini, W. 2010. Sifat, Komposisi mineral dan kandungan berbagai unsur pada abu erupsi Merapi. BBPSDL, Bogor. 12 hal.
[6] Dahlgren, R. and F. C. Ugolini. 1989. Aluminium fractionation of soil solution From upperturbed and tephra-treated Spodosols Cascade Range Washington USA. Soil Sci. Soc. Am. L. 53:559-566.
[7] Wahyuni, T. E., S. Triyono., dan Suherman. 2012. Penentuan komposisi kimia abu vulkanik dari erupsi gunung Merapi. J. Manusia dan lingkungan, Vol. 19(2): 150-159. PSLH UGM. Yogyakarta.
[8] Tindaon, F., Tampubolon dan P. Lumbanraraja. 2016. Komposisi kimia abu erupsi gunung Sinabung Tanah Karo dan lumpur Vulkanik Sidoarjo Jawa Timur. Dalam Prosiding Semirata BKS-PTN Wilayah Barat Bidang Ilmu Pertanian. Lhokseumawe, 04-06 Agustus 2016.
[9] Gusnidar, N. Hakim dan T. B. Prasetyo,. 2010. Inkubasi tithonia pada tanah sawah terhadap
assam-asam organik. J. Solum VII (1): 7-18.
[10] Hardjowigeno, S. 2003. Ilmu Tanah. Akademi Persindo. Jakarta. 268 hal.