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The Effect of Alfisol Soil Quality Improvement Using Filter Cake, Bagasse, and Dolomite Ameliorant on Peanut (*Arachis hypogaea* L.) Production

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Abstract*—Alfisol is the type of soil can be formed widespread in Indonesia, that has low soil quality low pH and nutrients characterized it. To improve the quality this soil, need adding ameliorant materials, i.e., filter cake, bagasse, and dolomite. The research aimed to determine the effect of dolomite dosage, the kinds of organic matter, and its interaction on the soil quality improvement and growth and production of peanuts. The research was arranged according to split-plot design, kinds of organic matter as main plots [bagasse (B1) and filter cake (B2)] with 5,000 kg ha^{-1} dosage, and dolomite as subplots [0 kg ha^{-1} (D0), 3,000 kg ha^{-1} (D1), 6,000 kg ha^{-1} (D2), and 9,000 kg ha^{-1} (D3)] with four replications. Parameters were measured were: soil pH, C-organic, total N, P_2O_5, K, K_2O, Ca, Mg, Na, cation exchange capacity (CEC), and base saturation percentage (BSP), the weight of dry pods, the weight of dry beans, and weight of 100 beans. The data were analyzed using analysis of variance followed by Duncan's Multiple Range Test (DMRT) α 0.05. The results showed that filter cake and dolomite 9,000 kg ha^{-1} dosage have the best results to improve soil quality and on peanut production. The interaction between organic matter and dolomite have not significant effect of improving soil quality and on peanut production. By combining filter cake and dolomite 9,000 kg ha^{-1}(B2D3) treatment, have the best result in production.

***Keywords*—alfisol soil quality; filter cake; bagasse, dolomite; peanut production.**

I. INTRODUCTION

The issue of agricultural land in Indonesia is generally associated with low levels of land productivity. On the other hand, the need for agricultural products as a source of food is increasing. The effort to improve the quality of land becomes an interesting study. Appropriate and efficient efforts are based on land characteristic data. Types of agricultural land throughout Indonesia vary depending on the constituent material. *Alfisol* is a type of soil can be found widespread in Indonesia and has plenty managed as agricultural land. *Alfisol* promotes better growth compared to *vertisol s*oil with nutrient content and soil moisture. The soil nutrients available on the *Alfisol* soil can be absorbed by the plant easily the mineral structure it contains [1].

Alfisol is soil with the high base saturation of more than 35% at a depth of 180 cm from the surface of the soil. On soils with very high base saturation, the lower horizon saturation of the base will be constant. But, on an *argillic* horizon with a low base saturation than the horizon beneath it has an increasingly growing saturation base. This soil type does not have *epipedon mollic, oxyc*, or *spodic* horizon. The Alfisol plane has a clayish earth texture derived from the horizon above it and is washed down along with the motion of the water. Classified *alfisol* into the fertile soil, although it is still necessary for intensification efforts to increase production, such as fertilization, liming, and other soil maintenance [2]. Productive land must have the level of soil fertility are favorable for plant growth. The fertile soil will be productive if managed correctly, using management techniques and suitable for kinds of crop.

Applying soil ameliorant is expected to improve the physical and chemical properties, and can increase fertilizer efficiency. The good ameliorant criterion can increase soil pH, improve soil structure and have complete nutrient content. The kinds of amelioration can be an organic or inorganic material. The source of ameliorant materials is such as organic fertilizer, mineral soil, zeolite, dolomite, natural phosphate, manure, agricultural lime, husk ash. Soil ameliorant often used is dolomite ($CaMg(CO_3)_2$). The

potential of dolomite in Indonesia is huge, and the price is affordable by the community. Dolomite is a compound material Ca, and Mg can neutralize soil acidity and reduce the activity of H and Al ions in the soil solution [3]. Amelioration can also be organic material. By adding organic matter on the land is vital because other than as a nutrient source, it can also improve the physical, chemical, and biological soil [4]. The improved physical properties of the soil due to organic matter are (1) soil structure is good, (2) aggregate stability becomes steady, (3) water holding capacity increases, (4) soil consistency becomes more friable, (5) bulk density becomes better and erosion decreases [5].

Many industrial wastes that can be used as organic fertilizer, for example, bagasse and filter cake is sugar cane industry waste that has nutrient required by plants [6]. Bagasse is a fibrous material from sugar cane extracted by on sugar cane processing at sugar mills. The using of bagasse to improve the physical properties of the soil and in the long term will improve the soil fertility. Currently bagasse many reused by sugar cane factory for fuel. The ash of bagasse is used as a fertilizer rich in potassium (2%-5% K_2O) [7]. The filter cake is solid waste sugar cane milling result is a soft, dark brown to black, and its composition is a mixture of sand, soil, dregs, sugar, colloid flocculants, and coagulants and precipitated including phosphate, lime, and albumin. Specific composition of filter cake are: oil and wax (5%-15%), fiber (15%-30%), sugar (5%-15%), solid protein (5%-15 %), total ash (9%-20%) and moisture content (65%-80%) [8].

Filter cake and bagasse are used as ameliorant because of their availability in the field. Especially in the area around the location of research is quite a lot because it is only a waste of sugar factory that is thrown away and left just around the sugar factory. The potential of waste material from sugarcane factory as ameliorant material is tremendous in Indonesia. Indonesia Sugar Cane Statistic [9] shows that the area of sugarcane plantation is 455 thousand hectares spread in South Sulawesi, East Java, Yogyakarta, Central Java, West Java, Lampung, and West Sumatra. This plantation is the source of raw material for five sugar mills in Indonesia.

One of the leading commodities of the plantation sector in Indonesia is peanuts. The fluctuation of production per year has not optimally proved the production of this commodity. Peanut (*Arachis hypogaea* L.) in Indonesia is one of the main food crops, as it is needed to supply the needs of food and industry. Peanuts are the second most crucial bean commodity after soybeans, where production is not able to supply national needs. The peanut harvest area continues to decline, and this condition is quite alarming given the growing peanut imports in line with the increasing demand for food and other uses. The average national production is currently only 1.34 ton ha^{-1}, this figure is still much lower than that of peanut production in the United States and Australia which reached 3 ton ha^{-1} of dry pods, and theoretically, the production. Peanut in Indonesia is still potential to be improved [10]. The research aimed to determine the effect of kinds of organic matter (bagasse and filter cake) and dolomite, and its interaction on soil quality improvement and growth and production of peanuts.

II. Materials and Methods

The study was conducted at STPP Gowa experimental farm, soil type based on soil taxonomy system is *Alfisol* [11] or *Mediterranean* soil based on PPT 1978/1982 (Indonesian method). This location was selected because of this land with low soil quality conditions. It was designed following the split-plot design, kinds of organic matter as main plots are bagasse and filter cake, with 5,000 kg ha^{-1} dosages per item, and dolomite as subplots are 0 kg ha^{-1}; 3,000 kg ha^{-1}; 6,000 kg $ha^{-1}$and 9,000 kg ha^{-1} with four replications.

Soil sampling before the research was conducted after tillage, while soil sampling at the end of the study was conducted at harvest time in all plots. Soil samples were taken in the topsoil (0-20 cm depth). This soil sample is brought to the laboratory and is dried at room temperature. The soil samples were then sieved using a sieve with a mesh size of 2 mm. Liming and organic matter are applying two weeks before planting. Planting is using a drilling system with distance planting 25 cm x 20 cm. Maintenance undertaken includes watering, weeding, and pest control if there are pests/ diseases. Harvesting is done when the peanut plant is old, which is marked with black pod skin, pod skin becomes hard, thin and peel easy to peel, and seed moisture content less than 25% — plant age at the time of old pod about 100 days.

Parameters were measured were: soil pH (soil-water ratio 1:2,5), C-organic (Walkley &Black), total N (Kjeldahl), P_2O_5 (extract HCl 25%), K_2O (extract HCl 25%), K (NH_4-Acetate 1 N, pH7), Ca (NH_4-Acetate 1 N, pH7), Mg (NH_4-Acetate 1 N, pH7), Na (NH_4-Acetate 1 N, pH7), cation exchange capacity (CEC) (NH_4-Acetate 1 N, pH7), and base saturation percentage (BSP) (NH_4-Acetate 1 N, pH7), the weight of dry pods, the weight of dry beans, and the weight of 100 beans. The data were analyzed using analysis of variance (ANOVA) followed by Duncan's Multiple Range Test (DMRT) α 0.05.

III. Results And Discussion

A. Soil Chemical Properties before Research, Bagasse and Filter Cake

The characteristics of native soil chemistry are basic data in analyzing characteristic changes after application of ameliorant materials. The results of soil analysis before research, bagasse and filter cake showed in Table 1 and Table 2.

TABLE I
Result of Soil Analysis Before Research

Parameters	Unit	Value	Criteria*
Soil acidity (pH)		5.00	Acid
C-organic	%	2.06	Moderate
Total N	%	0.13	Low
P_2O_5	mg kg^{-1}	7.90	Very low
Ca	cmol(+) kg^{-1}	4.26	Low
Mg	cmol(+) kg^{-1}	2.23	High
K_2O	cmol(+) kg^{-1}	0.32	Moderate
Na	cmol(+) kg^{-1}	0.21	Low
CEC	cmol(+) kg^{-1}	22.63	Moderate
BSP	%	31.00	Low

*Base on criteria of Indonesian Soil Research Institute, 2005

Table 1 shows that the soil chemical and fertility conditions used before the study, i.e., soil pH 5.0 were acidic, with C-organic content that was moderate, with nutrient content ranging from very low to high. CEC is moderate, and BSP is low. The result of this analysis shows that *Alfisol* soil in the research location has very low soil fertility level, with low soil pH constraint, which resulted in less availability of certain nutrients. The CEC value is indicating that this land still has the potential to be improved fertility. The improvement of the acid condition of soil by adding dolomite and the low C-organic will increase by the adding of ameliorant. CEC is the soil properties associated with textures and organic matter. This trait indicates the ability of the soil to absorb and exchange or release back into the soil solution. This property is useful in maintaining nutrients in the soil or the ability to absorb nutrients by plants.

TABLE II
RESULT OF NUTRIENT CONTENT ANALYSIS OF BAGASSE AND FILTER CAKE

Parameters	Unit	Bagasse	Filter cake
Acidity (pH)		4.78	8.06
C-organic	%	32.22	29.32
Total N	%	0.19	0.36
C/N Ratio		169.58	81.44
P_2O_5	mg kg^{-1}	80.00	190.00
K_2O	cmol(+) kg^{-1}	0.16	0.35
CEC	cmol(+) kg^{-1}	40.33	42.52

Table 2 showed that the chemical properties and nutrient content of bagasse and filter cake used in the research. In the pH parameter, the total N, C/N ratio, P_2O_5, and K_2O showed high different, whereas the C-organic content and CEC are have not significantly different. Organic matter applied is expected can improve the physical, chemical, and biological soil properties. The good soil for plant growth is having physical, chemical and biological soil fertility that allows water, air and plant nutrients available to the plant.

Applied of bagasse is used because it contains nutrients that K_2O is high, P_2O_5 is very high, C-organic is very high, and CEC is very high. Likewise, filter cake contains high nutrients such as K_2O is very high, P_2O_5 is very high, C-organic is very high, and CEC is very high. Nutrients from bagasse and filter cake were expected to increase the nutrient content in the soil. It is in line opinions by [12] that applied organic matter into the soil very helpful to the improvement of soil properties. Organic fertilizer is containing macro and micronutrients and also able to improve soil moisture [13]. Figure 1 and Figure 2 showed the organic matter used in this research; they are bagasse (Figure 1), and filter cake (Figure 2) were taken from Takalar sugar factory, Takalar, South Sulawesi.

Fig. 1 Bagasse

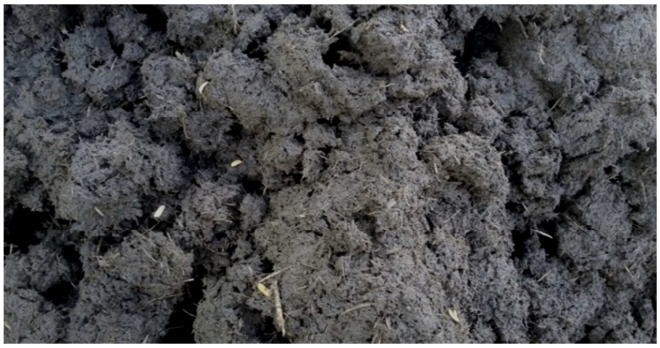

Fig. 2 Filter cake taken

B. Soil Chemical Properties after Research

The treatment of organic bagasse and filter cake have not significant different results on pH. While in dolomite, dolomite treatment of 9,000 kg ha^{-1} have the highest yield (6.63) and have a significant difference from other treatments (Figure 3).

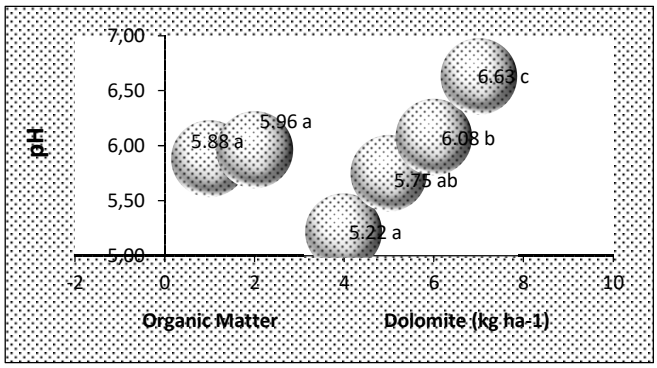

Fig. 3 Effect of organic matter and dolomite treatment on the soil pH

In Figure 4, the bagasse organic matter treatment has a higher result (2.35%) and have a significant difference to cake filter on C-organic, while in dolomite, all treatments have not a significant difference.

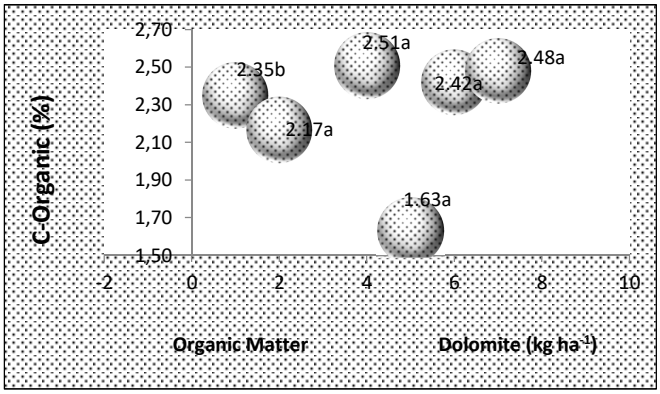

Fig. 4 Effect of organic matter and dolomite treatment on C-organic

For the soil N content (Figure 5), the treatment filter cake organic matter has a higher result (0.21%) and have a significant difference to bagasse. While in dolomite, treatment without dolomite (0 kg ha^{-1}) have the highest result although only have significant different to dolomite 3,000 kg ha^{-1}.

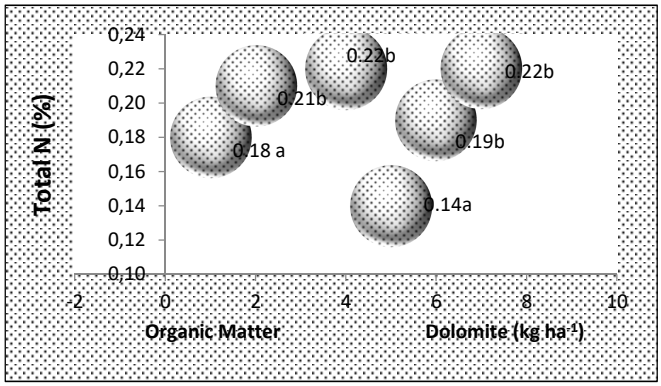

Fig. 5 Effect of organic matter and dolomite treatment on total N

P_2O_5 in Figure 6 below shows that the treatment of bagasse organic matter has a higher yield (22.53 mg kg^{-1}) and have significant differences to cake filter. While in dolomite, the dolomite 9,000 kg ha^{-1} have highest result (24.57 mg kg^{-1}) and have a significant difference with treatment without dolomite (0 kg ha^{-1}).

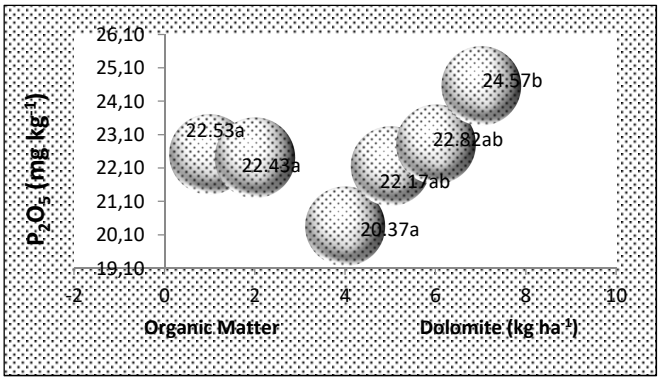

Fig. 6 Effect of organic matter and dolomite treatment on P_2O_5

K_2O in Figure 7 below shows that the treatment of filter cake organic matter has a higher result (15.20 mg kg^{-1}) and have not a significant difference to bagasse. While in dolomite treatment, the dolomite 9,000 kg ha^{-1} has the highest result (15.89 mg kg^{-1}) and have significant differences with other treatment.

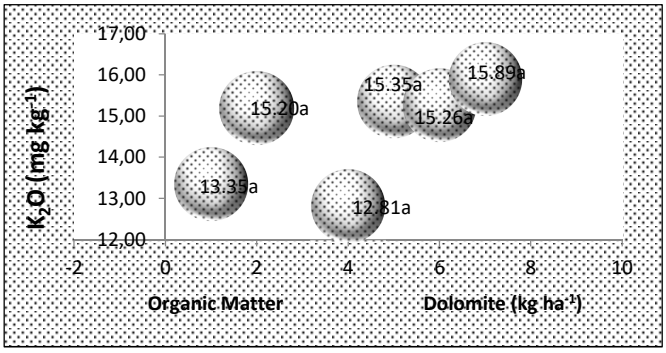

Fig. 7 Effect of organic matter and dolomite treatment on K_2O

Ca in Figure 8 below indicates that the treatment of cake filter organic matter has a higher yield (4.63%) and have not significantly different with bagasse. While in dolomite treatment, the dolomite 9,000 kg ha^{-1} have the highest result (5.96 cmol(+)kg^{-1}) and have not a significant difference with a dolomite 6,000 kg ha^{-1}.

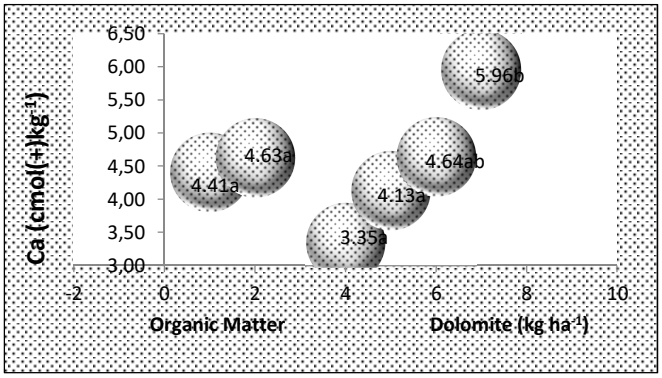

Fig. 8 Effect of organic matter and dolomite treatment on Ca

Mg in Figure 9 below indicates that the bagasse organic matter treatment has a higher yield (3.22 cmol(+)kg^{-1}) and have not significantly different with filter cake. While in dolomite, dolomite 9,000 kg ha^{-1} have the highest results (3.94 cmol(+)kg^{-1}) and have not a significant difference with dolomite 6,000 kg ha^{-1}.

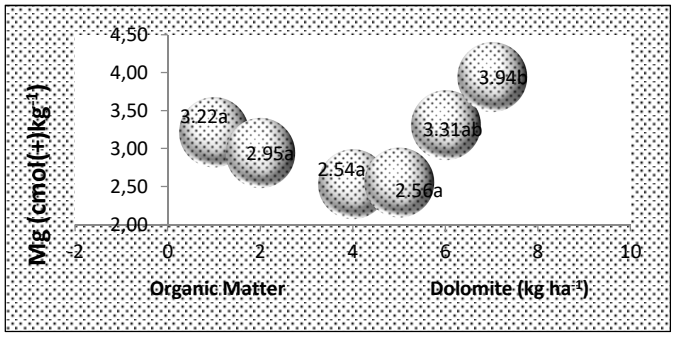

Fig. 9 Effect of organic matter and dolomite treatment on Mg

K in Figure 10 below shows that the treatment of filter cake organic matter has a higher yield (0.20 cmol(+)kg^{-1}) and have not significantly different with bagasse. While in dolomite, without dolomite treatment (0 kg ha^{-1}) have the highest result (0.20 cmol(+)kg^{-1}) and have not a significant difference with other treatments.

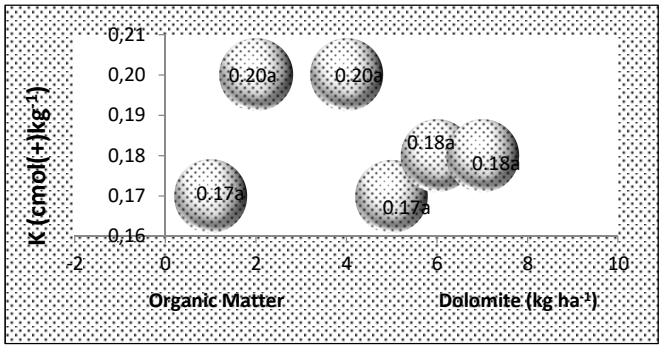

Fig. 10 Effect of organic matter and dolomite treatment on K

Na in Figure 11 indicates that the treatment filter cake organic matter has a higher result (0.25 cmol (+) kg^{-1}) and have not significantly different with bagasse. While in

dolomite, the dolomite 9,000 kg ha^{-1} treatment have the highest yield (0.29 cmol(+)kg^{-1}) and only have significant differences with without dolomite treatment (0 kg ha^{-1}).

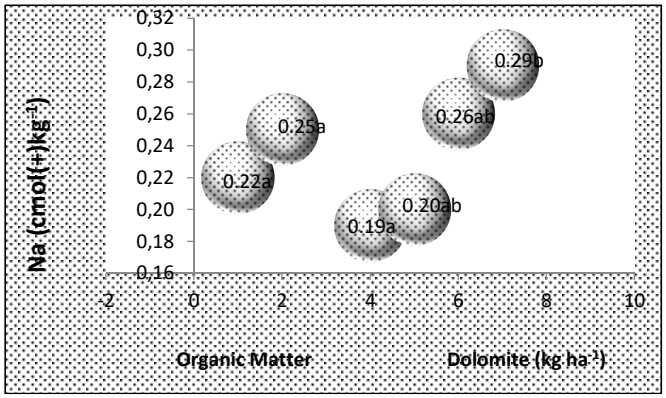

Fig. 11 Effect of organic matter and dolomite treatment on Na

CEC in Figure 12 shows that the treatment of bagasse organic matter has a higher result (22.83 cmol (+) kg^{-1}) and have not a significant difference with filter cake. While in dolomite, the dolomite 9,000 kg ha^{-1} treatment have the highest yield (23.39 cmol (+) kg^{-1}) and only have significant differences with without dolomite treatment (0 kg ha^{-1}).

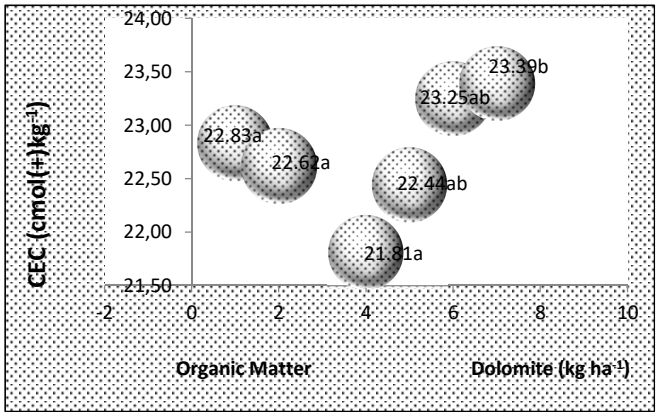

Fig. 12 Effect of organic matter and dolomite treatment on CEC

BSP in Figure 13 below shows that the treatment of filter cake organic matter has a higher yield (35.58%) and have not significantly different with bagasse. While in dolomite treatment, dolomite 9,000 kg ha^{-1} has the highest result (44.33%) although they have not significantly different with dolomite 6,000 kg ha^{-1}.

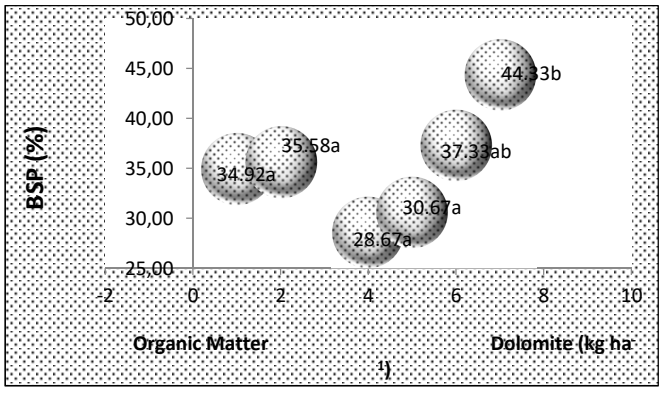

Fig. 13 Effect of organic matter and dolomite treatment on BSP

In general, the results showed that the use of organic matter (bagasse and filter cake) and dolomite application increased the pH value (Fig. 3) to slightly acid until neutral levels. If the pH is in a neutral, then almost all the nutrients needed by the plant for growth are available, particularly for C-organic, total N, K_2O and K [14]. The plants will grow well and produce optimally if nutrients are needed sufficiently [3]. Some important nutrients for plant growth such as N for cell formation and chlorophyll, P for the development of meristem tissue, K as activators of various enzymes involved in protein synthesis and starch. Ca and Mg elements of dolomite are also of great benefit, since Ca stimulates root and leaf development, and stimulates microbial activity, Ca element is also required in large quantities by N-atmospheric binding bacteria. Likewise, Mg in plants is as a central atom in chlorophyll, molecules, so it is very important in photosynthesis activities.

The high P_2O_5 value obtained as shown in Fig. 6 indicates that the use of organic matter has been shown to increase the availability of P_2O_5 in the soil compared to the soil P content before research (Table 1). The advantages of using organic matter to soil fertility are to increase CEC and increase the availability of P and Fe for crops [7]. Likewise, with dolomite application, with increasing of dolomite dosage, pH, P_2O_5, K_2O, Ca, Mg, CEC and BSP increases (Fig 3, 6, 7,8,9,12 and 13) [14]. That the dolomite application effect is to increase the pH, increase the Ca and Mg elements and increase the availability of the P element. With the increasing amount of Ca, Mg, Na, and K elements in the soil will further increase the BSP value of the soil, and soil BSP value is an indicator of soil fertility. The higher the BSP value, the more fertile of the soil.

C. Peanut production

For the weight of dry pods (Fig. 14), the treatment filter cake organic matter has a higher result (3,832 kg ha^{-1}) and have not a significant difference with bagasse. While in dolomite, the dolomite 9,000 kg ha^{-1} treatment have the highest result (5,078 kg ha^{-1}) and have significant differences with other treatment. For the weight of dry beans (Fig. 15), the treatment filter cake organic matter has a higher result (2,650 kg ha^{-1}) and have not a significant difference from bagasse. While in dolomite, the dolomite 9,000 kg ha^{-1} treatment have the highest result (3,293 kg ha^{-1}) and have significant differences with other treatment.

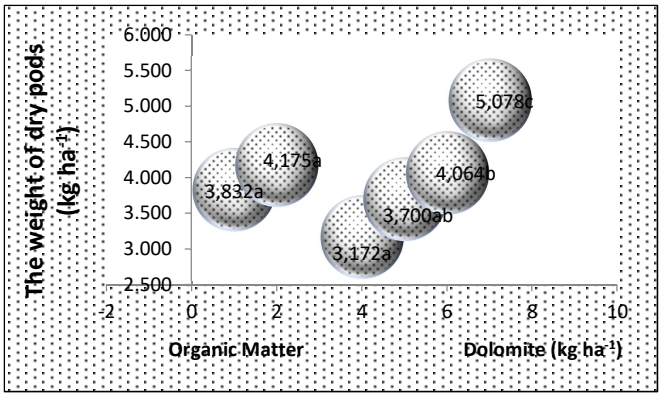

Fig. 14 Effect of organic matter and dolomite treatment on the weight of dry pods

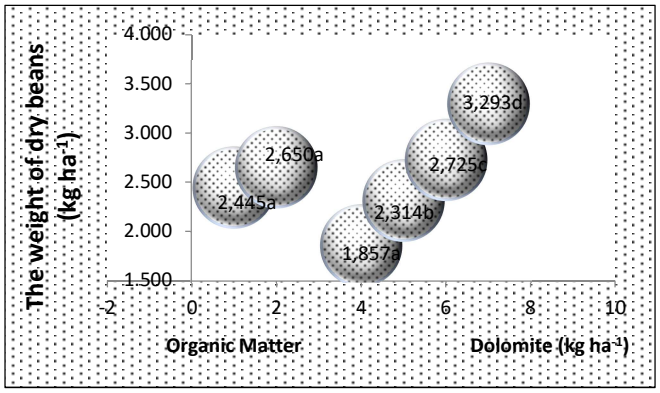

Fig. 15 Effect of organic matter and dolomite treatment on the weight of dry beans

For the weight of 100 beans (Fig. 16), the treatment bagasse organic matter has a higher result (40.46 g) and have not a significant difference with filter cake. While in dolomite, the dolomite 6,000 kg ha^{-1} treatment have the highest result (43.66 g) and have significant differences with other treatment.

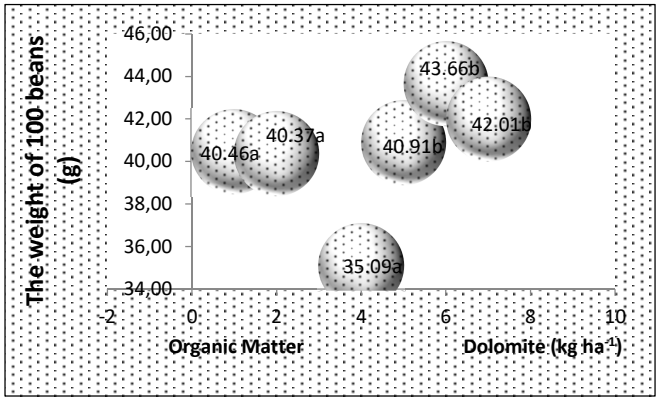

Fig. 16 Effect of organic matter and dolomite treatment of 100 beans

For dolomite 9,000 kg ha^{-1} have the highest with an average weight of dry pods 5,078 kg ha^{-1} and 3,293 kg ha^{-1} of weight dry beans and have a significant difference with other treatments. Whereas on the weight of 100 beans, treatment of 6,000 kg ha^{-1} produce the highest beans weight of 43.66 g and have not a significant difference with other treatments. For the applied of filter cake have the heavy weight of dry pods and dry beans of higher compared than bagasse. Although have not a significant difference, and the opposite happens to the weight of 100 beans. According to [15], this may use of organic matter in a short time, unable to deliver maximum results. Using organic matter also shown to increase the production of plants obtained [16] and [17]. It will be the visible effect when used in the longterm, due to continuous use will lead to nutrients accumulate and widely available to the plants, and have a significant effect on plant production [18].

For the applied of dolomite showed that dolomite 9,000 kg ha^{-1} have the highest yield and significant difference from other treatments on the weight of the dry pods and dry beans weight. While the weight of 100 beans, all three dosages of dolomite have no different results, and all three significant difference with dolomite 0 kg ha^{-1}. If the agricultural land has a low pH will result in the plant having less favorable growing conditions. To solve it is liming which aims to increase soil pH. Some benefits of lime allowing on acid soils [19]. Firstly, reducing aluminum and *toxication* other metals. Secondly, repair and improve soil physical condition. Thirdly, stimulating activity of microbiology in the soil. Fourthly, improving soil CEC through increasing soil negative charge to change or charge depending on pH. Fifthly, increasing the availability of some specific nutrients, especially P, Ca and Mg supply to plants. Sixthly, enhancing symbiotic N fixation by the legume plants.

IV. Conclusion

Filter cake and dolomite 9,000 kg ha-1 have the best results to the improvement of soil quality and in the production of peanuts. No interaction between the organic matter and dolomite to the soil quality improvement and on the production of peanuts. By combining filters cake and dolomite 9,000 kg ha-1 treatment, have the best result in production. The additional contribution of the results of this research is as part of the development of waste material utilization. This research is expected to contribute to the environment on ecological and economic aspects. On the ecological aspect, this effort is an innovation in reducing the volume of waste in the sugar industry. Reduction of waste volume will minimize the potential for soil pollution. Also, economic benefits are an effort to reduce production costs in the purchase of organic fertilizers.

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References

[1] B. Suwignyo, P. Suryanto, E. T. S. Putra, T. Alam, and S. D. A. Prianto, "Potential of Corn as Forage on Alfisol and Vertisol Soil in Agrosilvopastural System with Kayuputih (Melaleuca leucadendron Linn)," *J. Agric. Sci.*, vol. 7, no. 11, p. 268, 2015.

[2] S. W. Buol, R. J. Southard, R. C. Graham, and P. A. McDaniel, *Soil genesis and classification*. John Wiley & Sons, 2011.

[3] E. Sulistiyono, "Synthesis of Magnesium Carbonate Using Indonesian Dolomite," in *Advanced Materials Research*, 2015, vol. 1112, pp. 546–549.

[4] Kaharuddin *et al.*, "The Effectiveness of Liquid Cow Bokashi to Create Root Optimum Environmental Conditions on Maize Growth," *Int. J. Curr. Res. Biosci. Plant Biol.*, vol. 2, no. 12, pp. 26–31, 2015.

[5] V. S. Bawasker, V. P. Patil, S. J. Trandive, and G. K. Zende, "Respon of Sugar Cane to Press Midcake Effect on Soil Propertise Nutrient of Cane," *India Sugar*, 1978.

[6] N. Sennang, "Utilization of Sugar Factory Waste as an Organic Fertilizer on Growth and Production of Baby Corn," *Int. J. Sci. Res. Publ.*, 2015.

[7] R. Sutanto, *Penerapan pertanian organik: pemasyarakatan dan pengembangannya*. Kanisius, 2002.

[8] J. M. Paturau, *By-products of the cane sugar industry. An introduction to their industrial utilization.* Elsevier Science Publishers BV, 1989.

[9] D. Sari and M. Wegener, "Indonesian sugar production and recommendations for industry recovery," 2015.

[10] W. Wijayanti, "Keragaan 29 Galur Kacang Tanah (Arachis hypogaea L.) Pada Kondisi Salin," *Vegetalika*, vol. 3, no. 4, pp. 40–51, 2014.

[11] Soil Survey Staff, *Keys to Soil Taxonomy*, Twelfth Ed. United States Department of Agriculture, Natural Resources Conservation Service, 2014.
[12] E. Baldi and M. Toselli, "Root growth and survivorship in cow manure and compost amended soils," *Plan Soil Env.*, vol. 59, pp. 221–226, 2013.
[13] P. Mäder, A. Fliessbach, D. Dubois, L. Gunst, P. Fried, and U. Niggli, "Soil fertility and biodiversity in organic farming," *Science (80).*, vol. 296, no. 5573, pp. 1694–1697, 2002.
[14] S. M. Walker, *Studying Soil (Searchlight Books - Do You Dig Earth Science?)*. Lerner Publishing Group, 2013.
[15] J. P. Reganold and J. M. Wachter, "Organic agriculture in the twenty-first century," *Nat. Plants*, vol. 2, p. 15221, 2016.
[16] Gusmini, T. Itani, A. Adrinal, T. Ikeda, and K. Nishimura, "Effect of Nitrogen Application from Selected Manures on Growth, Nitrogen Uptake and Biomass Production of Cultivated Forage Rice," *Int. J. Adv. Sci. Eng. Inf. Technol.*, vol. 5, no. 2, pp. 110–114, 2015.
[17] Y. P. Situmeang, I. M. Adnyana, I. N. N. Subadiyasa, and I. N. Merit, "Effect of Dose Biochar Bamboo, Compost, and Phonska on Growth of Maize (Zea mays L.) in Dryland," *Int. J. Adv. Sci. Eng. Inf. Technol.*, vol. 5, no. 6, pp. 433–439, 2015.
[18] Dahlan, Kaharuddin, I. N. Parawansa, Syaifuddin, U. Aimanah, and Y. RS, "Effect of Liquid Organic Fertilizer of Cow Manure on Growth and Production of Kangkung Darat (Ipomea reptans)," vol. 9, no. 4, pp. 766–769, 2016.
[19] M. Kononova, *Soil organic matter: Its nature, its role in soil formation and in soil fertility*. Elsevier, 2013.