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**Characterization of biochar combination with organic fertilizer: the effects on physical properties of some soil types** Variability **of biochar, organic fertilizer** as well as soil type characteristics may causes different physical properties of the soil. The research aims to examine **the characteristics of biochar and organic fertilizer** on the physical properties of some soil in dry land in Malang Regency.

Incubation was conducted in greenhouses using three types of infertile soils and low productivity consists of lithosol, mediteran (clay) and regosol (sandy-loam). Twelve different treatments contain biochar (from rice husk, corncob and crook-cigarette industry byproduct), and organic fertilizer (single or combination of compost or dung) include controls was examined. Biochar-organic fertilizer mixed with soil (3.85 kg) at 150 g pot-1 **(single) and 75 g** pot-1 (combination) incubated at 70-80% field capacity. The physical properties of the soil were observed after 98 days incubation.

The results showed that combination of biochar-organic fertilizer may greatly improve physical properties of soil. Corncob biochar - dung in litosol increase porosity (14%) and macro pore (21-24%). Crooked biochar - compost increased porosity (21%) and macro pore (64%) in mediteran but decreases micro pore (25.4%) from 28.3% to 21.1%.

Crooked biochar could decrease meso pit of lithosol (56%) from 11.5% to 5.0%. Meso pores decreased respectively at 33% and 49% which is from 17.4% to 11.7% (corncob biochar) and 8.7% (rice husk biochar) in mediteran. Micro pore reduced 12% by combination of husk biochar - dung as well as corncob biochar - compost in lithosol .

Biochar-dung in regosol could increase meso pores 28.4%) from 9.6% to 13.4%, but the macro pore decreased 21%. **Keywords: physical properties of soil, porosity, macro and**

micro pore. **INTRODUCTION** South Malang was the third largest area in East Java which is mostly contain by dry soil (Widowati et al. 2015).

Dry soil was the mainly problem which is disturbed the plant sorption of the nutrients and may influence in soil productivity. Improvement of soil physical properties should be carried out in order to obtain the optimum quality. Soil texture is the most factors which is affect the organic matter content and water existance.

The amount of clay was essential to hold the important organic matter and create soil fertility, indicates that organic materials volatile and stable are contribute to the soil properties. Sutono and Nurida (2012), Sukartono and Utomo (2012); Yu et al. (2013), has demonstrated that biochar improves the ability of soil to hold water.

It is worthwhile to increase water existance in sandy soils as well as reducing the water in clay soils. Sandy soil lead the oxidation of the organic matter and easier to throughout, in other hand much water and aeration hampered the oxidation. Soil organic matter content may also influence by cover vegetation and the presence of lime.

Water content, soil texture, soil structure, organic matter, and topography was influenced in particle density. More organic matter in the soil will increase pore space and minimize the density. At the same volume organic matter is lighter than soil solids, and it may affect to the density of soil particles and soil moisture content.

Biochar has been reported to improve physical properties eg groundwater retention, hydraulic conductivity (Oguntunde et al, 2008; Asai et al, 2009). Soil moisture was affect into photosynthesis, transpiration-assimilation, chemical reaction, mineral and organic corrosion as well as a media of the nutrients motion. Excessive moisture might cause the nutrients washed out on the root and lifting salt was dissolved into upper layer in high evaporation.

Similarly, excessive water may block air circulation which is induced no oxygen condition for the roots then crop may be deaths. Previous study has reported that plant growth and agronomic performance depend on biochar characteristics and concentrations as well as the types of soil and plant species (Glaser et al, 2012).

Variability of biochar characteristics such as permanently carbon, surface area, ashes, nutrient, and pH and cation exchange capacity was found due to raw material properties and process condition (Manya, 2012). No specific studies have been carried out for vary of biochar type and organic fertilizer to addressing the soil fertility, whether in single or mixed applications.

Various process conditions may cause tough to compare the results consider the effects of biochar characteristics. There are limited studies for biochar and organic fertilizer application into soil and the effect on physical properties. The study aims to characterize biochar-organic fertilizers applicate into soil types as well as soil physical properties that implicate the suitability of biochar and organic fertilizers as an amandment to gain the soil fertility MATERIALS AND METHODS Soil Composite sample 0-30 cm consist of litosol (entisol order) was taken from dry land in Southern Malang Regency, Purwodadi Village, Donomulyo Subdistrict, Sukowilangun Village, Kalipare Subdistrict, and Sumberrejo Village, Poncokusumo Subdistrict. Donomulyo District is located at 112 ° 23'30 "- 112 ° 29'64" BT and 8 ° 16'75 "- 8 ° 19'81" LS.

Ground material of Litosol came from igneous rock or hard sediment which is has not weathering process perfectly and may lead the infertile and low productivity so that might not use for agriculture. This soil were located in Kalipare Sub-district is 21,950 - 29,610 BT and 9,400 - 16,480 LS with Red and Yellow Mediteran soil consist of Afisol Order.

Kecamatan Poncokusumo, approximately 24 km from the capital district, consists of Regosol land Entisol Order. The soil may cause dry growth of vegetables due to sandy loam condition and low nutrients contents. Air dry- ground samples at room temperature with moisture content of 0.34 g g<sup>-1</sup> (Regosol); 0.5 g g<sup>-1</sup> (Litosol); And 0.61 g g<sup>-1</sup> (Mediteran) (Soil Laboratory Survey Manual Method, 2004).

Pipette method was used to particle sizing distribution and potassium dichromate used to oxidize the soil organic carbon. Sample ring used to weight the content, particle, and porosity. pF curve gravimetrically at 0; 2; 4.2 used to determine the percentage of ground pore space based on calculation (pF curve is not presented in this paper, please contact the author).

Biochar production Raw materials are produced from rice husks, corncobs, and crooked (tobacco industry byproduct). Biochar rice husks and corncobs are produced at 350 - 500oC for 4 hours by fixed bed pyrolysis equipment equipped with a separator system connected to the condenser. The production was conducted at the Bioenergy Laboratory of Tribhuwana Tunggadewi University Malang.

Biochar crooked produced at temperature 700oC for 15 minutes by ethanol pyrolysis tools at PT. Gudang Garam, Tbk. Raw husk obtaned from commercial rice mills PT. International Branch of Kediri. Characteristic of biochar and organic fertilizer Biochar characterization such as bulk density was carried out by using FCO method (1985), water

holding by AOAC method 19th Ed., 2012, method 969.05; Total C was determined by the Gravimetric method and particle size (ASTM) was measured using mechanical method.

Then the organic fertilizers were analyzed using AOAC (2010) standard procedures. Biochar and organic fertilizer incubation into soil Greenhouse at the Tribhuwana Tunggaladewi University, Malang, Indonesia (7,48 ' .50 "BS and 112o.37 '41" BT) was applied for the treatment, with mean annual temperatures in range 16o- 36oC, relative humidity of approximately 43-86%, and light intensity about 365-1997 lux. Treatment consists of 2 factors, first is soil type (Regosol, Litosol and Mediteran).

The second factor is combination both biochar and organic fertilizer with 12 treatments. Biochar and organic fertilizer distribution into each soil repeated three times, so totally treatment 108 pots. Each soil sample was placed into a plastic pot (18 cm diameter and 25 cm high).

Biochar corn cobs are ground to be <2 mm, whereas biochar crooked tobacco and biochar rice husk were applied directly. 3.85 kg of soil mixed with 150 g of biochar or organic fertilizer according to treatment with ratio of biochar-organic fertilizer is 1 : 1 applied in 4% w/w and 1.2 mg/m<sup>3</sup> of bulk density (similar to field conditions). Soil weights of biochar and or organic fertilizer per each pot were up to 4 kg.

Ring sample (5 cm in diameter and 5 cm in height) was immersed up to 15 cm from the top soil surface to measure the physical properties of the soil. This is equivalent to the biochar and/or organic fertilizer alteration which raised up to 9.6 ton ha<sup>-1</sup> in 20 cm layer. During incubation, groundwater was maintained at 0.11-0.18 g g<sup>-1</sup> (equivalent to 70 - 80% of field capacity) using 1 liter of water added every 21 days.

70 - 80% of water content were used to get dry conditions. Then the physical properties was measured at the end of 98 days incubation to assess the effect of changes in biochar and or organic fertilizer. Statistic analysis This research uses nested design, factor 1 (Nest) is a type of soil, namely the land of Regosol, Litosol and Mediteran and factor 2 (the nested) is biochar and organic fertilizer, namely: Control : without biochar or organic fertilizer S : Rise husk biochar T : Corncob biochar J : Crooked (tobacco) biochar SA : Rise husk biochar - dung SK : Rise husk biochar - compost TA : Corncob biochar - dung TK : Corncob biochar - compost JA : Crooked biochar - dung JK : Crooked biochar - compost A : Dung K : Compost Two Way ANOVA was used to analyzed then followed by DMRT (Duncan Multiple Range Test) and also correlation and regression analysis RESULTS AND DISCUSSION Soil characteristic Characteristics of each soil types are shown in Table 1 below.

Clay textured up to 86%, sand fraction and very low organic carbon was contained in Regosol. Clay textured in both litosol and mediterans respectively 65% and 76%. Organic carbon soil is low in lithosol and very low in mediteran. All of those soils have low C / N which is have low pH (mediteran and regosol) to medium pH (litosol). Table 1. Soil characterization Parameter Litosol Mediteran Regosol Organic C (%) 1.36 0.72 0.48 pF 0 (cm-3 cm-3) 0.51 0.56 0.32 pF 2 (cm-3 cm-3) 0.36 0.40 0.15 pF 4.2 (cm-3 cm-3) 0.29 0.30 0.10 Macro pore(%) 15 16 17 Meso pore (%) 7 10 5 Micro pore (%) 29 30 10 BJ (g cm-3) 2.46 2.49 2.12 DMR (mm) 1.27 1.13 0.56 Sand (%) 11 9 86 Ash (%) 24 15 3 Clay (%) 65 76 11 Texture Clay Clay Sand clay Physical characteristic of **biochar and organic fertilizer** Table 2 represent the physical characteristics of biochar and organic fertilizer which are followed corncob biochar > biochar crooked tobacco > biochar husk.

More over the value of organic carbon from dung was bigger compost. The lowest of carbon and the highest of ash content was raised in rice husk biochar, **on the other hand**, highest carbon content and lowest ash on corncob biochar. Ender et al. (2012) reported that high ash in the biochar may led low fixed carbon content due to the high ash content inhibits carbonformation.

There was significant effect ( $p < 0.05$ ) of raw materials and temperature on agronomic properties of biochar. The ash content in this study raised 24 -53% which is had the same range with previous study reported by Muhammad et al. (2014) that **the biochar ash content** ranged between 25-52% and ash content significantly ( $p < 0.05$ ) along with increasing temperature.

The pyrolysis temperature and the raw materials have **a significant impact on the chemical properties of biochar**. Water holding capacity depends on **biochar and organic fertilizer** which have result for biochar rice husk > corncob biochar > dung > biochar crooked tobacco > compost. Downie et al. (2009) and Sohi et al.

(2010) conveying the surface area and porosity of biochar under different pyrolysis temperatures have significant potential effect on water holding capacity, adsorption capacity (particle ability to stick to the biochar surface) and nutrient retention capability. Bulk density of biochar rice husk, corncob, and tobacco crooked respectively 0.65; 0.27; and 0.31 g cm-3.

According to Ammu and Anitha (2015), low of weight, porosity and high water holding capacity make biochar suitable for nutrient and water management. Biochar pores are higher than organic fertilizers pore (Table 2). Distribution of grain particles using 30 meshes and 18 mesh shown was greatly raised on crooked biochar.



The opposite result was measured when 325 mesh and 60 mesh was used, corncob biochar particle raised the highest one. The particle size of biochar is produced from pyrolysis (temperature and residence time in the furnace) of organic matter which depends on physical properties of material origin (Gaskin et al, 2008).

The effects of biochar **combination with organic fertilizer** on the physical properties of some soil types Physical properties alteration as response of the combination of **biochar and organic fertilizer** applied in some soil type were analyzed. The combination was greatly influence for the content weight, particle weight, porosity, and soil pore (macro, meso, and micro) contents with significant value  $p < 0.05$  (show in Table 3 - 8 below).

The content weight Generally, the provision of **biochar and organic fertilizer** decreases the content weight in the three soil types, however it may not be occur on the rest of some soil types. Brady and Weil (2004) has reported that biochar has a much lower bulk density than mineral soils in the tropics ( $\sim 0.3 \text{ mg m}^{-3}$  for biochar compared to the volume weight of  $1.3 \text{ mg m}^{-3}$ ) which is desirable for growth plantation.

Moreover, the soil strength reduced by biochar applications (Chan et al, 2007). The provision of organic matter trigger the aggregation created a pore space which is could decrease of particulate solid particles, implicate to reduce soil compaction and make the roots easier through the soil. The treatment also affect in the difference of the lowest weights for three soil type.

Regosol has the lowest content weights using rice husk biochar treatment and the same time raised the highest Bulk density. Three types of biochar given the same content weight when treated in lithosol. the weight of the soil content is lower than if only using a single biochar. While organic fertilizer combined to the biochar, it would have lower content weight of litosol compared with only biochar specifically 16% and 7%.

Application of corncob biochar - dung, rise husk biochar - compost and rise husk - dung on mediteran implied the same content weight which is decreases into 17 - 26%. The particle weight The particle weight of regosol increases with the combination corncob biochar - dung as well as crooked biochar - organic fertilizer (compost or dung). The highest particle weight in lithosol was raised when it is treated with croncob and/or crooked biochar - dung combination.

Similarly, the highest particle weight in mediteran was obtained when treated by crooked biochar - dung. Rough textured have a lower water holding capacity compared with the opposite textured. Organic matter level also affects in soil aggregation which is turn to the particle weight, content weight, and pore space in the soil.

**Porosity** Almost all of the treatments did not decrease the porosity of the soil regosol in this study, even increased with rice husk biochar. Porosity of regosol increased by 8%, from 57% (control) to 62% (rice husk biochar). Moreover, porosity increased after treated the biochar-organic fertilizer on litosol and mediteran land.

The best treatment for increasing the porosity of clay comes from a combination of biochar and organic fertilizer. Combination of corncob biochar - organic fertilizer increases porosity of lithosol by 14%, while the crooked biochar - compost increases porosity of mediteran by 21%. Asai et al. (2009) has reported that biochar has a high total porosity and could store water in the pores implied high nutrient availability. However, combination of types of biochar - organic fertilizers indicate distinct respond to clay-textured due to different sand, dust, clay and organic C content (Table 1) which is similarly with **the characteristics of biochar and organic fertilizer** (Table 2).

Ammu and Anitha (2015) stated that the highest porosity of wild wood biochar resulted in significantly higher water holding capacity into the clay- textured. Table 2. Physical characteristic of **biochar and organic fertilizer**

Parameter	Karakteristik Biochar	Pupuk Organik Rce	husk biochar	Corn cob biochar	Crooked Biochar	Dung Compost	Water retention (%)
Bulk Density (g/cm <sup>3</sup> )	0,65	0,27	0,31				
Volatile matter (%)	42	75	66				
Particle size (%) - 325 mesh (0,044 mm)	2,70	0,8	0,55	0,15			
0,2 - > 60 mesh (0,250 mm)	16,75	14,25	4,9	3,05	7,6		
30 mesh (0,595 mm)	42,60	54,2	79,9	10,55	22		
18 mesh (1,00 mm)	68,15	70,8	94,9	20,95	36,2		
Total C (%)	29,8	45,6	40				
Organic C (%)	25,02	15,58					
Ash (%)	53,4	23,6	32,8				

Note: It was analyzed at PT Sucofindo Surabaya joint with PT Gudang Garam, Tbk Gempol Pasuruan

Table 3. The content weight in regosol, litosol, and mediteran

Treatment	Regosol	Litosol	Mediteran
Kontrol	1.015 ± 0.022 c	0.832 ± 0.011 c	0.924 ± 0.074 e
S	0.923 ± 0.016 a	0.772 ± 0.026 b	0.735 ± 0.107 bc
T	0.962 ± 0.037 ab	0.778 ± 0.016 b	0.687 ± 0.028 a
J	0.966 ± 0.017 abc	0.767 ± 0.005 b	0.808 ± 0.023 d
SA	0.955 ± 0.038 ab	0.699 ± 0.026 a	0.697 ± 0.026 a
SK	1.001 ± 0.006 b	0.711 ± 0.008 a	0.771 ± 0.040 c
TA	1.013 ± 0.046 c	0.689 ± 0.022 a	0.710 ± 0.034 ab
TK	0.972 ± 0.017 abc	0.726 ± 0.007 ab	0.790 ± 0.010 c
JA	0.999 ± 0.043 bc	0.720 ± 0.010 ab	0.760 ± 0.030 c
JK	0.960 ± 0.053 ab	0.677 ± 0.010 a	0.682 ± 0.004 a
A	1.016 ± 0.025 c	0.711 ± 0.005 a	0.679 ± 0.002 a
K	0.960 ± 0.009 ab	0.823 ± 0.041 c	0.771 ± 0.039 c

Note : difference notation indicate the use of different fertilizer (analyzed by DMRT, ? 5%)

Table 4.

The particle weight of regosol, litosol and mediteran

Treatment	Regosol	Litosol	Mediteran
Kontrol	57.117 ± 0.996 ab	63.924 ± 1.329 a	58.582 ± 2.842 a
S	61.598 ± 0.310 d	65.816 ± 1.049 ab	66.088 ± 5.196 cd
T	58.536 ± 2.709 ab	67.764 ±	



0.957 bc 68.911 ± 1.204 d J 57.874 ± 0.922 ab 66.813 ± 0.664 abc 62.372 ± 1.232 b SA 59.524 ± 2.779 bc 70.243 ± 1.172 d 70.872 ± 1.086 de SK 56.149 ± 0.189 ab 67.580 ± 0.329 bcd 66.180 ± 1.987 cd TA 58.042 ± 1.515 ab 72.884 ± 1.025 e 68.471 ± 1.554 de TK 58.190 ± 0.356 ab 69.220 ± 1.808 cd 65.197 ± 0.952 c JA 58.803 ± 2.138 bc 69.239 ± 0.113 cd 70.476 ± 1.304 de JK 60.555 ± 4.501 cd 71.448 ± 1.131 de 71.157 ± 0.462 e A 55.117 ± 0.907 a 68.971 ± 1.282 cd 70.541 ± 0.292 de K 58.628 ± 0.527 bc 65.313 ± 1.385 ab 66.907 ± 2.193 c Note: difference notation indicate the use of different fertilizer (analyzed by DMRT, ? 5%) Macro pore implied rapid drainage pores so that need decreasing of macro pore specially in regosol. Combination biochar and dung show the best result to decreased the macro in sandy soil, amounted to 21.4% from 37.3% to 29.3%.

Lower macro pore almost got when dung fertilizer was applied compared to the three types of biochar - compost (Table 2), which is it may be more suitable for sandy soil. decline of macro pore is very important in sandy soil pores, as well as meso or micro pore increases so that water retention would be increased and could be utilized effectively. In contrast, all treatments increase the macro pore of the mediterranean (clay-textured).

Combination of crooked biochar - compost have significantly increased of the macro pore by 179% from 13% to 36%. This condition may not be same in the other combination when applied in litosol. Rice husk and corncob biochar gave the same effect to increase macro pore on litosol soil.

The use of crooked biochar - dung combination shows better macro pore than a single-use biochar jengkok. The use of rise husk biochar - dung and corncob biochar - dung amandment gave higher macro pores than single treatment (biochar only) in lithosol which is the pore increase of 28%, from 32% to 45%. This condition was greatly affect for root respiration.

There is a marked correlation both the content weight and the percentage of macro pores in the three soil types within the Rvalue = - 0.807 (regosol); R = - 0.454 (lithosol); R = -0,873 (mediteran). The result shown that the R2 value of 0.65 (regosol); 0.21 (litosol) and 0.76 (mediterranean) indicate. The content weight would be increased when the macro pore declined. Meso pores gave higher water retention into the soil.

In this study, the meso pore increased 28%, from 9.6% (control) to 13.4% (biochar and organic fertilizer) on sandy soils. Purakayastha et al. (2013) reported that the water capacity raised high value when rise husk biochar (561%) and corncob biochar (456%) was used. It further conveyed that the porosity was increased the surface area threefold

and may affect to water retention in the soil. Table 5.

**Porosity in regosol, litosol, and mediteran Treatment Porosity (%) Regosol Litosol Mediteran Kontrol**

Treatment	Regosol	Litosol	Mediteran
Kontrol	57.117 ± 0.996 ab	63.924 ± 1.329 a	58.582 ± 2.842 a
S	61.598 ± 0.310 d	65.816 ± 1.049 ab	66.088 ± 5.196 cd
T	58.536 ± 2.709 ab	67.764 ± 0.957 bc	68.911 ± 1.204 d
J	57.874 ± 0.922 ab	66.813 ± 0.664 abc	62.372 ± 1.232 b
SA	59.524 ± 2.779 bc	70.243 ± 1.172 d	70.872 ± 1.086 de
SK	56.149 ± 0.189 ab	67.580 ± 0.329 bcd	66.180 ± 1.987 cd
TA	58.042 ± 1.515 ab	72.884 ± 1.025 e	68.471 ± 1.554 de
TK	58.190 ± 0.356 ab	69.220 ± 1.808 cd	65.197 ± 0.952 c
JA	58.803 ± 2.138 bc	69.239 ± 0.113 cd	70.476 ± 1.304 de
JK	60.555 ± 4.501 cd	71.448 ± 1.131 de	71.157 ± 0.462 e
A	55.117 ± 0.907 a	68.971 ± 1.282 cd	70.541 ± 0.292 de
K	58.628 ± 0.527 bc	65.313 ± 1.385 ab	66.907 ± 2.193 c

Note: difference notation indicate the use of different fertilizer (analyzed by DMRT, ? 5%) Table 6.

**The percentage of macro pores in regosl, litosol and medteran Treatment Macro pore (%) Regosol Litosol Mediteran Kontrol**

Treatment	Regosol	Litosol	Mediteran
Kontrol	37.345 ± 5.501 b	32.359 ± 1.744 a	13.010 ± 2.580 a
S	38.556 ± 0.483 b	36.476 ± 0.862 b	27.512 ± 1.875 cd
T	35.616 ± 3.107 ab	36.932 ± 2.576 b	33.022 ± 3.434 d
J	35.159 ± 1.040 ab	26.334 ± 1.402 a	18.818 ± 2.159 ab
SA	37.533 ± 3.865 b	45.128 ± 4.873 c	34.881 ± 1.972 de
SK	31.980 ± 0.376 ab	27.799 ± 3.359 a	24.489 ± 3.178 b
TA	31.888 ± 4.780 ab	44.794 ± 1.791 c	31.480 ± 3.542 de
TK	35.050 ± 0.118 ab	37.015 ± 4.763 b	22.987 ± 1.610 bc
JA	35.031 ± 3.122 ab	35.407 ± 3.623 b	28.991 ± 3.880 cd
JK	37.935 ± 5.449 b	40.087 ± 2.287 bc	36.339 ± 2.036 e
A	29.386 ± 0.686 a	37.130 ± 3.047 b	28.210 ± 1.305 cd
K	35.617 ± 0.741 ab	31.869 ± 3.237 a	28.347 ± 4.630 cd

Note: difference notation indicate the use of different fertilizer (analyzed by DMRT, ? 5%) Three types of whether in biochar - organic fertilizers combination or a single-use of biochar was increased the meso pore in sandy soil.

This result are in line with Atkinson et al, (2010); Sutono and Nurida (2012); and Suwardji et al., (2012) which were reported that biochar effectively improves groundwater retention in sandy soils. The water available upto 16% specific in biochar-dung (cattla manure) (Sukartono and Utomo (2012) .The particle size distribution reflects to the pores and indicate that using biochar might increase the meso pore and **surface area of the** soil texture than organic fertilizers in single-uses in sandy soil.

Granulator may also contribute to the aggregation and make crumb structure organic material which is could increase water retention in to the soil. Meso pores decreased respectively at 33% and 49% from 17.4% (control) to 11.7% (corn cob biochar) and 8.7% (rise husk biochar) on mediteran . Further meso pores also decreased using rise husk biochar - dung combination and corn cob biochar but it could not influence using biochar - compost combination.

**The use of single-use of biochar both rise husk and/or corncob was decreased meso pore effectively than combine with dung. Crooked biochar whether in single-use or combined with dung may not affect to decrease meso pore, whereas gave some alter when crooked biochar - compost was treseted in mediteran. Different affect of crooked biochar application in both mediteran and litosol even there have same textured (clay) especially in meso pore.**

**Litosol contain organic carbon two times as large as in mediteran, however the clay and meso pore levels of the lithosol are lower than the mediterane (Table 1). Crooked biochar may decrease meso pore 56% from 11.5% to 5.0% in lithosol, while that is may not influence in mediteran. Crooked biochar has low water holding capacity (143.7%) with particle size approximately 0.044 mm and 0.25 mm.**

**It form are lower than the other biochar with particle size approximately 0,595 and 1 mm. Another of biochar useful also shown that there may not influence for meso pore in litosol. There was a marked correlation both the content weight and the percentage of meso pores with  $R = 0.371$  (regosol) and  $R = 0.578$  (mediteran), whereas in lithosol did not show any real correlation.  $R^2$  value of 0.14 (regosol) and 0.33 (mediteran) The micro pore indicates slow drainage pore which is determines high value of water retention.**

**Provision of biochar - organic fertilizer combination has not an effect on increasing the percentage of micro pore even it's applied in sandy soil. In the other hand, all treatment may affect in micro pore when its applied in mediteran, except rise husk biochar. The use of crooked biochar - compost and single-use of dung might decrease the micro pores at 25.4% from 28.3% to 21.1% in mediteran.**

**Other treatments also affect in meso pore decline at 14.9% from 28.3% to 24.1% in mediteran. Decrease of percentage of micro pore in mediteran was useful to reduce excess water content that disturbs of air circulatio in the soil. The addition of organic matter plays a role for clay aggregation so that air circulation runs better.**

**The use of three types biochar could affect whether increase or decrease the micro pore in litosol soil. Rise husk and corncob biochar might decreased the micro pore at 11.9% from 20.2% to 17.8% in lithosol, but the different condition was found when crooked biochar could gave increased the micro pore at 22.9% from 20.2% to 26.2% in lithosol.**

**Crooked biochar has the lowest water retention and particle size (0.044 mm and 0.250 mm) but contain the highest particle size (0.595 mm and 1 mm) compared to other biochar. The three types of biochar - dung can decrease the micro pores, but may not**

**gave significantly affect when combined with compost in lithosol.**

**The micro pore decline in clay implicated the reduction due to excess water which prevents air circulation. It thus might cause limited oxygen on the root followed by the death of the plant. There is a marked correlation between the contents weight of the clay soil with the percentage of micro pore with the value of  $R = 0,557$  (litosol) and  $R = 0,536$  (mediteran).**

**The value of  $R^2$  is 0.29 (mediteran) and 0.31 (litosol) but on sand the correlation may not gave their influence. Table 7. The percentage of meso pore in regosol, litosol and mediteran Treatment Meso pore (%) Regosol Litosol Mediteran Kontrol  $9.614 \pm 4.262$  a  $11.456 \pm 1.166$  bc  $17.422 \pm 2.663$  c S  $13.834 \pm 0.228$  b  $11.063 \pm 1.207$  bc  $8.783 \pm 5.935$  a T  $12.328 \pm 0.738$  ab  $13.072 \pm 1.865$  bc  $11.718 \pm 2.943$  a J  $12.791 \pm 0.199$  ab  $5.038 \pm 6.068$  a  $18.123 \pm 2.230$  c SA  $12.231 \pm 0.979$  ab  $11.785 \pm 1.180$  bc  $12.787 \pm 1.453$  b SK  $13.124 \pm 0.205$  b  $12.001 \pm 6.130$  bc  $18.256 \pm 0.905$  c TA  $13.915 \pm 1.855$  b  $13.439 \pm 0.463$  bc  $12.065 \pm 2.540$  b TK  $12.387 \pm 0.375$  ab  $11.498 \pm 2.040$  bc  $17.272 \pm 0.648$  c JA  $13.838 \pm 1.016$  b  $12.855 \pm 1.720$  bc  $18.182 \pm 0.769$  c JK  $12.866 \pm 1.029$  ab  $14.401 \pm 1.195$  c  $13.586 \pm 1.424$  b A  $15.869 \pm 0.523$  b  $13.964 \pm 2.848$  bc  $15.748 \pm 0.248$  bc K  $14.198 \pm 0.280$  b  $10.844 \pm 1.989$  b  $12.999 \pm 2.613$  b Note: difference notation indicate the use of different fertilizer (analyzed by DMRT, ? 5%) Table 8.**

**The percentage of micro pore in regosol, litosol and mediteran Treatment Micro pore (%) Regosol Litosol Mediteran Kontrol  $10.171 \pm 0.297$  bc  $20.229 \pm 0.686$  d  $28.323 \pm 0.587$  e S  $8.933 \pm 0.116$  a  $17.745 \pm 0.441$  c  $29.827 \pm 0.756$  f T  $10.802 \pm 0.343$  bc  $17.836 \pm 0.284$  c  $24.198 \pm 0.723$  bc J  $9.982 \pm 0.031$  b  $26.192 \pm 0.731$  f  $25.167 \pm 1.259$  d SA  $9.929 \pm 0.123$  b  $14.911 \pm 1.136$  a  $23.300 \pm 0.608$  b SK  $10.934 \pm 0.114$  bc  $21.102 \pm 0.176$  e  $23.310 \pm 0.598$  b TA  $11.002 \pm 0.004$  c  $14.670 \pm 0.571$  a  $24.731 \pm 0.466$  cd TK  $10.773 \pm 0.392$  bc  $19.226 \pm 0.689$  d  $24.820 \pm 0.312$  cd JA  $9.984 \pm 0.027$  bc  $18.844 \pm 0.270$  d  $23.122 \pm 2.186$  b JK  $9.951 \pm 0.084$  b  $14.817 \pm 0.316$  a  $21.129 \pm 0.224$  a A  $9.862 \pm 0.240$  b  $15.759 \pm 0.672$  b  $21.047 \pm 0.082$  a K  $9.023 \pm 0.040$  b  $21.761 \pm 0.413$  e  $25.864 \pm 0.236$  d Note: difference notation indicate the use of different fertilizer (analyzed by DMRT, ? 5%) (14%) similarly in mediteran (21%).**

**Macro pore increased almost 3-fold using CONCLUSION Applied rise husk biochar gave the highest percentage to reduce the contents weight and increase porosity of regosol. Treatment using biochar - dung combination is better than single-use of biochar to decrease the content weight in litosol. Single-use of corncob biochar, rise husk biochar - dung, crooked biochar - compost, and crooked biochar - dung gave lower the content weight in mediteran.**

The lowest content weight was given when rice husk biochar (single-use) was treated in regosol. Lower content weight decline was found in litosol when combination of biochar - organic fertilizer were treated rather than the single use of biochar 16% and 7% respectively. On mediteran soils, all treatments could decreased the content weight upto 17-26%.

The particle weights could be increased using a combination of biochar - chicken manure. Biochar types would determine for the particle weight alteration. All the treatments applied have not significantly decreased the particle weight and porosity in regosol. The highest particle weight was raised using corncob biochar - dung or crooked biochar - dung in litosol.

Moreover, The highest particle weight in mediteran was raised using crooked biochar = dung. Porosity decline was found in regosol using dung. Treatment using corncob biochar - dung combination increases the porosity of lithosol soil crooked biochar jengkok - compost combination in mediteran. Macro pore increased 21-24% using rice husk biochar combination or corncob biochar - dung combination in lithosol.

However, the macro pore decreased 21% using single-use of dung with in regosol. Meso pores decline on clay was determined by combination three biochar - organic fertilizer utilization. The highest meso pore decrease was obtained using crooked biochar treated in litosol as well as rice husk and corncob in mediteran.

Biochar type determines meso pore alteration especially in clay-textured. Crooked biochar may decrease meso pore 56% from 11.5% to 5.0%. Meso pores decreased respectively 33% and 49% from 17.4% to 11.7% (using corncob biochar) and 8.7% (using rice husk biochar) in lithosol. The use of **biochar and organic fertilizer** on sandy soil can increase meso pores 28.4% from 9.6% to 13.4%. 7.

The utilizatio of **biochar and organic fertilizer** combination has not been able to increase the micro pore on regosol soil. The largest decrease of micro pore 25% was raised using crooked biochar - compost combination and/or combined with dung in mediteran. The micropore was reduced 12% using rice husk biochar - dung combination, corncob biochar - dung combination, and crooked biochar - compost combination treated in litosol. Treatment using crooked biochar - compost combination and/or crooked biochar - dung combination could decrease micro pore 25.4% from 28.3% to 21.1% in mediteran.

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