Characterization of biochar combination with organic fertilizer: the effects on physical properties of some soil types

by Hidayati Karamina

Submission date: 27-Nov-2019 02:42PM (UTC+0700)
Submission ID: 1222722610
File name: 017_Characterization_of_biochar_combination_with-dikonversi.docx (40.81K)
Word count: 6244
Character count: 31156

Available online freely at www.isisn.org

Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2017 14(4): 955-965. **OPEN ACCESS**

Characterization of biochar combination with organic fertilizer: the effects on physical properties of some soil types

Widowati, Sutoyo, Taufik Iskandar, and Hidayati Karamina

Agrotechnology Department, Agriculture Faculty, Univerisity of Tribhuwana Tunggadewi Malang, East Java, **Indonesia**

***Correspondence**: widwidowati@gmail.com **Accepted**: 10 Sep. 2017 **Published online**: 10 Dec. 2017

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 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 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-1 (Regosol); 0.5 g g-1 (Litosol); And 0.61 g g-1 (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 – 500°C 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 700°C 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 th 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 Tunggadewi University, Malang, Indonesia (7,48 '.50 "BS and 112o.37 '41" BT) was applied for the treatment, with mean annual temperatures in range 16°-

36°C, 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^3 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-1 in 20 cm layer. During incubation, groundwater was maintained at 0.11-0.18 g g-1 (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 carbon formation. 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 meash 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 <α (= 0.05) (show in Table 3 – 8 below).

The content weigth

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 (~ 0.3 mg m^{-3} for biochar compared to the volume weight of 1.3 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 denstity.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 fertlizer 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 dan Pupuk Organik				
	Rce husk biochar	Corncob biochar	Crooked Biochar	Dung	Compost
Water retention (%)	326,04	249,6	143,7	213,38	111,68
BulkDensity (grm/cm^3)	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	The content weight of the soil (g cm^{-3})											
	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, α 5%)

Table 4. The particle weight of regosol, litosol and mediteran

Treatment	The particle weight (%)											
	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, α 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 (mediterran) 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	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, α 5%)

Table 6. The percentage of macro pores in regosl, litosol and medteran

Treatment	Macro pore (%)											
	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, α 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% (corncob biochar) and 8.7% (rise husk biochar) on mediteran . Further meso pores also decreased using rise husk biochar - dung combination and corncob 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 wehther in single-use or combined with dung may not affect to decrease meso pore, whereas gave some alter when crooked biochar - compost was treted 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. R2 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 R2 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	±	4.262	a	11.456	±	1.166	bc	17.422	±	2.663	c
S	13.834	±	0.228	b	11.063	±	1.207	bc	8.783	±	5.935	a
T	12.328	±	0.738	ab	13.072	±	1.865	bc	11.718	±	2.943	a
J	12.791	±	0.199	ab	5.038	±	6.068	a	18.123	±	2.230	c
SA	12.231	±	0.979	ab	11.785	±	1.180	bc	12.787	±	1.453	b
SK	13.124	±	0.205	b	12.001	±	6.130	bc	18.256	±	0.905	c
TA	13.915	±	1.855	b	13.439	±	0.463	bc	12.065	±	2.540	b
TK	12.387	±	0.375	ab	11.498	±	2.040	bc	17.272	±	0.648	c
JA	13.838	±	1.016	b	12.855	±	1.720	bc	18.182	±	0.769	c
JK	12.866	±	1.029	ab	14.401	±	1.195	c	13.586	±	1.424	b
A	15.869	±	0.523	b	13.964	±	2.848	bc	15.748	±	0.248	bc
K	14.198	±	0.280	b	10.844	±	1.989	b	12.999	±	2.613	b

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

Table 8. The percentage of micro pore in regosol, litosol and mediteran

Treatment	Micro pore (%)											
	Regosol				Litosol				Mediteran			
Kontrol	10.171	±	0.297	bc	20.229	±	0.686	d	28.323	±	0.587	e
S	8.933	±	0.116	a	17.745	±	0.441	c	29.827	±	0.756	f
T	10.802	±	0.343	bc	17.836	±	0.284	c	24.198	±	0.723	bc
J	9.982	±	0.031	b	26.192	±	0.731	f	25.167	±	1.259	d
SA	9.929	±	0.123	b	14.911	±	1.136	a	23.300	±	0.608	b
SK	10.934	±	0.114	bc	21.102	±	0.176	e	23.310	±	0.598	b
TA	11.002	±	0.004	c	14.670	±	0.571	a	24.731	±	0.466	cd
TK	10.773	±	0.392	bc	19.226	±	0.689	d	24.820	±	0.312	cd
JA	9.984	±	0.027	bc	18.844	±	0.270	d	23.122	±	2.186	b
JK	9.951	±	0.084	b	14.817	±	0.316	a	21.129	±	0.224	a
A	9.862	±	0.240	b	15.759	±	0.672	b	21.047	±	0.082	a
K	9.023	±	0.040	b	21.761	±	0.413	e	25.864	±	0.236	d

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

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 whne rise husk bio char (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 (14%) similarly in mediteran (21%).

Macro pore increased almost 3-fold using crooked biochar jengkok – compost combination in mediteran. Macro pore increased 21-24% using rise 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 rise 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 rise 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 micro pore 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.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

ACKNOWLEGEMENT

Many thanks to the Ministry of Higher Education Technology Research (Kementrian Riset dan Teknologi) which has funded Superior Research of Higher Education in 2017, PT Gudang Garam, tbk who has provided and analyzed biochar jengkok, and PT Bisi International which has provided corn cob waste.

AUTHOR CONTRIBUTIONS

WDW designed and performed the experiments and also wrote the manuscript. STY designed experiment and reviewed the manuscript. TI performed main material production. HK performed the treatment and data analysis. All authors read and approved the final version.

REFERENCES

Ammu, P and S. Anitha (2015). Production and characterisation of biochar from different organic materials. Journal of Tropical Agriculture. 53 (2), pp. 191-196.

Asai H, Samson BK, Stephan HM, Songyikhangsuthor K, Homma K, Kiyono Y, Inoue Y, Shiraiwa T, and Horie T (2009). Biochar amandement techniques for upland rice production in Northern Laos 1.Soil physical properties, leaf SPAD and grain yield. Field Crops Research. 111, pp. 81–84.

Atkinson, C.J., J.D. Fitzgerald, and N.A. Hipps (2010). Potential mechanisms for chieving agricultural benefits from biochar application to temperate soils: a review. Plant Soil. 337, 1–18.

Brady NC and Weill RR (2004). Elements of the Nature and Properties of Soils 2nd Ed. Pearson Prentice Hall. Upper Saddle River NJ. pp. 111-112.

Chan KY, Van Zweiten L, Meszaros I, Downie A and Joseph S (2007). Assessing the agronomic values of contrasting char materials on Australian hardsetting soil. Proceedings of the Conference of the International Agrichar Initiative. Australia, Terrigal NSW.

Downie A, Crosky A and Munroe P (2009). Physical properties of biochar. In Biochar for environmental management science and technology Eds. J Lehmann and S Joseph. Earthscan, London. Sterling VA, pp. 13-32.

Enders A, Hanley K, Whitman T, Joseph S and Lehmann J (2012). Characterization of biochars to evaluate recalcitrance and agronomic performance. Journal of Bioresour Technology. 114, pp. 644-53.

FCO [Fertilizer Control Order] (1985). Fertilizer Association of India. New Delhi. p. 202.

Gaskin, J.W., Steiner, C, Harris, K, Das KC, Bibens, B (2008). Effect of low temperature pyrolysis conditions on biochar for agricultural use. Transactions of the Asabe. 51, pp. 2061–2069.

Glaser, B.,Johannes, L., Wolfgang, Z (2002). Ameliorating physical and chemical properties of highly weathered soils in the tropics with charcoal – a review. Biology and Fertility of Soils. 35, pp. 219–230. Doi 10.1007/s00374-002-0466-4

Kolb TE, Agee JK, Fule PZ, McDowell NG, Pearson K, Sala A and Waring RH (2007). Perpetuating old ponderosa

Lehmann, J., da Silva, J.J.P., Steiner, C., Nehls, T., Zech, W., Glaser, B (2003). Nutrient availability and leaching in an archaeological Anthrosol and a Ferralsol of the Central Amazon basin: fertilizer, manure and charcoal amendments. Plant Soil, pp. 249:343–357

Manya JJ (2012). Pyrolysis for biochar purposes: a review to establish current knowledge gaps and research needs. Journal of Environ Sciences Technology. 46, pp. 7939 – 7954.

Muhammad, AN, Muhammad, K, Muhammad, A, Rashid, A (2014). Yield And Nutrient Composition Of Biochar Produced From Different Feedstocks At Varying Pyrolytic Temperatures. Pak. J. Agri. Sci., Vol. 51(1), pp. 75-82.

Oguntunde PG, Abiodun BJ, Ajayi AE and Van de Giesen N (2008). Effects of charcoal production on soil physical properties in Ghana. Journal of Plant Nutrient and Soil Science. 171, pp. 591–596.

Purakayastha, T.J., Pathak, H. and Savita, K (2013). Effect of feedstock on characteristics of biochar and its impact on carbon sequaestration in soil. In: Procedings of National seminar on current environmental challenges and possible solutions, 15-16 February 2013, University of Delhi, pp 74-75.

Sohi SP, Krull E, Lopez CE and Bol R (2010). A review of biochar and its use and function in soil. Journal of Advances in Agronomy. 105, pp. 47–82.

Soil Survey laboratory Methods Manual (2014). United States Department of Agriculture.

Sukartono dan Utomo (2012). Peranan biochar sebagai pembenah tanah pada pertanaman jagung di tanah lempung berpasir semiarid tropis Lombok Utara. Buana Sains, vol 12 no1, pp. 91-98.

Sutono dan N.L. Nurida (2012). Kemampuan biochar memegang air pada tanah bertekstur pasir. Buana Sains, vol 12 no 1, pp. 45-52.

Suwardji, Sukartono dan W.H.Utomo (2012). Kematapan agregat setelah aplikasi biochar di tanah lempung berpasir pada pertanaman jagung di lahan kering Kabipaten Lombok Utara. Buana Sains, vol 12 no 1, pp. 61-68.

Yu Ok-You.R. Brian and S. Sam (2013). Impact of biochar on the water capacity of loamy sand soil.4:44.http://www.journal.ijeee.com/content/4/1/44 (di download 24 Mei 2014).

Characterization of biochar combination with organic fertilizer: the effects on physical properties of some soil types

ORIGINALITY REPORT

18%	12%	9%	15%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Universitas Brawijaya Student Paper	3%
2	media.neliti.com Internet Source	1%
3	repository.unair.ac.id Internet Source	1%
4	Submitted to University of Southampton Student Paper	1%
5	Submitted to Universitas Diponegoro Student Paper	1%
6	Submitted to Harper Adams University College Student Paper	1%
7	Submitted to Papua New Guinea University of Technology Student Paper	1%
8	Submitted to Higher Education Commission Pakistan Student Paper	1%

9	www.climateactionreserve.org Internet Source	1%
10	Basso, Andres S., Fernando E. Miguez, David A. Laird, Robert Horton, and Mark Westgate. "Assessing potential of biochar for increasing water-holding capacity of sandy soils", GCB Bioenergy, 2013. Publication	1%
11	Submitted to University of Nottingham Student Paper	1%
12	X. Peng, L.L. Ye, C.H. Wang, H. Zhou, B. Sun. "Temperature- and duration-dependent rice straw-derived biochar: Characteristics and its effects on soil properties of an Ultisol in southern China", Soil and Tillage Research, 2011 Publication	1%
13	Submitted to University of Florida Student Paper	1%
14	Submitted to University of Wales Swansea Student Paper	<1%
15	www.springerprofessional.de Internet Source	<1%
16	Submitted to University of Reading Student Paper	<1%

17	id.123dok.com Internet Source	<1%
18	eprints.lancs.ac.uk Internet Source	<1%
19	biochar.ucdavis.edu Internet Source	<1%
20	link.springer.com Internet Source	<1%
21	utahbiomassresources.org Internet Source	<1%
22	amsdottorato.unibo.it Internet Source	<1%
23	www.media.uio.no Internet Source	<1%
24	Submitted to North West University Student Paper	<1%
25	www.archive.org Internet Source	<1%
26	scholar.lib.vt.edu Internet Source	<1%
27	Submitted to University of Keele Student Paper	<1%
28	Submitted to University of Wales, Bangor Student Paper	

<1%

29	Gowariker. "Bibliography", The Fertilizer Encyclopedia, 01/05/2008 Publication	<1%
30	Submitted to University of Venda Student Paper	<1%
31	Submitted to King Saud University Student Paper	<1%
32	mediatum.ub.tum.de Internet Source	<1%
33	docobook.com Internet Source	<1%
34	Submitted to Associatie K.U.Leuven Student Paper	<1%
35	www.tandfonline.com Internet Source	<1%
36	Gusiatin, Zygmunt Mariusz, Radosław Kurkowski, Szczepan Brym, and Dariusz Wiśniewski. "Properties of biochars from conventional and alternative feedstocks and their suitability for metal immobilization in industrial soil", Environmental Science and Pollution Research, 2016. Publication	<1%

37	dspace.ucuenca.edu.ec Internet Source	<1%
38	Submitted to University of Salford Student Paper	<1%
39	Evan A. N. Marks, Josep M. Alcañiz, Xavier Domene. "Unintended effects of biochars on short-term plant growth in a calcareous soil", Plant and Soil, 2014 Publication	<1%
40	Submitted to Buford High School Student Paper	<1%
41	Functions of Natural Organic Matter in Changing Environment, 2013. Publication	<1%

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	Off		