SINAI Journal of Applied Sciences 9 (2) 2020 157-168

Available online at www.sinjas.journals.ekb.eg

SCREENED BY iThenticate Professional Plagiarism Prevention

SINAI Journal of Applied Sciences

Print ISSN 2314-6079
Online ISSN 2682-3527

ARU-EGYPT SJAS Trust Science | It Creates

IMPROVING SANDY SOIL PROPERTIES BY USING BIOCHAR

Nedaa M. Radwan[1]; Ezzat R. Marzouk[2]; Atif M. El-Melegy[1]; Mostafa A. Hassan[2]

1. Inst. Res. Soil and water, Minist. Agric. and Land Reclam., Egypt.
2. Dept. Soil and water, Fac. Environ, Agric. Sci., Arish Univ., Egypt.

ARTICLE INFO

Article history:
Received: 01/03/2020
Revised: 31/03/2020
Accepted: 02/05/2020
Available online: 02/05/2020

Keywords:
Biochar,
sandy soil,
drainage,
bulk density,
water holding capacity.

Check for updates

ABSTRACT

Increasing water-holding capacity of sandy soils will help improve efficiency of water use in agricultural production. We hypothesized that addition of biochar will increase the water-holding capacity and decrease drainage of sandy soil. Biochar used from local plant residuals; olive wastes including olive pomace (OP) and olive trees wood chops (WC). column experiment had undertaken at the laboratory of the Faculty of Environmental Agricultural Sciences, Arish University, Arish City, Egypt, using different rates of OP and WC. Slow pyrolysis had undertaken on 400^{o}c at 75 min for (OP) and 350^{o}c at 150min for (WC). Biochar was mixed with soil at (0%, 0.2%, 0.4% and 0.8% W/W) and placed into columns. Biochar amended columns had a significant average increase of 44.4% and 70.4% in gravity drained water content, relative to the controls for WC and OP. Columns receiving the 0.8% biochar treatment lost significantly less water to drainage comparably with the other treatments. There were significantly differences in evaporation and drainage between 0.2 and 0.4% addition of WC350 and OP400, respectively. On the other hand, values of drainage observed in the 0.4 and 0.8% of both biochars were significantly less than the values of drainage for the 0.2% addition rates. Bulk density of the control columns increased significantly during the incubation from 1.42 to 1.47 g cm^{-3} for incubation day 0 and 36, respectively. On incubation day 36, significant lower bulk densities of 8.82, 10.6, 3.11, 85.1, 5.45, and 8.56% for OP400-0.2%, OP400-0.4%, OP400-0.8%, WC350-0.2%, WC350-0.4%, and WC350-0.8% treatments we observed, respectively, relative to controls. The results suggest that biochar added to sandy soil increases water-holding capacity, decrease drainage of sandy soil and might increase water available for crop use.

INTRODUCTION

Soil water movement and storage are crucial for nutrient delivery and plant productivity. Agricultural and environmental applications of biochar to soils have received increasing attention as a possible means of improving productivity and sustainability (**Lehmann and Joseph, 2015**). Biochar is a fine-grained, carbon rich product obtained by heating biomass such as wood, manure, or leaves in a closed container with a limited or no supply of oxygen. Amending soil with biochar is an approach to mitigate climate changed to improve crop productivity (**Sohi *et al*. 2009**). Once mixed with soil, Biochar can affect plant growth by altering soil hydrologic properties and nutrient availability (**Liu *et al*. 2017**). Biochar is known for its neutral to high surface area, high water holding capacity, and high cation exchange capacity (CEC) (**Mukherjee *et al*., 2011**).

Increasing population, economic growth, and climate change are putting substantial stress on the world’s water resources. Biochar has the potential to alter soil hydrology and to drive shifts in the amount

---

*** Corresponding author: E-mail address:** nedaa.m.redwan@gmail.com

https://doi.org/10.21608/SINJAS.2020.86405

of water stored in soils. Previous studies concerning the addition of biochar to soil have shown the potential for increasing soil water holding capacity (**Smith *et al.*, 2016**). The ability of biochar to increase water holding capacity of soils might have a positive effect by either reducing the amount of water used by the agricultural sector or increasing food production for a given amount of water (**Basso *et al.*, 2013**). Sandy soils generally have low capacity for retaining water; hence supplement an irrigation is often needed for agricultural production on these soils. There are only a few studies testing the impact of biochar additions on water retention by sandy soils (**Sohi *et al.*, 2010**). Current work assesses the potential of adding different ratio of biochar on increasing water holding capacity and decreasing drainage of sandy soil by using infiltration soil column experiment**.**

MATERIALS AND METHODS

Soil

The soil used in this study was a sandy soil sampled from the surface 20 cm of a field on the research farm, Faculty of Environmental Agricultural Sciences, Arish University, North Sinai, Egypt. Soil sample was air dried, ground with a wooden mallet and passed through a 2 mm sieve and stored in clean dry plastic bags for further use. General soil properties were presented in Table 1. Soil texture was determined using hydrometer methods as described by (**McKeague, 1978**). The tested soil was sandy in nature with 4.50% and 2.30% clay and 93.2% sand fractions, respectively. Soil pH was determined in soil: water suspensions (1:2.5 ratio) using a pH meter and combined glass electrode (Ag/AgCl) (Model pH 209, HANNA Instruments, Bedford, UK). Electric conductivity (EC) was measured in 1:5 soil: water suspension using a Conductivity meter (Model HI 9033 Multi-range, Hanna instruments, Bedford, UK). Total soil carbonate content was measured using the Collins' Calcimeter method (**Piper, 1954**). Briefly, 1 g dried soil (< 2 mm size) interacted with 2 ml of 6 M HCl in a sealed connected vail to the instrument. After a set reaction time, CO_2 was measured to calculate $CaCO_3$%. The instrument was calibrated using pure reagent grade $CaCO_3$. Soil organic carbon (SOC) concentrations were determined in HCl treated samples using a CNS Analyzer (FlashEA® 1112) following standard methods as described by **Mahayni (2012)**. Multi-element analysis was undertaken by ICP-MS (Model X-Series^{II}, Thermo-Fisher Scientific, Bremen, Germany).

Biochar

Two types of biochars were used in soil column experiment. Olive pomace (OP) samples were collected from an extra-virgin olive oil extractor located in the Faculty of Environmental Agricultural Sciences, Arish University, Arish City and the Wood branches (WC) were collected from olive trees grown in Experimental Farm of the Faculty of Environmental Agricultural Sciences, Arish University, Arish city. A known quantity of dried material of olive wood chops (WC) and olive pomace (OP) wastes were taken in closed perforated crucible and heated in muffle furnace (**Sadaka *et al.*, 2014**), (OP) on 400^{o}C/75 min and (WC) on 350^{o}C/150 min slow pyrolysis.

Biochar Characteristics

Characteristics of the biochar are provided in Tables 2 and 3.

Yield

After the pyrolysis process, the biochar yield was recorded. Biochar yield was calculated using the following equation: Mass yield (%) = $(W_f / W_0) \times 100$

Where:

W_f is the dry mass (g) of the produced biochar and W_0 is the dry mass (g) of the precursors (**Vijayanand *et al.*, 2016**).

Table 1. Tested Soil chemical characterization

Parameter	Value
PH	7.66
EC dSm^{-1}	0.30
$CaCO_3$ (%)	0.05
Organic matter (%)	0.01
Total element concentrations mg kg^{-1}	
Na	3134
Mg	2502
K	4410
Mn	140
Fe	6106
Particle size distributions (%)	
Sand	93.2
Silt	2.30
Clay	4.50
Soil Texture	Sand

Table 2. Total elemental and phenol concentrations in Biochar from OP and WC synthesized by different pyrolysis time and temperature

Element	OP at 400 °C and 75 min	WC at 350 °C and 150 min
C (%)	73.20	74.50
H (%)	3.01	3.01
N (%)	0.30	0.20
Molar ratio		
H:C	0.490	0.481
C: N	285.0	434
Fe (mg kg^{-1})	317.0	166
Mn (mg kg^{-1})	13.3	18.3
Ca (%)	1.31	1.51
Mg (%)	0.106	0.244
Na (%)	0.100	0.14
K (%)	0.900	0.14
T. Phenol (%)	0.32 (0.61)*	n.a

*Value in parenthesis is the concentration of total phenol in OP raw materials

Table 3. Summary of physicochemical analysis of Biochar from OP and WC synthesized by different pyrolysis time and temperature

Parameter	OP at 400 °C and 75 min	WC at 350 °C and 150 min
Pore number per unit area	39400	21500
Pore diameter nm	66.3	55.9
pH	8.09	7.49
EC dSm^{-1}	0.145	0.245
ORP mV	115	70.0
Biochar yield (%)	42.7	41.2
OM (%)	46.0	40.6
SOM (%)	49.8	55.3
SOMYI	2130	2280

Moisture content

Cleaned oven-dried porcelain crucibles were weighed and added to each approximately 1 g and weighed to the nearest 0.1 mg of the ground WC and OP. The samples were placed in the oven at 105°C for 120 minutes, dried in a desiccator for an hour and the crucible was weighed. Percent moisture in the sample was calculated according to: Moisture (%)= [(A-B)/A] x 100

Where:

A= Grams of the air-dry sample used, B= Grams of the sample after drying at 105°C (**Vijayanand *et al*., 2016**).

Organic matter, stable organic matter, and indexed organic matter

The manufactured biochar was characterized for oxidizable organic carbon (OC) content by the potassium dichromate oxidation method using methods described by the Black and Weekly method modified as described by **Sopok (1992)**. Loss on ignition (LOI) was determined by ASTM method D-1762-84. The carbon liability index was calculated as the OC/LOI ratio. A comparative measure of stable organic matter (SOM) was calculated as below (**Thomas *et al*., 2013**):

$$\text{SOM} = \text{LOI} - (\text{OC} \times 1.724)$$

Where:

1.724 is the factor to convert organic carbon to organic matter.

Stable organic matter yield index (SOMYI) was determined by the following equation: SOMYI= Char yield 100 × SOM

pH, oxidation-reduction potential (ORP) and electrical conductivity (EC)

Sample pH and ORP of biochars were measured according to the procedure described by **Ahmedna *et al.* (2000)**. A proportion of 1.0% (W/W) water suspension of each type of Biochar was heated to approximately 90°C, and stirred for 20 min. The mixture was allowed to cool to room temperature and the pH and ORP were determined using pH Meter (HANNA Instruments, Ann Arbor Michigan) after initial calibration with standard pH 4 and pH 7 buffers. The EC was determined by stirring a 1.0% (W/W) solution of biochar for 20 min and was measured using a Conductivity meter (HANNA Instruments, Ann Arbor Michigan). All analyses were performed in triplicate.

Scanning electron microscope (SEM)

The microstructural features of some biochar samples produced at different pyrolysis temperatures and times were investigated by means of scanning electron microscopy (SEM; Quanta 450 FEG-ESEM, FEI Company) as shown in Fig. 1.

Pore number and size per area unit

The SEM images were imported into ImageJ software to analyze them in order to find out the number and size of samples' pores and the average pore diameter.

BET surface area

The surface area was determined using dry biochar samples via N2 adsorption at 77 K on Surface Area Analyzer (Micromeritics ASAP 2020 BET).

Zeta potential

Zeta potential (ZP) was determined for each sample in duplicate using a Zeta-Meter 3.0 system (Zeta Meter Inc., VA).

Total phenolic content

Phenolic compounds were determined using the Folin–Ciocalteu method (**Singleton *et al.*, 1965**).

Available elements

Available (Fe, Mn, Ca, Mg, Na and k) were extracted according to the method of **Soltanpour (1991)** by mixture solution of ammonium bicarbonate and diethylenetriamine pentaacetic acid 97% (AB-DTPA) with adjusting pH at 7.6; 20 g of biochar sample was shaken with 40 ml from the mixture solution to 15 minutes before being filtered through filter paper.

Incubation

The soil incubation was carried out in PVC columns of 29 cm height and 6 cm external diameter. A PVC end cap on the bottom of each column had a drain hole (3 mm) with an attached tube (4.3 mm) for collecting water draining out the bottom of the columns. The total mass of oven dry soil in each column was 1000 g. There were four rates of biochar application 0% (control), 0.2%, 0.4% and 0.8% (W/W) for each feedstock OP and WC. The biochar completely mixed with soil in all treatments. The columns were incubated for six leaching events. Every event lasting for a week. The 24 columns were randomly distributed in two square tables (Fig. 2). Every seven days 150 mL of 0.001M $CaCl^2$ solution was added to each column to produce a leaching event. Dilute $CaCl^2$ was used to reduce soil dispersion. The solution was introduced on the top of each column at approximately 4 $mlmin^{-1}$, using a dropper system. Fiberglass filter paper was placed at the soil surface of each column to help disperse solution drops as they impacted the soil.

Water Partitioning

Water partitioning was assessed for every leaching event during the incubation by measuring the mass of water draining out the bottom of the column, water retained within the column, and water evaporated out the top of the column. The weight of each column was determined before the start of a leaching event and the mass of water retained within the column was determined by subtracting the initial dry column weight. Drainage was collected for approximately 24 hr., after the beginning of the leaching event in plastic bottles placed below each column and connected with the drainage tube. The collection bottles had a cap with a small hole that allowed the drain tube to be fitted into the bottle to minimize evaporation loss. The weight of each bottle was subtracted from the weight of the bottle without solution and weekly drainage was determined. Evaporation was assessed by computing the difference between water added and drainage plus any change in water content. In order to wet the entire column and produce leaching, the first leaching event was made using 300 ml of solution. The remaining leaching events

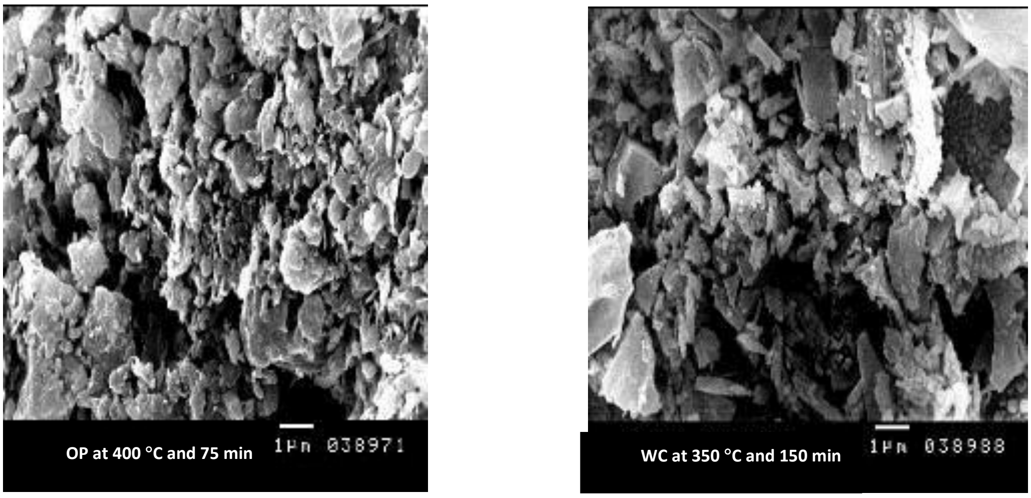

Fig. 1. SEM images for OP pyrolysis at 400°C and for 75 min and WC pyrolysis at 350°C and for 150 min.

Fig. 2. Soil column experiments design incubated for 36 days with different rate of (OP) and (WC).

were completed using 150 mL of solution. The amount of water potentially available for evapotranspiration (ET) was the sum of water retained in the column and the amount of water lost to evaporation between watering events.

Evaporative demand temperature in the room where the columns were incubated was kept constant during the incubation. Nevertheless, there were differences in temperature across the room and evaporative demand was also influenced by proximity to overhead air circulation fans. In order to take into account these differences, evaporative demand was determined. For this, PVC cups were filled with an equal amount of water and placed above each column. Several times during the period of two or three days, the PVC cups were weighed to determine average water loss per hour for each column. This measure of evaporative demand was used as a covariate in the statistical analysis.

Bulk Density

Bulk density was determined before and after every leaching event. The distance from the top surface soil to the top of the column was recorded and the volume of soil was determined. Bulk density was calculated by dividing the mass of soil by the soil volume. This approach assumes no changes in soil mass during the incubation and the value obtained was the average bulk density of the column (**Grossman *et al.*, 1968**).

Statistical Analysis

Analysis of variance (ANOVA), paired T-tests and Pearson correlation coefficients were determined using Minitab ® 15.1.3.0.; the default level of confidence was 95.0% ($P < 0.05$) unless stated otherwise in the discussion.

RESULTS AND DISCUSSION

Water Partitioning (Amount of Water Retained by the Soil, Evaporated and Drained)

Fig. 4 show that biochar amended columns had a significant average increase of 44.4% and 70.4% in gravity drained water content, relative to the controls for WC and OP. Biochar increased gravimetric water content in experiments by other researchers (**Novak *et al.*, 2009; Laird *et al.*, 2010; Sun *et al.*, 2019**). Differences in water content between biochar treatments were not significant although OP amended column showed slightly higher water content than the other biochar treatment in all application rates. Columns receiving the 0.8 % biochar treatment lost significantly ($p < 0.05$) less water to drainage to the other treatments. There were significantly differences in evaporation and drainage between 0.2 and 0.4% addition of WC and OP, respectively. On the other hand, values of drainage observed in the 0.4 and 0.8% of both biochars were significantly ($p<0.05$) less than the values of drainage for the 0.2% addition rates. This difference might be due to the fact that the more additions of biochar in the soil columns had slower water infiltration rates during most of the incubation time compared to the other treatments, resulting not only in the least drainage, but also in greater evaporation due to ponding of water. **Tryon (1948)** observed that addition of charcoal to soil reduced slightly the loss of moisture by evaporation, and that the effect was more pronounced when a sandy soil was used instead of a clayey soil. In the present study, we observed a contrast results as biochars were mainly well mixed with the whole soil column not the top surface. However, in the experiment setup that **Tryon (1948)** used to determine evaporation there was no possibility for drainage and the quantities of biochar used were much greater than in the present experiment, so his results are not directly comparable with those obtained here.

During most of the incubation time, water infiltration was very slow in the columns of the OP treatments, requiring approximately 20 min for all of the added water to infiltrate. In all WC treatments, around 10 min was sufficient for all of the water to infiltrate. The infiltration rate of the OP columns, however, increased with time and became similar to the infiltration rate of the other treatments by the end of the incubation period (36 days). Infiltration rate was not measured in this experiment; these values are estimates from observation made during the incubation course. However, this observation suggests that the biochar used might be hydrophobic when it is fresh and that it become more hydrophilic after prolonged contact with soil, air and watering solution, as observed in other studies (**Cheng *et al.*, 2008; Joseph *et al.*, 2010**).

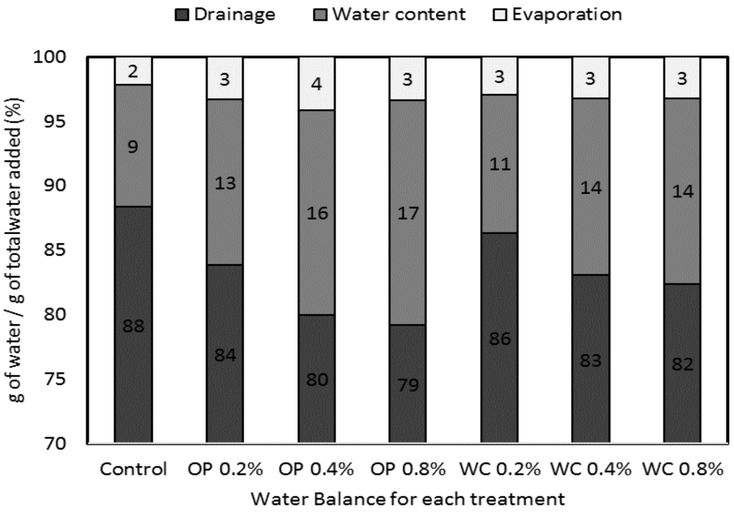

Fig. 3. Water partitioning for each treatment averaged across 36 days of incubation. Biochar rates for both selected materials (OP and WC) were 0.00, 0.2, 0.4, 0.8%

Soil water content of columns treated with biochar were relatively constant during the incubation period while the water content of the control slowly increased during the incubation from day 7 to 36 (Fig. 4), probably due to the decrease in soil bulk density observed for the control columns (Fig. 5).

The same as control, all other treatments behalf the same trend. In comparing day 29 with other event days, there were significant decreases in water content for all columns that received biochar and the control.

Average values of available water for ET for each treatment at incubation day 36 were 35.0, 35.7, 34.6, 36.3, 39.3, 38.8 and 40.4 g of water per kg of oven-dry soil for the control, OP 0.2%, OP 0.4%, OP 0.8%, WC 0.2%, WC 0.4%, and WC0.8% treatment, respectively. These values represent a significant increase in available water for ET for the biochar treatment with high rate of additions of WC relative to OP treatments.

Determine Changes in Bulk Density after Biochar Addition to the Soil

Bulk density of the control columns increased significantly during the incubation from 1.42 to 1.47 g cm^{-3} for incubation day 0 and 36, respectively (Fig. 4). On the other hand, changes in bulk density for the biochar treatments were not significant along the incubation period for OP and WC at 0.4% (Fig. 4). At the end of the incubation, the average values of bulk density were 1.43 (control), 1.35 (OP 0.2%), 1.31 (OP 0.4%), 1.44 (OP0.8%), 1.36 (WC 0.2%), 1.39 (WC 0.4%) and 1.35 (WC 0.8%) gcm^{-3}. Other researchers have also found a decrease in soil bulk density after biochar additions (**Laird *et al.*, 2010; Githinji, 2014; de Jesus Duarte *et al.*, 2019**), probably due to the low bulk density of the biochar itself (**Downie *et al.*, 2009**). On incubation day 36, we observed a significant ($p<0.05$) lower bulk densities of 8.82, 10.6, 3.11, 85.1, 5.45, and 8.56% for OP 0.2%, OP 0.4%, OP 0.8%, WC 0.2%, WC 0.4%, and WC 0.8% treatments, respectively, relative to controls. Decrease in bulk densities may promote plant root elongation (**Voorhees *et al.*, 1975**) and root density (**Thompson *et al.*, 1987**). In addition, reduction of bulk density by 12% has been shown to improve water infiltration by 27% (**Franzluebbers, 2002**).

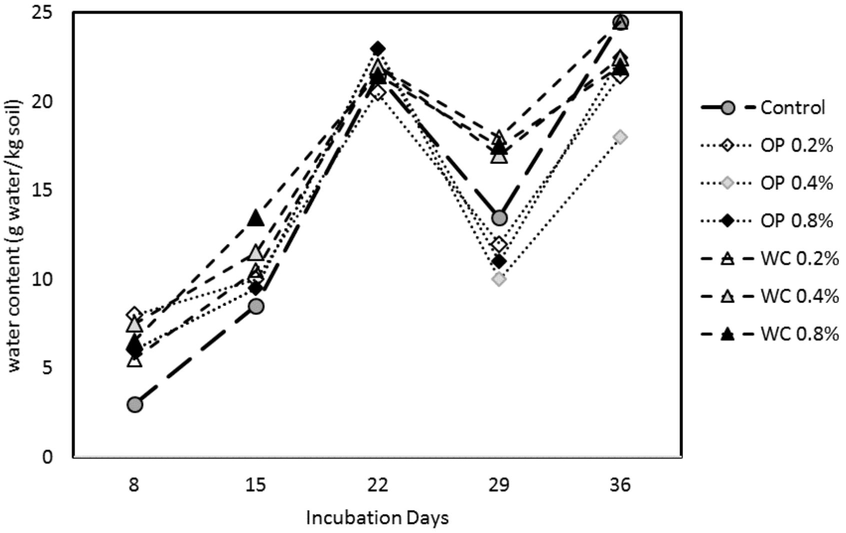

Fig. 4. Temporal dynamic of gravimetric water content for each treatment during the 36 days of incubation. Biochar rates for both selected materials (OP and WC) were 0.00, 0.2, 0.4, 0.8%. Error bare were removed for clarity

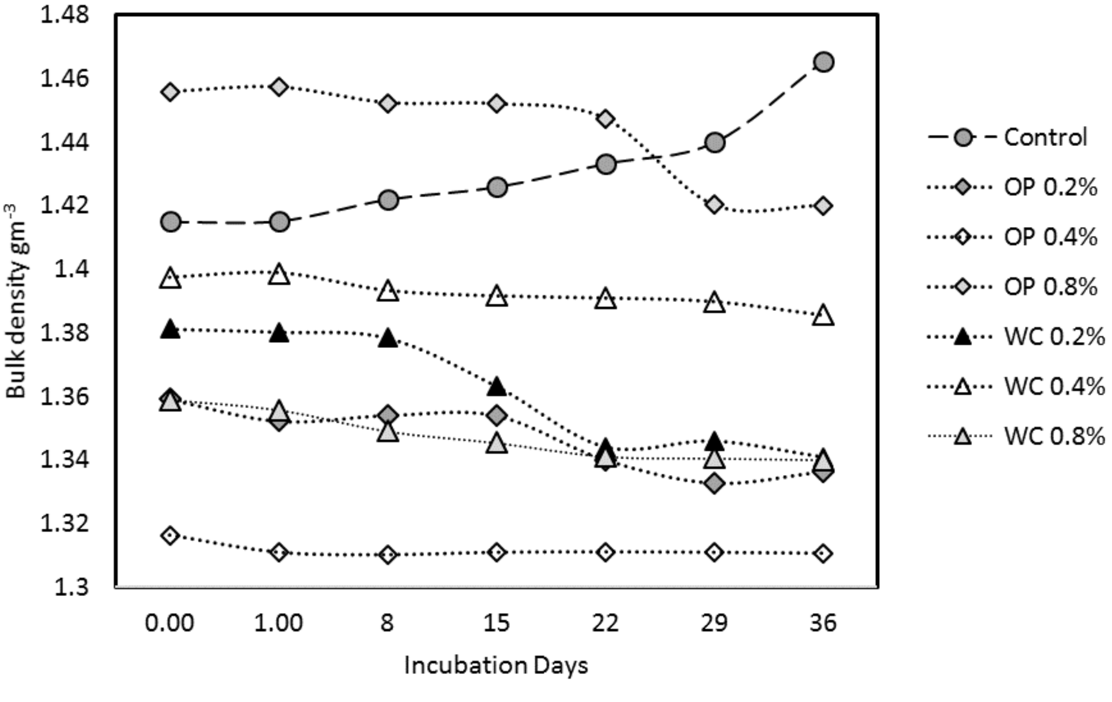

Fig. 5. Temporal dynamic of bulk density for each treatment during the 36 days of incubation. Biochar rates for both selected materials (OP and WC) were 0.00, 0.2, 0.4, 0.8%. Error bare were removed for clarity.

REFERENCES

Ahmedna, M.; Marshall, W. and Rao, R. (2000). Production of granular activated carbons from select agricultural by-products and evaluation of their physical, chemical and adsorption properties. Biores. Technol., 71 (2): 113-123.

Basso, A.S.; Miguez, F.E.; Laird, D.A.; Horton, R. and Westgate, M. (2013). Assessing potential of biochar for increasing water-holding capacity of sandy soils. Gcb Bioen., 5 (2): 132-143.

Cheng, C.-H.; Lehmann, J. and Engelhard, M.H. (2008). Natural oxidation of black carbon in soils: changes in molecular form and surface charge along a climosequence. Geochimica et Cosmochimica Acta., 72 (6): 1598-1610.

de Jesus Duarte, S.; Glaser, B.; Cerri, P. and Eduardo, C. (2019). Effect of biochar particle size on physical, hydrological and chemical properties of loamy and sandy tropical soils. Agron., 9 (4): 165.

Downie, A.; Crosky, A. and Munroe, P. (2009). Physical Properties of Biochar. Biochar for Environmental Management Science and Technology, Earthscan Publ., London, S. Joseph and J. Lehmann, London, GB: Earthscan., 13–32.

Franzluebbers, A.J. (2002). Water infiltration and soil structure related to organic matter and its stratification with depth. Soil and Tillage Res., 66 (2): 197-205.

Githinji, L. (2014). Effect of biochar application rate on soil physical and hydraulic properties of a sandy loam. Archives of Agron. and Soil Sci., 60 (4): 457-470.

Grossman, R.B.; Brasher, B.R.; Franzmeier, D.P. and Walker, J.L., (1968). Linear extensibility as calculated from natural-clod bulk density measurements. Soil Sci. Soc. Ame. J., 32 (4): 570-573.

Joseph, S.; Camps-Arbestain, M.; Lin, Y.; Munroe, P.; Chia, C.; Hook, J.; Van Zwieten, L.; Kimber, S.; Cowie, A. and Singh, B. (2010). An investigation into the reactions of biochar in soil. Soil Res., 48 (7): 501-515.

Laird, D.A.; Fleming, P.; Davis, D.D.; Horton, R.; Wang, B. and Karlen, D.L. (2010). Impact of biochar amendments on the quality of a typical Midwestern agricultural soil. Geoderma, 158 (3): 443-449.

Lehmann, J. and Joseph, S. (2015). Biochar for environmental management: an introduction. Biochar for environmental management, Routledge: 33-46.

Liu, Z.; Dugan, B.; Masiello, C.A. and Gonnermann, H.M. (2017). Biochar particle size, shape, and porosity act together to influence soil water properties. Plos One, 12 (6): e0179079.

Mahayni, T.W. (2012). Radionuclide transport at the geosphere-biosphere interface-a combined measurements and modelling study. Ph.D. Univ. Nottingham.

McKeague, J. (1978). Manual on soil sampling and methods of analysis, Canadian Soc. Soil Sci.

Mukherjee, A.; Zimmerman, A. and Harris, W. (2011). Surface chemistry variations among a series of laboratory-produced biochars. Geoderma, 163 (3-4): 247-255.

Novak, J.M.; Lima, I.; Xing, B.; Gaskin, J.W.; Steiner, C.; Das, K.; Ahmedna, M.; Rehrah, D.; Watts, D.W. and Busscher, W.J. (2009). Characterization of designer biochar produced at different temperatures and their effects on a loamy sand. Ann. Environ. Sci.

Piper, C.S. (1954). Soil and Plant Analysis: A laboratory Manual of Methods for the

Examination of Soils and the Determination of the Inorganic Constituents of Plants, Int. Sci. Publisher Inc., New York.

Sadaka, S.; Sharara, M.; Ashworth, A.; Keyser, P.; Allen, F. and Wright, A. (2014). Characterization of biochar from switchgrass carbonization. Energies, 7 (2): 548-567.

Smith, P.; House, J.I.; Bustamante, M.; Sobocká, J.; Harper, R.; Pan, G.; West, P.C.; Clark, J.M.; Adhya, T. and Rumpel, C. (2016). Global change pressures on soils from land use and management. Global Change Biol., 22 (3): 1008-1028.

Sohi, S.P.; Krull, E.; Lopez-Capel, E. and Bol, R. (2010). A review of biochar and its use and function in soil. Advances in Agronomy, Elsevier, 105: 47-82.

Sohi, S.; Lopez-Capel, E.; Krull, E. and Bol, R. (2009). Biochar, climate change and soil: A review to guide future research. CSIRO Land and Water Sci. Rep., 5 (09): 17-31.

Soltanpour, P. (1991). Determination of nutrient availability and elemental toxicity by AB-DTPA soil test and ICPS. Advances in soil science, Springer, 165-190.

Sopok, S. (1992). Determination of Copper Cyanide Plating Solutions and Cadmium in Cadmium Cyanide Plating Solutions by Atomic Absorption Spectrometry. Army Armament Research Development and Engineering Center Watervliet Ny Benet Labs.

Sun, J.; Yang, R.; Zhu, J.; Pan, Y.; Yang, M. and Zhang, Z. (2019). Can the increase of irrigation frequency improve the rate of water and salt migration in biochar-amended saline soil?" J. Soils and Sediments, 1-10.

Thomas, S.C.; Frye, S.; Gale, N.; Garmon, M.; Launchbury, R.; Machado, N.; Melamed, S.; Murray, J.; Petroff, A. and Winsborough, C. (2013). Biochar mitigates negative effects of salt additions on two herbaceous plant species. J. Environ. Manag., 129: 62-68.

Thompson, P.; Jansen, I. and Hooks, C. (1987). Penetrometer Resistance and Bulk Density as Parameters for Predicting Root System Performance in Mine Soils 1. Soil Sci. Soc. Ame. J., 51 (5): 1288-1293.

Tryon, E.H. (1948). Effect of charcoal on certain physical, chemical, and biological properties of forest soils. Ecol. Monographs, 18 (1): 81-115.

Vijayanand, C.; Kamaraj, S.; Sriramajayam, S. and Ramesh, D. (2016). Biochar production from arecanut waste. Int. J. Farm Sci., 6 (1): 43-48.

Voorhees, W.; Farrell, D. and Larson, W. (1975). Soil Strength and Aeration Effects on Root Elongation 1. Soil Sci. Soc. Ame. J., 39 (5): 948-953.

الملخص العربي

تحسين خواص التربة الرملية باستخدام البيوتشار

نداء محمد رضوان[1]، عزت رشاد مرزوق[2]، عاطف محمد المليجي[1]، مصطفي علي حسن[2]

1. معهد بحوث الأراضي والمياه والبيئة بالجيزة، مركز البحوث الزراعية، مصر.
2. قسم الأراضي والمياه، كلية العلوم الزراعية البيئية، جامعة العريش، مصر.

إن زيادة قدرة التربة الرملية على الاحتفاظ بالمياه سيساعد على تحسين كفاءة استخدام المياه في الإنتاج الزراعي، استخدام البيوتشار قد يزيد من قدرة التربة الرملية ويساهم في تقليل الصرف السريع للتربة الرملية، في العمل الحالي استخدمنا البيوتشار المنتج من بقايا المخلفات المحلية مثل مخلفات الزيتون بما في ذلك تفل الزيتون (OP) ومخلفات تقليم الزيتون (WC)، تم عمل تجربة أعمدة بمعمل كلية العلوم الزراعية البيئية، جامعة العريش، مدينة العريش باستخدام معدلات مختلفة لكل من نوعي البيوتشار (OP) و(WC). تم انتاج البيوتشار بالانحلال البطيء تحت درجات حرارة ٤٠٠ درجة مئوية بالنسبة لـ (OP) لمدة زمنية 75 دقيقة و ٣٥٠ درجة مئوية بالنسبة لـ (WC) لمدة زمنية 150 دقيقة. تم خلط البيوتشار بالتربة بالنسب التالية [صفر0%، 0.2%، 0.4%، 0.8% وزن/وزن] ووضعه في أعمدة. وأظهرت النتائج تأثير كبير لإضافة البيوتشار على الاحتفاظ بالرطوبة ضد الجذب الأرضي بنسبة 44.4% و70.4% في المتوسط مقارنة بالمعاملة دون إضافة بالنسبة لـ WC و OPعلى التوالي. وقد لوحظ أن قيم صرف المياه بالنسبة لمعدل إضافة 0.8% اقل بكثير مقارنة بقيم الصرف المياه بمعدلات الإضافة الأخرى، أيضا كان هناك اختلاف مؤثر بين معدلي الإضافة 0.2% و0.4% لـ WC وOP على التوالي، من ناحية أخرى، كانت قيم الصرف التي لوحظت في 0.4 و0.8% من كل البيوتشار أقل بكثير من قيم الصرف لمعدلات الإضافة 0.2%. زادت الكثافة الظاهرية لأعمدة من دون إضافة بشكل كبير أثناء التجربة من 1.42 إلى 1.47 جم سم$^{-3}$ خلال أيام التحضين الـ 36 على التوالي. في يوم التحضين 36، لاحظنا انخفاضًا كبيرًا في الكثافة الظاهرية 8.82 و10.6 و3.11 و85.1 و5.45 و8.56% للمعاملات 0.2OP% و0,4OP% و0.8OP% و0.2WC% و0.4WC%، و0.8WC%، على التوالي، مقارنة بالمعاملة دون إضافة. تشير النتائج إلى أن البيوتشار المضاف إلى التربة الرملية يزيد من قدرة التربة بالاحتفاظ بالمياه، ويقلل من تصريف التربة الرملية وقد تزيد من المياه المتاحة لاستخدام المحاصيل.

الكلمات الاسترشادية: البيوتشار، التربة الرملية، الصرف، الكثافة الظاهرية، قدرة التربة على الاحتفاظ بالمياه.

المحكمــــون:

1- **أ.د. أيمن محمود حلمــي**	أستاذ الأراضي والمياه، كلية الزراعة، جامعة الزقازيق، مصر.
2- **د. محمـد سعد القصاص**	أستاذ الأراضي والمياه المساعد، كلية العلوم الزراعية البيئية، جامعة العريش، مصر.