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Effect of Olive mill Wastewater and Biochar under Different NPK Rates on Sandy Soil Properties and Peanut productivity

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ABSTRACT
The field experiment was conducted two successive summer seasons of 2018 and 2019 at Ismailia Agricultural Research Station, Egypt to evaluate the effect of Olive mill wastewater (OMW), Biochar and NPK fertilizers rates on some sandy soil properties and peanut (*Arachish ypogaea*) productivity in sandy soil. A randomized complete block design was used. The results indicated that soil pH and EC was not significantly affected in the soil treated with Olive mill wastewater (OMW) and biochar. There are positive significant effects on nutrient availability (NPK) in both seasons by using biochar and olive mill wastewater in soil as well as their content in peanut plants. The application of OMW can improve soil quality indices (nutrients (N, P, and K), organic matter, pH, total porosity, bulk density and plant growth performance. The Olive mill wastewater (OMW) and Biochar application increased plant height, No. of branches, No. of pods, protein (%), seed oil (%) and seed yield (ton fed^{-1}) as well as NPK content in peanut plant.

Keywords: Olive mill wastewater, Biochar, NPK, sandy soil, peanut (*Arachis hypogaea*)

Introduction

Egypt occupies a total area of about 100 million hectares, out of this area, is about 3.1 million hectares as cultivated area. The newly reclaimed lands (0.8 million hectares) included sandy and calcareous soils, which the soil in poor in organic matter and macro-and micronutrients (Abd El-Hadi, 2004). The sandy and calcareous soils faces large constraints due to low water holding and nutrient retention capacity, and accelerated mineralization of soil organic matter, (Abdelraouf *et al.,* 2017).

Olive mill wastewater (OMW) is the liquid waste produced from olive oil production process. The reuse and management of OMW is a major issue in the olive oil–producing regions. An estimated 30 million m^3 of Olive wastewater is yearly produced from olive oil process (Ouzounidou and Asfi, 2012). The application of OMW can improve soil quality indices nutrients (N, P, and K), organic matter, pH and plant growth. Soil nutrient contents, as well as soil physical properties (structure, porosity, density) and hydraulic (saturated hydraulic conductivity), were improved with Olive wastewater application (Kavvadias *et al.,* 2015; Belqziz *et al.,* 2016). OMW chemical properties might cause soil and water contamination. However, it is used in agriculture as soil amendment or fertilizer can be rationalized because of the high content of plant growth nutrients, such as nitrogen (N), phosphorus (P), and potassium (K), organic matter which can contribute positively to plant nutrient requirements especially under arid environment and poor soil fertility conditions (Mohawesh *et al.,* 2014; Belqziz *et al.,* 2016). Piotrowska *et al.* (2006) found that soil application of OMW increased soil water holding capacity, total soil porosity and aggregate stability density which was attributed to the effect of the soil compounds provided to the soil with OMW application. Ahmed *et al.* 2020) found growth experiment was performed to test the potential effects of Olive mill wastewater on germination efficiency, growth rate, total dry weight, nutrient content and uptake of Peanut, in sandy clay loam soil under 80% field capacity water regime.

Biochar (BC) is a carbonaceous residue produced through the thermal breakdown of organic materials under limited conditions of oxygen. Biochar was characterized by hydrophobic groups such cyclic acid anhydrides (C-C and C-O); asymmetric carboxylates (CO_2), aromatic ketones (C=O); silicon (Si-O); and hydrophilic groups such carbonates (C-O) and silanol (Si-O-H). With these

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classifications, this biochar was determined to have a high hydrophobicity (Duarte *et al.,* 2019). Leonard, (2013) suggested that the biochar is used as a soil amendment for improving soil quality and enhancing carbon sequestration. Biochar is positive improvement of soil physical and hydraulic properties. Khaled and Jeff (2019) reported that the application of biochar led to a decrease in soil pH and increase in soil OM and CEC. Application rates of biochar can significantly improve soil physical quality in terms of bulk density (BD), and water holding capacity (WHC). However, little data are available on surface area (SA), aggregation stability, and penetration resistance (PR), (Atanu and Rattan, 2013). Biochar is abundant in the organic matter, water holding capacity, nutrient-retaining capacity, and bioavailability nutrition elements (e.g., N, P, K, Ca), (Lehmann and Josehp, 2009). The biochar amendment enhanced the formation and stabilization of the soil macro-aggregates, especially in the sandy loam soil. Aggregate formation and stabilization are affected by the type and amount of organic materials, which include the microorganisms and microbial synthesis (Ouyang *et al.,* 2013). Biochar produced at 300 or 400 Co and added with NPK provided the highest yield compared to that with the NPK alone treatment and also compared to the biochar produced at 500 or 600 °C treatments (Novak *et al.*, 2009b). Bio-fertilizer plays a substantial role in chemical and biological transformations in soil and maintains soil fertility. The major biological elements, (carbon, nitrogen, oxygen and sulphur) are subjected to comparable cyclic processes. Nevertheless, on top of them is the nitrogen cycle, from both ecological and economic viewpoints (Idriss, 2004). Bio-fertilizers used can either fix atmospheric nitrogen and solubilize phosphate or stimulate plant growth through synthesis of growth promoting substances led to enhancing the decomposition of plant residues to release vital nutrients (Wu *et al.,* 2006). Bio fertilizer application led to improved soil chemical and biological characteristics; moreover due to the use of low doses of chemical fertilizers, agricultural production will be free from contaminants (Salimpour *et al.,* 2010).

Peanut (*Arachis hypogaea* L.) is one of self-pollinating most essential among edible oil seed crops throughout the world. The peanut is an important food and oilseed crop. It is called as the king of oilseeds crops .Peanut ranks the 13th among food crops, 4th among source of the oil seed crops and the 3rd among source of vegetable protein crops (Taru *et al.,* 2008). It is worth to note that, Egypt is suffering from dramatically shortage in edible oils, needed for nutritional consumption. Although in Egypt, the local production from crop oils is about 340 thousand tons in 2015, the Egyptian consumption is about 2.7 million tons in the same season. This indicated that, there is a major gap (87.4%) between local production and consumption, which has created importation to fulfill the requirements of market (FAO, 2016). Therefore the objectives of this work were to investigate : the effect of Biochar and Olive mill wastewater (OMW) application on NPK fertilization soil properties and productivity of Peanut plant grown on sandy soil.

Materials and Methods

A field experiment was conducted at Ismailia Research Station 2019 Agricultural Research Center (A.R.C), Egypt during two successive seasons of winter 2018 and. The soil samples were taken at depth 0-30 cm before cultivation and after harvesting to determine physical and chemical characteristics of the investigated soil according to Page *et al.* (1982) as shown in Table (1).

Some properties of the used Olive mill wastewater and bio-char were carried out as described by Brunner and Wasmer (1978) as illustrated in Table 2.

The investigation was conducted to evaluate the effect of biochar, Olive mill wastewater under different NPK rates on soil properties, and productivity of plant peanut grown in sandy soil. The initial soil was analyzed and showed in table 1 soil analysis showed that soil was sandy texture and low fertility for available macronutrients. Biochar and olive mill waste analysis were showed in table 2.The applied biochar to this experiment made of different types of citrus trees it was produced using pyrolysis at a final temperature of 500 °C with a retention time of 2 h. Biochar samples were ground and sieved at <0.5mm diameter. Biochar was applied to the soil at 4 ton/fed rate while, OMW was applied to the soil at two rates 10% and 20 % of 50 L/fed.

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Table 1: Some physical and chemical properties of the initial soil (0-30 cm depth).

Chemical properties					
		Soluble cations(meq.I)**			
pH	7.84	**Ca^{++}**	3.51	**Na^{+}**	8.69
EC (dsm)	1.45	**Mg^{++}**	1.75	**K^{+}**	0.85
		Soluble anions(meq.I)**			
SAR	1.64	**CO_3^{--}**	**HCO_3^{-}**	**Cl^{-}**	**SO_4^{-}**
ESP	1.14	0.0	1.01	11.82	1.67
			Available nutrients (ppm)		
SP	21.23	**O.M%**	**N**	**P**	**K**
$CaCO_3$ %	5.95	0.40	34.5	3.65	164

Physical properties					
Particle size distribution (%)				**Texture class**	
Coarse sand	**Fine sand**	**Silt**	**Clay**		
55.60	34.06	6.57	3.83	**sand**	
Hydraulic conductivity (cm/h)		8.80	**Available water (%)**		15.3
Field capacity (% v/v)		9.13	**Total porosity %)**		38.4
Wilting point (% v/v)		1.90	**Bulk density (g cm^{-3})**		1.65

*pH *: in suspension 1:2.5* *EC**(ds/m) soil paste*extract

EC: Electrical conductivity, **SAR:** Sodium absorption Ratio, **ESP:** Exchangeable sodium Percent, **SP:** Saturation Percent, **O.M:** Organic matter

Table 2: Characteristics of olive mill wastewater and Biochar.

Olive mill wastewater analysis			
Parameters	**Values**	**Parameters**	**values**
Total COD (gI^{-1})	131.87	**N (%)**	1.63
phenols(gI^{-1})	6.95	**P (%)**	0.13
Total carbohydrates(gI^{-1})	24.57	**K (%)**	2.45
Oil and grease (gI^{-1})	11.14	**Fe mgL^{-1}**	22.45
TSS (gI^{-1})	34.36	**Mn mgL^{-1}**	8.61
Biochar analysis.			
Organic carbon %	26.91	**Total K %**	8.11
Organic matter %	46.39	**CEC (cmol/ kg)**	32.15
Ash (g kg^{-1})	3.2	**Moisture (g kg^{-1})**	60
Fixed (g kg^{-1})	60	**Volatiles (g kg^{-1})**	233
EC (dSm^{-1}) (1:10 biochar water suspension)dS/m	1.4	**pH**	6.87
Total N %	1.55	**Bulk density (g /cm^{3})**	0.16
Total P %	0.65		

The experiment included 11 treatments with three replicates as follow:

1. Control NPK $_{(100\ \%)}$ recommended dose
2. Biochar $_{(4ton/fed)}$+ NPK $_{(50\%)}$
3. Biochar $_{(4ton/fed)}$ + NPK $_{(75\%)}$
4. Olive mill wastewater 10% (OMW) + NPK $_{(50\ \%)}$
5. Olive mill wastewater 20% (OMW) + NPK $_{(50\ \%)}$
6. Olive mill wastewater 10% (OMW) + NPK $_{(75\ \%)}$
7. Olive mill wastewater 20% (OMW) + NPK $_{(75\ \%)}$
8. Olive mill wastewater 10% (OMW) + Biochar $_{(4ton/fed)}$ + NPK $_{(50\%)}$
9. Olive mill wastewater 20% (OMW) + Biochar $_{(4ton/fed)}$ + NPK $_{(50\%)}$
10. Olive mill wastewater 10% (OMW) + Biochar $_{(4ton/fed)}$+ NPK $_{(75\%)}$
11. Olive mill wastewater 20% (OMW) + Biochar $_{(4ton/fed)}$+ NPK $_{(75\%)}$

Superphosphate was applied during soil preparation. Ammonium nitrate was added at four split equal doses after 2, 4, 6 and 8 weeks from sowing. Potassium fertilizers were divided into two equal doses, the first was added at sowing after 31 days and the second was added after 55 days from sowing. At harvesting, ten plants from each plot were taken randomly, and threshed. Grain and straw

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were dried using an electrical oven on 75° C until constant weight obtained. Then weighted to obtain their dry weight and transferred to seed yield. The grain and straw were ground 0.5 g powder and digested by concentrated digestion mixture of H_2SO_4 + $HClO_4$ acids according to Sommers and Nelson (1972). Nitrogen was determined by micro Keldahl, according toPhosphorus was determined by spectrophotometric ally using ammonium moly date stannous chloride method according to Chapman and Pratt (1978). Potassium was determined by a flame photometer, according to Page *et al.* (1982). Available P and K were extracted by Ammonium-Bicarbonate- according to Soltanpour (1985). Field capacity was determined according to USDA (1962). Soil bulk density, total porosity and saturation percent were determined according to Black *et al.* (1965).

At harvest, Sample of vegetative growth were taken after 75 days from sowing.Determine the yield components as follows: Plant height (cm), number of branches/plant, and number of pods/plant. Whole plot was harvested and the pods were air dried to calculate seed yield per faddan. Oil and protein yields were calculated per fadden.

The experimental Design was randomized complete block design. Analysis of Variance (ANOVA) and least significant difference (LSD) were calculated according to Gomez and Gomez (1984)

Result and Discussion

1. Effect of olive mil wastewater and boichar combined with different NPK rate on soil physical properties.

1.1. Bulk density, total porosity and hydraulic conductivity.

Data presented in Table 3 showed that application of the biochar and olive mill waste water improved bulk density(BD) values, total porosity (TP) and hydraulic conductivity (K_{sat}) in two seasons compared with control ($NPK_{100\%}$)recommended dose. The best value of bulk density, total porosity and hydraulic conductivity were 1.37(g/cm^{-3}), 43.90(%) and 8.49(cm/h) respectively, in the second season with treatment by biochar + olive mill wastes $_{(20\%)}$ + $NPK_{(75\%)}$ was more than the other treatments. Application of biochar + olive mill wastes $_{(20\%)}$ + $NPK_{(75\%)}$ reduced bulk density and hydraulic conductivity values by percentage 16.4 and 6.1% respectively, compared with control, while total porosity values was increased by percentage 6.6%compared with control. These results were agreement with (**Arvidsson, 1999**).

Table 3: Effect of olive mill wastewater and boichar combined with different NPK rate on soil bulk density (BD), total porosity (TP) and hydraulic conductivity (K_{sat}) in two seasons.

Treatments	**First season**			**Second season**		
	BD (g/cm^3)	**TP (%)**	**K_{sat} (cm/h)**	**BD (g/cm^3)**	**TP (%)**	**K_{sat} (cm/h)**
Control (NPK) ($_{100\%}$)	1.68	39.9	8.70	1.65	41.6	8.69
Biochar + NPK $_{(50\%)}$	1.49	40.1	8.65	1.46	42.2	8.61
Biochar + NPK $_{(75)}$	1.43	41.3	8.61	1.44	42.4	8.58
Mean	**1.46**	**40.7**	**8.63**	**1.45**	**42.4**	**8.59**
OMW$_{(10\%)}$ +NPK $_{(50\%)}$	1.38	42.3	8.62	1.41	42.7	8.56
OMW$_{(10\%)}$ +NPK $_{(75\%)}$	1.37	42.5	8.61	1.42	42.6	8.54
OMW$_{(10\%)}$ + Biochar + NPK $_{(50\%)}$	1.34	42.6	8.56	1.41	42.9	8.53
OMW$_{(10\%)}$ + Biochar NPK $_{(75\%)}$	1.33	42.70	8.54	1.40	43.01	8.51
Mean	**1.35**	**42.52**	**8.58**	**1.41**	**42.80**	**8.53**
OMW$_{(20\%)}$ +NPK $_{(50\%)}$	1.38	42.3	8.63	1.42	43.3	8.53
OMW$_{(20\%)}$ +NPK $_{(75\%)}$	1.36	42.6	8.64	1.43	43.6	8.57
OMW$_{(20\%)}$ + Biochar + NPK $_{(50\%)}$	1.33	42.7	8.55	1.39	43.7	8.51
OMW$_{(20\%)}$ + Biochar + NPK $_{(75\%)}$	1.32	42.90	8.50	1.37	43.90	8.49
Mean	**1.34**	**42.6**	**8.58**	**1.40**	**43.6**	**8.52**
LSD. at 0.05						
Treatment	0.36	2.11	0.22	0.293	2.3612	0.23
OMW Rates	0.34	1.1	0.15	0.27	1.4	0.165
Biochar	0.22	0.967	0.07	0.21	0.83	0.133

Also, Ndor *et al.* (2015) mentioned that the applications of biochar had a significant effect on hydraulic conductivity, bulk density, porosity, and soil water-filled pore space. The effect of addition olive mill waste water on soil bulk density indicated a decrease. This reduction in bulk density can be attributed to the dilution effect resulted from mixing olive mill waste water added with the more dense soil minerals (Giovanna *et al.,* 2008). In agreement with these results, the effect appeared to be more obvious for coarse textured soils than fine textured. This may be tended to reduce soils erosion as a result of Bulk density, Total porosity and Hydraulic conductivity improvement (Mekki *et al.,* 2013).

Field capacity, wilting point and available water

Data presented in Table 4 showed that applications of the biochar and olive mill waste water had positive effect on field capacity values, wilting point and available water in the two seasons compared with control. Where the highest values of field capacity, wilting point and available water were higher with application of biochar + olive mill wastes $_{(20\%)}$ + NPK$_{(75\%)}$compare with other treatments, while the highest value of available water was with control. Biochar + NPK $_{(75\%)}$application increased of field capacity, wilting point and available water by 13.98,6.44 and 7.54% respectively, these results were agreement with (Giovanna *et al.,* 2008; Barbera *et al.,* 2013; Adnan and Ghaida, 2015) which reported that addition of (OMW) olive mill waste water was affected on field capacity and witling point depend on texture. The fine-textured soils; the increase in wilting point is less than at field capacity. As a result of sand fraction, the opposite occurred in coarse-textured soils, significant increase in wilting point rather than at field capacity Novak *et al.,* (2009b); Dumroese *et al.* (2011) found a significant influence of biochar addition on water retention. Addition of biochar increases soil field capacity Albuquerque *et al.* (2014) and Chan *et al.* (2007) found that biochar addition increased field capacity Lei & Zhang (2013) observed a significant increase in plant available water and macro pores in soil amended with biochar.

Table 4: Effect of olive mill wastewater and boichar combined with different NPK rate on field capacity (FC), wilting point (WP) and available water(AW) in two seasons.

Treatments	First season			Second season		
	FC (%)	WP (%)	AW (%)	FC (%)	WP (%)	AW (%)
Control (NPK) $_{(100\%)}$	11.16	2.14	9.02	11.66	2.24	9.42
Biochar + NPK $_{(50\%)}$	13.01	5.56	7.45	13.33	5.60	7.73
Biochar + NPK $_{(75)}$	13.22	5.61	7.61	13.62	5.68	7.94
Mean	13.11	5.58	7.53	13.47	5.64	7.83
OMW $_{(10\%)}$ + NPK $_{(50\%)}$	12.89	4.23	8.66	13.09	4.4	8.69
OMW $_{(10\%)}$ + NPK $_{(75\%)}$	12.51	4.41	8.1	12.81	4.51	8.31
OMW $_{(10\%)}$ + Biochar + NPK $_{(50\%)}$	13.31	5.98	7.33	13.16	6.08	7.08
OMW $_{(10\%)}$ + Biochar NPK $_{(75\%)}$	13.66	6.01	7.65	13.82	6.31	7.51
Mean	**13.09**	**5.15**	**7.93**	**13.33**	**5.32**	**7.89**
OMW $_{(20\%)}$ + NPK $_{(50\%)}$	12.15	4.5	7.65	12.20	5.01	7.19
OMW $_{(20\%)}$ + NPK $_{(75\%)}$	12.98	4.79	8.19	13.03	5.32	7.71
OMW $_{(20\%)}$ + Biochar + NPK $_{(50\%)}$	13.50	6.01	7.49	13.84	6.23	7.61
OMW $_{(20\%)}$ + Biochar + NPK $_{(75\%)}$	13.88	6.33	7.55	13.98	6.44	7.54
Mean	**13.12**	**5.40**	7.72	**13.26**	**5.75**	7.51
LSD. at 0.05						
Treatment	2.72	3.93	1.57	2.32	4.23	2.34
OMW Rates	1.93	2.19	1.38	1.51	3.41	1.91
Biochar	1.95	3.26	1.49	1.81	3.51	1.59

2. Effect of olive mill wastewater and boichar combined with different NPK rate on soil chemical properties.

2.1. Soil pH

Data in Table 5 showed that soil pH values decrease slightly and moderate with application of biochar and olive wastes water (OMW) at two rates 10% and 20% with NPK rates (50 %, 75% recommended dose), the decrease of soil pH was not significantly in both season, where the best value of soil pH was at first season with treated OMW$_{(20\%)}$+biochar$_{(4\ ton/fed)}$+ NPK $_{(75\%)}$ more than other treatments. These results are in agreement with Magdich *et al.* (2013) who reported that the soil pH at soil treated with OMW, was noted to decrease in comparison with the control, which could presumably be attributed to the acidic nature of OMW. In the same trend with Biochar agreement by Simon *et al.* (2019) who found that the biochar combined with nitrogen mineral rates was slightly reduced the pH by 0.22 than biochar alone. Albert and Kwame (2018) suggested that the added Biochar as soil amended level reduce pH. Reduction in soil pH may be related to the residual organic matter after different biochemical and chemical changes.

2.2. EC value

Data in Table 5 showed that the electric conductivity (EC) values were affected by all treatments, where low EC values were with treatment of Biochar (4 ton/fed) and olive wastes water with two rates (10% and 20%) combined with NPK (50 %, 75%) in both season. The low EC value was (1.04) (dSm^{-1}) at second season compared with other treatments. These result agree with Jones *et al.* (2011) who reported that the applying of biochar together with N fertilizer led to decrease soil salinity (EC). These results may be due to that biochar application has reduced soil bulk density and improved soil aggregate structure, which led to increase total porosity in soil and increase in macro pores and in turn to increased water content at low suction pressures led to movement of leaching water that enhance progressive removal for Na-salts (Lei & Zhang, 2013).

2.3. Organic matter

Data in Table 5 showed that organic matter(OM) increased by different treatments application in the soil, organic matter values significantly increased with addition of biochar (4 ton/fed)+ olive wastes water at two rates 10% and 20% combined with NPK (50 %, 75%) in both seasons. The highest values of organic matter were (0.81%) at first season and (0.83%)at second season with OMW(20%) + Biochar (4 ton/fed)+ NPK(75%)application more than other treatments. The increase in organic matter following biochar application could be due to high carbon (C) associated with biochar (Abdulaziz, 2018). While Several studies showed an increase in organic matter content, total N and C/N ratio following irrigation with OMW and may have a beneficial effect on soil fertility (Mekki *et al.,* 2006; Brunetti *et al.,* 2007; Mekki *et al.,* 2013).

Table 5: Effect of olive mill wastewater and boichar combined with different NPK rate on soil pH, EC and OM of two seasons in tested soil.

Treatments	First season			Second season		
	pH	**EC (dSm^{-1})**	**OM (%)**	**pH**	**EC (dSm^{-1})**	**OM (%)**
Control (NPK) (100%)	7.80	1.29	0.50	7.81	1.31	0.52
Biochar (4ton/fed)**+ NPK (50%)**	7.71	1.15	0.52	7.73	1.13	0.54
Biochar(4ton/fed) **+ NPK (75)**	7.73	1.18	0.50	7.70	1.15	0.53
Mean	**7.72**	**1.16**	**0.51**	**7.71**	**1.14**	**0.53**
OMW (10%) + NPK (50%)	7.61	1.21	0.51	7.71	1.20	0.52
OMW (10%) + NPK (75%)	7.71	1.17	0.52	7.72	1.16	0.50
OMW (10%) + Biochar + NPK (50%)	7.63	1.16	0.56	7.63	1.15	0.57
OMW (10%) + Biochar + NPK (75%)	7.61	1.15	0.57	7.59	1.14	0.58
Mean	**7.64**	**1.172**	**0.54**	**7.66**	**1.1625**	0.54
OMW (20%) + NPK (50%)	7.71	1.20	0. 56	7.72	1.19	0. 58
OMW (20%) + NPK (75%)	7.72	1.19	0.51	7.70	1.18	0.52
OMW (20%) + Biochar + NPK (50%)	7.62	1.16	0. 57	7.61	1.17	0. 58
OMW (20%) + Biochar + NPK (75%)	7.60	1.14	0. 58	7.58	1.12	0. 59
Mean	**7.66**	**1.175**	**0.55**	**7.65**	**1.167**	0.56
LS.D. at 0.05						
Treatment	0.04	0.14	0.08	0.05	0.18	0.09
OMW Rates	0.16	0.12	0.051	0.14	0.14	0.04
Biochar	0.08	0.13	0.01	0.06	0.17	0.01

3. Available of macronutrient content in soil.

Data presented in Table 6 showed that the available macronutrients i.e.(N, P and K mg/kg soil) as affected by all treatments, where the positive effect was achieved under all treatments compared with control. Generally, data showed that the available N, P, and K in soil were significantly enhanced by using treatments biochar$_{(4\ ton/fed)}$ and Olive mill wastewater with two rates (10%, 20%) compared with control NPK $_{(100\%)}$ of recommended dose. The highest values of N, P and K contents in soil were 48.1,5.62 and 183mg/kg soil respectively, at first season and 48,9,6.3 and 184mg/kg soil respectively, at second season for soil treated by OMW$_{(20\%)}$+Biochar (4 ton/fed)+ NPK $_{(75\%)}$than other treatments. These results are in agreement with those reported by Barbera *et al.* (2014) who mentioned that olive mill wastewater helps in fixing N_2, solubilizing mineral phosphates and other nutrients. Increasing the soil content of N, P and K due to the application of organic fertilizers might be a result of its decomposition and producing organic acids, which increases the nutrients availability in the soil. Also, reported Liang *et al.* (2006) indicated that addition of biochar led to increased contents of N, P and K in soil. Biochar addition to soil led to an increase of organic matter, water holding capacity, nutrient retaining capacity, and bioavailability nutrition elements (e.g., N, P, K, Ca) in soil (Ouyang *et al.,* 2013).

Table 6: Effect of olive mill wastewater and boichar combined with different NPK rate of NPK in two seasons in tested soil.

Treatments	First season (mg Kg-1soil)			Second season (mg Kg-1soil)		
	N	P	K	N	P	K
Control (NPK) (100%)	41.4	4.1	174	40.1	5.2	171
Biochar + NPK (50%)	44.2	4.99	177.0	43.3	4.8	180
Biochar + NPK (75)	44.8	5.20	179.0	45.1	5.3	174
Mean	**44.5**	**5.19**	**178.0**	**44.2**	**5.75**	**177**
OMW(10%) +NPK (50%)	39.9	4.44	169.0	40.2	5.4	174
OMW(10%) +NPK (75%)	40.1	4.6	173.0	40.5	5.45	170
OMW(10%) + Biochar + NPK (50%)	44.3	5.20	175.0	45.1	6.12	176
OMW(10%) + Biochar NPK (75%)	46.9	5.56	181.0	47.1	6.2	182
Mean	**42.1**	**4.95**	**174.5**	**43.22**	**5.79**	**175.5**
OMW(20%) +NPK (50%)	39.9	4.57	171.0	40.8	5.7	172
OMW(20%) +NPK (75%)	41.8	4.85	176.0	42.3	5.9	177
OMW(20%) + Biochar + NPK (50%)	46.1	5.45	179.0	47.3	5.91	180
OMW(20%) + Biochar + NPK (75%)	48.1	5.62	183.0	48.9	6.3	184
Mean	**43.9**	**5.12**	**177.3**	**44.82**	**6.2**	**178.25**
LSD. at 0.05						
Treatment	2.6	0.77	3.33	2.34	0.75	2.3
OMW Rates	2.55	0.76	3.27	2.31	0.61	3.31
Biochar	2.19	0.70	2.09	1.71	0.58	2.08

4. NPK Contents in seeds of peanut.

Data presented in Table 7 the concentration of macronutrients i.e., N, P and K in the studied seed under the effect of different treatments. Data show that the increasing of available N, P, and K concentrations in seed as significantly by using treatments biochar (4 ton/fed) and Olive mill wastewater with two rates compared with control NPK $_{(100\%)}$. The highest values of N, P and K contents in seeds were4.90, 0.56 and 1.096% seed at first season and 4.97,0.59 and 1.11(g plant-1) seed at second season for plant treated by 20% OMW+ 75% NPK + biochar than other treatments. These results are in agreement with those reported by Laird *et al.* (2010) who showed biochar (4 ton/fed) was responsible improve nutrient status content in plant. Therefore, N and P availability could be expected to increase with biochar application rather than responsible improve crop growth and nutrient status. In the same trend Lesage-Meessen *et al.* (2001) reported that some OMW characteristics are favorable for agriculture since this effluent is rich in water, organic matter, nitrogen, phosphorous, potassium and magnesium. In line with this finding Osama and Wolfgang (2019) metioned that Olive mill wastewater (OMW) application increased the soil nutrient contents due to its richness in nutrient N,P,K concentration in plant..

Table 7: Effect of olive mill wastewater and boichar combined with different NPK rate on NPK content in seeds.

Treatments	**First season**(g plant-1)			**Second season**(g plant-1)		
	N	**P**	**K**	**N**	**P**	**K**
Control (NPK) (100%)	3.77	0.30	0.45	3.81	0.32	0.47
Biochar + NPK (50%)	4.83	0.51	0.94	4.87	0.52	0.95
Biochar + NPK (75)	4.89	0.54	0.96	4.91	0.53	0.98
Mean	**4.86**	**0.52**	**0.95**	**4.89**	**0.52**	**0.96**
OMW (10%) + NPK (50%)	4.15	0.34	0.951	4.19	0.35	0.93
OMW (10%) + NPK (75%)	4.22	0.36	0.940	4.21	0.37	0.97
OMW (10%) + Biochar + NPK (50%)	4.85	0.52	0.991	4.91	0.51	1.03
OMW (10%) + Biochar NPK (75%)	4.89	0.58	1.01	4.94	0.55	1.04
Mean	**4.52**	**0.45**	**0.97**	**4.56**	**0.44**	**0.99**
OMW (20%) + NPK (50%)	4.51	0.41	0.97	4.53	0.44	0.983
OMW (20%) + NPK (75%)	4.68	0.42	0.95	4.61	0.46	0.987
OMW (20%) + Biochar + NPK (50%)	4.85	0.55	1.01	4.93	0.54	1.02
OMW (20%) + Biochar + NPK (75%)	4.90	0.56	1.09	4.97	0.59	1.11
Mean	**4.73**	**0.48**	**1.005**	**4.76**	**0.50**	**1.02**
LSD. at 0.05						
Treatments	1.58	0.25	0.476	1.87	0.21	0.671
OMW rates	1.08	0.19	0.55	1.35	0.18	0.55
Biochar	1.59	0.25	0.56	1.88	0.22	0.49

5. Plant growth

Results in Table 8 revealed that there are significant effect by the biochar$_{(4\ ton/fed)}$ and Olive wastewater with two rates 10 % and 20 % treatments on all studied traits of plant growth in both seasons compared with NPK$_{(100\%)}$ of recommended dose. The maximum values of Plant height (cm), number of branches/plant and number of pods/Plant were 79.6 cm6.99and 20.66 respectively, in second season were achieved with 20% OMW+ 75% NPK + biochar application than other treatments at first season. These results are agreement with Boz *et al.* (2009) who reported that using OMW to soil led to increase of crops yields. Sasanelli *et al.* (2011) reported OMW can improve plant growth which may be due to resistance to photo- pathogens attack by stimulating root development and large content of nutritive elements and biocide compounds. El-Abbassi *et al.* (2017) reported that Olive wastewater (OMW) increase the plant growth reflected to of the main bacterial, fungal photo-pathogens, and weed species without any negative. Biochar amendment application improved peanut biomass and pod yield in both seasons.

5. Yield and yield components

Results in Table 9 showed that Yield and yield components were affected by the biochar and Olive mill wastewater with two rates 10 % and 20 %with NPK $_{(100\ \%)}$ application, where the characters seeds yield, seeds protein (%) and Seeds oil(%), components in both seasons were improved compared with control. Where, the highest values of seeds yield (kg/fed), seeds protein (%) and Seeds oil(%)were achieved with treated by20% OMW+ 75% NPK + biochar than other treatments at first season as follow 1330.54(kg/fed), 31.75% and 44.03%, respectively. The same in second season 1332.52(kg/fed), 32.03%and 44.05%, respectively. This result agreement with Belaqziz *et al.* (2008); Mahmoud *et al.* (2010) reported that using OMW to soil led to increase of crops yields. Biochar amendment application was improved peanut biomass and pod yield in both seasons. The significant yield increase in peanut in response to the application of biochar to soil was significant increase of yield peanut (Liu *et al.,* 2013). Biederman and Harpole (2013) reported Biochar was improved the biomass and pod yield of peanut and enhance leaf photosynthetic rate and crop production.

Table 8: Effect of olive mill wastewater and boichar combined with different NPK rate on plant height, No. of branches and No. of pods in peanut plant.

Treatments	First season			Second season		
	Plant height (cm)	**No. of branches/plant**	**No. of pods/ plant**	**Plant height (cm)**	**No. of branches/plant**	**No. of pods/ plant**
Control (NPK) (100%)	62.7	4.5	17.71	63.7	4.3	16.23
Biochar + NPK (50%)	74.3	6.11	19.81	74.8	6.12	19.94
Biochar + NPK (75)	75.2	6.17	19.99	75.7	6.19	20.1
Mean	**74.75**	**6.14**	**19.9**	**75.25**	**6.15**	**20.02**
OMW (10%) + NPK (50%)	66.7	5.091	18.23	66.9	5.23	18.45
OMW (10%) + NPK (75%)	67.3	5.41	18.55	67.7	5.45	18.61
OMW (10%) + Biochar + NPK (50%)	75.1	6.49	19.73	78.3	6.55	20.281
OMW (10%) + Biochar NPK (75%)	77.5	6.61	20.92	78.9	6.63	20.51
Mean	**71.55**	**5.90**	**19.35**	**72.95**	**5.96**	
OMW (20%) + NPK (50%)	70.2	5.82	19.31	70.9	5.86	19.37
OMW (20%) + NPK (75%)	71.8	5.91	19.43	72.4	5.92	19.47
OMW (20%) + Biochar + NPK (50%)	76.7	6.94	20.51	78.8	6.97	20.53
OMW (20%) + Biochar + NPK (75%)	77.7	6.987	20.59	79.6	6.998	20.66
Mean	**74.05**	**6.41**	**19.96**	**75.42**	**6.43**	
LSD. at 0.05						
Treatments	14.87	2.49	2.29	15.9	2.70	4.49
OMW Rates	11.35	1.92	1.77	11.55	2.14	2.79
BIochar	8.509	1.65	2.301	11.74	1.87	2.41

Table 9: Effect of olive mill wastewater and boichar combined with different NPK rate on yield components

Treatments	First season			Second season		
	Seeds yield (kg/fed)	**Seeds protein (%)**	**Seeds oil (%)**	**seeds yield (kg/fed)**	**Seeds protein (%)**	**Seeds oil (%)**
Control (NPK) (100%)	1011.76	23.56	37.01	1011.91	23.81	37.98
Biochar + NPK (50%)	1233.1	30.18	42.61	1233.87	30.43	42.73
Biochar + NPK (75)	1234.19	30.56	42.81	1234.33	30.68	42.87
Mean	**1233.64**	**30.37**	**42.71**	**1234.1**	**30.56**	**42.81**
OMW (10%) + NPK (50%)	1100.45	25.93	39.21	1130.81	26.18	39.43
OMW (10%) + NPK (75%)	1189.21	26.37	39.98	1201.31	26.93	40.3
OMW (10%) + Biochar + NPK (50%)	1320.21	31.56	43.01	1321.71	30.75	42.97
OMW (10%) + Biochar NPK (75%)	1322.43	32.06	43.66	1323.61	31.18	43.44
Mean	**1233.075**	**29.25**	**41.75**	**1244.25**	**29.25**	**41.75**
OMW (20%) + NPK (50%)	1225.76	28.81	41.57	1226.61	28.93	41.66
OMW (20%) + NPK (75%)	1227.17	29.25	41.73	1228.19	29.43	41.84
OMW (20%) + Biochar + NPK (50%)	1328.94	31.51	42.93	1329.1	31.96	43.22
OMW (20%) + Biochar + NPK (75%)	1330.54	31.75	44.03	1332.52	32.03	44.05
Mean	**1277.58**	**30.75**	**42.75**	**1279.55**	**30.75**	**43.1**
LSD. at 0.05						
Treatments	318. 73	8.91	7.81	320.61	8.22	6.81
OMWRates	262.47	7.77	5.15	267.59	6.77	5.05
Biochar	222.49	4.83	3.71	222.47	4.83	3.71

Conclusions

Olive mill wastewater and biochar constitutes a serious environmental problem. Several physical, chemical and biological processes to reduce their contaminant impacts have been proposed. Many researchers have established that this wastewater have a high fertilizer value when applied to the soil.

Soils in semi-arid and arid areas are known to have low organic matter levels, a low fertility and a high exposure to degradation, desertification and pollution. Currently, organic wastes of various origins and nature are widely used as amendments to increase soil organic matter and crop productivity.

The peanut plant is an important food and oilseed crop, it is called as the king of oilseeds crops. We indicated the results of physical and chemical factors and biochar-associated organic compounds associated by application of OMW and biochar can improve soil quality indices nutrients (N, P, and K), organic matter and pH**.** Biochar amendment application improved peanut biomass and pod yield in both seasons. The significant yield increase in peanut in response to the application of OMW + biochar combined with NPK to soil was significant increase of yield peanut compared with control.

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