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Effect of different types of biochar on soil chemical properties, microbial community, pathogenic fungi and faba bean productivity

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ABSTRACT

This experiment was carried out in sandy loam soil of private farm at Romana , North Sinai Governorate, Egypt during two successive winter seasons 2017 / 2018 and 2018 /2019, to study the effect of three types of biochar, (A) produced from corn stalk, straw rice , straw of faba bean and cotton stalk, (B) produced from trees stalk and (C) town refuse, with three levels from Urea fertilizer (0, 20, 30 Kg N/fed), plus control treatment which received the recommended dose of urea (46 %N), to examine the effects of biochar types combined with or without nitrogen fertilizer on faba bean productivity under saline soil conditions. Faba bean variety Giza 843 were sowed on 12 November 2017 and 2018.The experiment was carried out in a split plot design with three replicates. Results obtained that, the combination between biochar types with different levels of N fertilizer enhanced all tested parameters. Moreover, biochar type (C) with level 30 Kg N/fed recorded the highest values of all tested parameters. On the other hand, the same treatment was the most effective on the root rot and wilt incidences, where the survival plants was 97.9 % and 93.4% respectively and decreased the number of the pathogenic fungi.

KEYWORDS: faba been, biochar, N fertilizer, and pathogenic fungi.

1. INTRODUCTION

Biochar is produced through pyrolysis, the thermo-chemical degradation of biomass under anaerobic or oxygen-limited conditions. Biochar's physical, chemical and nutritional properties depend on the chemical composition of the feedstock used, pyrolysis system and production conditions (Bruun, *et.al.* 2011). Due to biochar's surface area and porosity, bulk density, nutrient content, stability, cation exchange capacity (CEC), pH value and carbon content it is expected to improve water retention, nutrient retention and plant uptake of nutrients. Biochar is a C-rich product of biomass pyrolysis intended for use as a soil amendment. Biochar amendment has been found to increase both the soil water-holding capacity (Adel *et al*., 2013) and nutrient availability (Zheng *et al*., 2018).

Biochar is important roles on microbial activity in different soil types, Leta (2018). Biochar has also been shown to enhance nutrient availability over longer time by enhancing nitrogen (N) mineralization or nitrification. As a result of increased microbial growth and activity, Ameloot *et al*., (2015). Biochar effect on physical and chemical properties as well as beneficial soil microorganisms like bacteria, fungi, and invertebrates, both in field and laboratory conditions (Sławomir *et al*., 2017). The application of biochar (pyrolysis d at 600°C) to soil was improves soil organic carbon and soil pH and would have an effects on soil enzymes, microbial biomass for soil quality. It was found that soil pH, total organic carbon and urease increased significantly with increasing biochar rate (Walelign and Mingkui 2015).

Biochar soil amendment not only promotes the plant growth, but also has a suppressive effect against several foliar and soil borne fungal diseases (Jaiswal *et al.*, 2015). Application soil of Biochar delayed *Fusarium oxysporum* and *Rhizoctonia solani* development, hence significantly reduced their disease incidences by up to 85% and 80%, respectively and the disease severities of fusarium wilt and root rot were progressively lowered by as much as 84% and 80%, respectively, in tomato plants treated by biochar (Khalifa and Thabet, 2015).

Nodulation parameters and Nitrogenase activity showed higher values in faba bean by biochar application (Ibrahim, 2017). Also, Guerena *et al*. (2015) reported that the biochar additions resulted in 35.75% increase in nodule biomass and 21.26% increase in N derived from the atmosphere over the control.

Faba bean (*Vicia faba* L.) is an important legume crop in Egypt and many parts of the world. Its seeds exhibit high levels of protein (28– 36 % of seed dry matter). It is popular food as it is used as green vegetable or fresh canned. Also, it is an important crop for soil improvement and is used as crop in cereal rotation to keep the soil fertile and productive through nitrogen fixation, (Mohammad *et al*., 2011). Growing faba bean can markedly minimize the application of chemical fertilizers due to the high capability of the symbiosis in the fixation of atmospheric N_2. The application of biochar led to improve and increased of growth parameters and quality of legumes Guerena *et al*., 2015). Application of biochar to sandy soil was increased plant growth, biomass and yield of mung bean (Wang *et al*., 2016).

However, little is known about observed study biochar and mineral nitrogen interactions, especially about whether they have synergisms in influencing the availability of soil nutrients in sandy soil, leading to increases of plant growth and crop yield.

The objective of this study was to examine the effects of biochar types combined with or without nitrogen fertilizer on soil proparties, some soil borne diseases and productivity of faba bean under saline soil conditions.

2. MATERIALS AND METHODS

A field experiment was carried out in sandy loam soil of private farm at Romana,, North Sinai Governorate , Egypt during two successive seasons 2017 - 2018 and 2018 -2019, to study the effect of three type of biochar on some soil properties and faba bean productivity. The mean physical and chemical soil properties before sowing according to the methods described by Cottenie *et al* (1982), page *et al* (1982) and Kult (1986). The obtained data recorded in Table (1).

Table 1. Some physical and chemical properties of soil

Particle size distribution (%)				Texture	O.M (%)	CaCO$_3$ (%)
Coarse sand	Fine sand	Silt	Clay			
8.15	72.93	6.20	12.72	Sandy loam	0.61	6.95

pH (1:2.5)	EC (dSm^{-1})	Soluble cations (meq/l)				Soluble anions (meq/l)		
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO$_3^{-}$	Cl^{-}	SO$_4^{--}$
7.99	4.20	12.75	7.88	20.55	0.82	4.82	17.34	24.66

Macronutrients (mg/kg)			Micronutrients (mg/kg)		
N	P	K	Fe	Mn	Zn
32.95	4.10	184.00	2.77	1.20	0.58

In both seasons, each experiment was carried out in a split plot design with three replicates. The used of three biochar types were arranged randomly as main plot , were different rates of mineral nitrogen fertilizer was distributed randomly as sub plot. The area of each experimental unit plot was 5 X 10 m which divided into rows width 60 cm.

Biochar was produced from residuals of different plants sources and town refuse charred anoxically at 450 C^{o} /6 h. Biochar types were (biochar A : was produced from corn stalk, straw rice , straw of faba bean and cotton stalk) ;
(biochar B : was produced from trees stalk) and biochar C : was (town refuse). All residues were collected from a local farm, chopped at the site and air dried at 40 C^{o}. the fine ground of all residual plants and town refuse were placed in a stainless still container and closed tightly to absente oxygen. The closed container transferred to an electrical muffle furnace where it remained for 6 h at the desired temperature. The all biochar types were movement from room temperature followed by basic characterization analysis. The biochar applied with 10 ton/fed. Biochar was applied in furrows and was incorporated manually to a soil depth 15 cm. Compost analysis was done according to the standard methods as described by Brunner and Wasmer (1978). Some properties of used biochar types were presented in Table (2).

Table 2. Some chemical properties of biochar types used.

Treatments	pH (1:2.5)	EC (dSm^{-1}) (1:10)	(%)					(mgkg^{-1})					Ash (g/g)
			C	O.M	N	P	K	Na^{+}	O2	Fe	Mn	Zn	
Biochar A	8.35	2.85	68.46	35.32	1.65	0.39	5.41	6.52	10.36	75.62	130.89	19.34	0.25
Biochar B	8.53	3.55	72.14	44.10	1.78	0.44	6.12	8.22	12.10	82.16	156.14	25.34	0.34
Biochar C	8.60	4.10	75.61	50.31	1.83	0.49	6.85	10.46	13.75	88.19	164.30	32.10	0.46

Hand selected seeds of (Faba bean variety Giza 843) were sowed on 12 November 2017 and 2018 at a row space of 60 cm and a cover space of 20 cm. About 30 days after sowing was thinning to one plant /hill.

All treatments received the recommended dose of super calcium phosphate (15.5 % P_2O_5) and potassium sulfate (48 % K_2O) fertilization in the rate 100 kg P_2O_5 was applied during tillage soil before planting and 75 kg K_2O per fad was applied after 30 and 45 days from planting. Urea (46 %N) at rates 40 kg N /fed as control without biochar and (0, 20 and 30 kg N/fed with biochar application was applied after 30, 45 and 65 days from planting.

At harvest time, ten plants were randomly taken from each sub-plot to estimate plant height (cm); No. of branch/plant; No. of pod /plant ; weight of seeds /plant ; weight of 100 seeds (g) ; weight of seeds yield (ton/fed) and weight of pods yield (ton/fed).

Soil samples were collected from all studied treatments at a depth of (0 – 30 cm) to determine some soil physical and chemical characteristic. Soil pH was determined in 1:2.5 soils: water suspensions according to the standard method of Kult (1986). Total soluble salt was measured in soil paste extract as described by Jackson (1973). Nitrogen was determined by kjeldahl method (Page *et al.*, 1982). Phosphorus was determined calorimetrically and potassium was determined using flame- photometer according to Jackson (1973). Available micronutrients extracted by DTPA (Soltanpour 1985) and determined using Atomic Absorption Spectrophotometer.

2.1. Plant analysis:

Dry weight of seeds of faba bean plants was determined after harvest. Concentration of N, P and K, Fe, Mn and Zn of seeds were determined after digestion using a mixture of H_2SO_4 and $HClO_4$ (2:1 ratio) according to Chapman and Pratt (1961) and Cotteine *et al* (1982).

2.2. Pathological Studies;

2.2.1. Isolation and frequency pathogenic fungi:

Infected roots were cut into small fragments, washed thoroughly with tap water, then sterilized with 1% sodium hypochlorite solution then dried between two sterilized filter papers. Fragments were placed on potato dextrose agar (PDA) medium in Petri dishes and incubated at 25°C for 7 days and observations were recorded (Christensen, 1957). Hyphal-tips and single spore of grown fungi were transferred individually to new PDA plates (Riker and Riker, 1936) and then identified according to their morphological and microscopically characters as described by (Jenset *et al.*, 1991). Identification was confirmed by the Department of Mycology, Plant Pathology Institute, Agricultural Research Center, Giza, Egypt.

The frequency pathogenic fungi calculated as follow:

Freq. fungi = <u>The number of isolated type</u> <u>X100</u>
Total of isolates

2.3. The Pathogenicity tests:

The pathogenesis were carried out under greenhouse conditions at (Integrated Pest Management Green house, Plant Pathology Institute, Agricultural Research Center, Giza, 2017/2018 and 2018/2019) growing seasons. At the first, all fungal isolates which were isolated from rotten roots of faba bean were tested for their pathogenic potentialities on the susceptible cultivar, Giza 843, under greenhouse conditions and study effects of the different treatments of biochar on disease incidence as in order to select the highly pathogenic isolates. Pots (25 –cm-diameter) were sterilized by dipping into 5% formalin solution for 5 min and then left in open air till dryness. Soil was sterilization was accomplished with using 5% formalin solution, by mixing thoroughly, Then the treated soil was covered with plastic sheet for one week and then the plastic sheet was removed in order to allow complete formalin evaporation (Whitenhead, 1957). Soil infestation with each individual fungus pathogen was carried out at the rate of 3% of soil weight (Metwally, 2004). Fungi were individually grown on sand barley (SB) medium (25 g clean sand, 75 g barley and enough water to cover the mixture). Flasks contained sterilized medium were inoculated with each particular fungus and incubated at 25°C for two weeks. Potted soil was watered daily for a week to enhance fungal growth. Soil of control pots was mixed with the same amount of sterilized fungus-free sand-barley (SB) medium. Ten faba bean seeds were surface sterilized using 5% sodium hypochlorite for 2 min., washed several times with sterilized water, before and then sowing. Three replicate pots with a total of 30 seeds were used for each particular treatment (Farahat, 1970).

Pre-emergence (%) =
<u>Number of non-germinated seeds X100</u>
Total number of seeds

Post-emergence (%) =
<u>Number of germinated plantsX100</u>
Total number of seedlings

Survival plant (%) =
<u>Number of survived plant Survival</u> X100
Total number of seedlings

2.4. Disease assessment:

Percentages of pre- and post-emergence as well as healthy survival plants in each treatment were determined 15 and30 days after sowing, respectively using the next formula according to El-Helaly *et al*. (1970).

Disease Incidence % =

$$\frac{\text{The number of diseased plants}}{\text{Total number of plants}} \times 100$$

2.5. Microbial counts:

The following parameters were estimated in the treated and untreated soil after 30, 60, and 90 days from application. The soil samples of the 3 replicates of each treatment were mixed thoroughly, then 10 grams of each mixed sample were suspended in 90 ml. sterilized distilled water in 200 ml. flasks and shacked for 20 min. Serial dilutions up to 10^6 were done by repeatedly adding 1 ml. soil suspension to 9 ml. sterilized distilled water. All determined microorganisms were estimated using the optimum dilution for each group were total bacterial count x $1/10^6$ according to (Allen, 1950) , total actinomycetes count x10^5 according to (Jensen 1930) , total fungal count x 10^3 according to (Martin, 1950) and nitrogen fixers count x 10^3 according to (Allen, 1950) by using Base medium 77.

2.6. Soil Enzymes activity:

2.6.1. Cellulase activity: cellulase activity was determined according to (Takoa *et al*., 1985).

2.6.2. Dehydrogenase activity: dehydrogenase activity was assessed according to method of (Thalman, 1967).

2.7. Assessment of nodules parameters and nitrogenase activity in root nodules:

Nodule numbers on roots of faba bean and their fresh and dry weights were estimated 50 days after sowing. Nitrogenase activity (N_2 – ase) as uL. C_2H_4/g dry nodules was measured in nodules using the acetylene reduction technique according to (Silvester, 1983).

Statistical analysis: was assigned using MSTAT-C developed by Russell (1994).

3. RESULTS AND DISCUSSION

3.1. Effect of biochar types residual sources on sandy soil properties after faba bean harvested.

3.1.1. Soil pH:

Various types of biochar exhibit a neutral to alkaline pH value and are consequently suitable for neutralizing acidic soils (Gwenzi et al., 2015). Data presented in Table (3) show that the soil treated with biochar types can slightly acidic. The pH value of soil can range from 7.94 (with biochar A+30) to 8.07(with biochar C without nitrogen fertilizers) the decreased of soil pH depending on biochar sources used. Moreover, soil pH value increase in soil treated with biochar C without nitrogen 8.07 than other treatments. Biochar can function as a limiting agent by causing an increase in pH of soil depending in biochar types (Lehmann and Joseph, 2009).

Table 3. Soil pH, EC and available macro-micronutrients contents in soil

Treatments	N rates (kg/fed)	pH (1:2.5)	EC (dSm^{-1})	Available macronutrients (mg /kg^{-1})			Available micronutrients (mg/kg^{-1})		
				N	P	K	Fe	Mn	Zn
Control	**40**	**7.98**	**3.14**	**37.52**	**4.55**	**187.00**	**2.81**	**1.44**	**0.63**
	0	**8.01**	**2.18**	**39.42**	**4.86**	**192.00**	**2.93**	**1.59**	**0.68**
Biochar A	**20**	**8.00**	**2.05**	**41.52**	**5.02**	**194.00**	**3.04**	**1.75**	**0.72**
	30	**7.94**	**1.95**	**42.61**	**5.09**	**198.23**	**3.08**	**1.89**	**0.75**
Mean			**2.06**	**41.18**	**4.99**	**194.74**	**3.02**	**1.74**	**0.72**
	0	**8.04**	**3.75**	**37.85**	**4.93**	**185.00**	**3.05**	**1.66**	**0.66**
Biochar B	**20**	**8.02**	**2.34**	**42.38**	**5.03**	**189.31**	**3.09**	**1.78**	**0.74**
	30	**8.01**	**2.22**	**45.10**	**5.08**	**195.20**	**3.12**	**1.90**	**0.79**
Mean			**2.77**	**41.78**	**5.01**	**189.84**	**3.09**	**1.78**	**0.73**
	0	**8.07**	**3.89**	**40.62**	**4.88**	**192.00**	**3.07**	**1.75**	**0.68**
Biochar C	**20**	**8.04**	**2.66**	**43.18**	**4.97**	**196.00**	**3.14**	**1.88**	**0.78**
	30	**8.02**	**2.35**	**45.88**	**5.04**	**198.30**	**3.19**	**1.97**	**0.85**
Mean			**2.97**	**43.23**	**4.96**	**195.43**	**3.13**	**1.87**	**0.77**
LSD.0.05 treatments		**--**	**0.38**	**3.10**	**Ns**	**1.86**	**Ns**	**Ns**	**Ns**
LSD. 0.05 rate		**---**	**0.57**	**Ns**	**Ns**	**3.33**	**Ns**	**Ns**	**0.017**
Interaction			**ns**	**Ns**	**Ns**	*******	**Ns**	**Ns**	******

The decreased in soil pH was observed with biochar combined with nitrogen fertilizer. This result may be due to the processes buffer the pH soil acidification results in slowly decreasing pH while one process buffers inputs, followed by a relatively rapid decrease in pH when that process is exhausted and the next takes over. Such decrease in pH values could be attributed to the production of CO2 and organic acids by soil microorganisms acting and other chemical transformation in the soil added biochar (A) type combined with 30 kg N. This finding is expected to be due to the active microorganism, biological activity in particular and organic acid produced. The addition of biochar may induce an increase in soil pH, through the negative charge on the surface that buffers acidity in soils and the presence of mineral ashes in the biochar, which has a positive effect on soil microbial activity in soil. El-Naggar et al (2019) indicated that biochar is alkaline, and therefore its effect on increasing acidic soil pH was demonstrated in several studies whereas its impact on alkaline soil pH is expected to be minimal.

3.1.2. Soil Salinity (EC dSm^{-1}):

Results in Table (3) also show that the soil electrical conductivity (EC DSM^{-1}) values were decreased as compared with initial soil value before planting. The soil treated with biochar types sources alone without mineral nitrogen led to increase compared with biochar types combined with mineral nitrogen especially biochar A type combined with mineral nitrogen fertilizer. Biochar type sources application was showed a significant effect on decreasing soil salinity. Concerning N (urea) rates of application, they were significant in reducing the soil salinity. On the other hand, the interaction between biochar type's sources and different rates of mineral nitrogen fertilizer was no significant effect. The relative decreases of mean values EC (DSM-1) in soil treated with defferent biochar types combined with different mineral nitrogen were 5.50 %; 26.13% and 23.65 % for soil treated with biochar A; biochar B and biochar C respectively, compared with biochar alone. These results are in agreement by Amonette and Joseph (2009) found that biochar application to soils markedly influenced their chemical properties such as pH and EC. Khaled and Jeff (2019) reported that the decrease of soil pH and EC was observed with the biochar 300 Co than biochar 600 Co. Generally, the EC increase in the sandy loam soil amendment with biochar C (3.98 DSM-1) produced from town refuse may led to high salinity compared with other biochar types. Mahmood et al (2016) found that biochar (rice husk) application led to soil bulk density decreased and soil porosity increased, followed by an increase in available water.

Available macro-micronutrients contents in soil.

3.1.3. Available macro-micronutrients contents in soil:

Results in Table (3) also show that the effect of biochar types application to soil on available macro-micro nutrients content in soil i.e. (N, P, K, Fe, Mn and Zn) were positive effect. The increase of macro –micronutrients available in soil with increasing of mineral nitrogen rates combined with biochar types. The maximum mean values of N, K, Fe, Mn and Zn contents in soil treated with biochar C (town refuse), while the increase of P content in soil treated with biochar B (trees stalk). On the other hand, the used of biochar types led to significant increase of N and K content in the soil, while the available P, Fe, Mn, and Zn were no significant. Also, the used mineral nitrogen different rates were significant increases of K and Zn contents in soil, while other elements contents in soil were no significant effect. The interaction between biochar types with different rates of mineral N on N, P, Fe, and Mn were no significant, while the K and Zn contents were significant. The relative increases of mean values N, P , K and Fe, Mn and Zn available contents in soil treated with biochar A were 9.75 % for N; 9.67 % for P ; 4.14 % for K and 7.47 % for Fe; 20.83 % for Mn and 14.29 for Zn compared without biochar (control). As well as, the relative increases of mean values were 11.35 % for N; 10.11 % for P, 1.52 % for K and 9.96 % for Fe; 23.61 % for Mn and 15.87 % for Zn contents in soil treated with biochar B combined with or without mineral nitrogen respectively compared with control. Concerning , the relative increases of mean values available macro-micro nutrients contents in soil treated with biochar C combined with or without mineral nitrogen fertilizer rates were 15.22 % for N; 9.01 % for P ; 4.51 for K and 11.39 % for Fe ; 29.86 % for Mn and 22.22 % for Zn respectively , compared with control (without biochar) .This result may be due to the addition of biochar can enhance soil fertility through increasing symbiotic N2 fixation, which is highly dependent on different mechanisms such as immobilization of inorganic nitrogen and enhancing the availability of nutrients (Nelissen et al., 2012). Ibrahim et al (2017) indicates that the soil amended with biochar highest values of available nutrients (N, P, and K) were observed in soil. Sohi et al. (2009) mentioned that biochar addition had positive effects on nutrients availability. Under these biochar types' sources conditions, can have increase nutrient availability and improve nutrient bioavailability. Amonette and Joseph (2009) found that biochar application to soils markedly influenced their chemical properties such as nutrient contents. Mahdi et al (2010) reported that the N2 fixation in faba bean in the range of 165 – 240 kg N/ha with nitrogen. This is mainly due to their surface accumulations from the added biochar types used, especially those are addition biochar C, as well as, soil management practices and micro-organisms activities in topsoil's, which positively affected the availability of these elements in the soil. In general, the positive effects of the used

Different biochar type's sources on available N, P, K and Fe, Mn and Zn could be arranged in the following order:

Biochar C > Biochar B > biochar A > control for N., Fe, Mn and Zn

Biochar B > Biochar A > biochar C > control for P.

Biochar C > Biochar A > Biochar B > control for K

The relative increases in soil available of macro-micro nutrients as results of using biochar type's sources may be due to a pronounced content of organic materials. We recommendation need to assess the impact of various types of biochar on the behavior and dynamics of the pH-sensitive microelements in such soils.

3.2. Isolation and identification soil borne fungi

Soil borne fungi were isolated from rotted and wilted faba bean plants in this study showed in table (4), where about 96 isolates and the most frequency isolates were identified in the Department of Mycology, Plant Pathology Institute, Agricultural Research Center, Giza, Egypt. As, Fusarium oxysporium, Fusarium solani, Fusarium monilliforme, Fusarium semitictum, Macrophomina phasolina, and Rhizoctonia solani. .

R. solani and F. oxysporium were are the highest frequency, 22.92% and 18.75% respectively, while the F. semitictum showed the least number . These data agreement with Sahar (2011) and El-Metwaly (2004), who are reported that the most frequency pathogenic fungi of faba bean were root rot and wilt caused by R. solani and F. oxysporium . Abo-Shady et. al., (2007) also isolated seven pathogenic fungi Including F. oxisporum, F. solani and R. solani, they cause some serious diseases for faba bean. Seed borne pathogenic fungi that cause losses of yield and quality of common bean worldwide include, but are not limited to, M. phaseolina (Tassi) Goid F.oxysporum (Schltdl.) Fr., F. solani (Mart.) Sacc ., and R. solani, Naseri (2008).

Table 4. Isolated and frequency fungi from rooted and wilted faba bean plants

Isolated Fungi	No.	Freq. %
Rhizoctonia solani	22	22.92
Fusarium oxisporium	18	18.75
Fusarium solani	13	13.54
Fusarium monilliform	12	12.5
Fusarium semitictum	7	7.29
Macrophomina phasolena	14	14.58
Rhizoctonia solani	22	22.92
Unknown fungi	10	10.41
Total	96	-

3.3. Effect of treatments pathogenic fungi isolates under the pathogenicity test.

Data in table (5) showed the effect of biochar type's combination with or without mineral fertilizers on pathogenicity test and disease incidences caused by most frequency pathogenic fungi, *R. solani* and *F. oxysporium* .Results showed that all treatments significantly decreased the disease incidence, while the untreated was the lowest effect on it. The data also showed the most effective type of biochar was (C) especially Biochar with 30 kg mineral nitrogen fertilizers showed 3.2 and 2.1 Pre and post emergency with root rot and 3.4, 3.2 post emergency with wilt but the survival plants were 94.7 and 88.9 respectively where the untreated recorded the 10 and 18.7 survival plants. (Khalifa and Thabet, 2015) investigated that the disease incidence was significantly reduced in response to treatments by up to 85% and 80% for fusarium wilt and root rot respectively. These results are agreement with several previous studies were reports that the biochar types have the suppressive effects against different soil borne diseases as, F. oxysporium, Pythium aphanidermatum and R. solani (Jaiswal et al, 2015). Wirths et al. (2016), Reported that the application of biochar to soil is considered to have the potential for long-term soil carbon sequestration, as well as for improving plant growth and suppressing soil pathogens. Biochar soil application delayed F. oxysporum and R. solani development, hence significantly reduced their disease incidences by up to 85% and 80%, respectively. Moreover, the disease severities of fusarium wilt and root rot were progressively disease resistance (Graber et al. 2014).

Table 5. Effect of different treatments on disease incidence under artificial infection conditions.

Treatments	Rate application of	*Rhizoctonia solani* (Root Rot %)			*Fusarium oxisporium* (Wilted Plant %)		
	Days treatment	Preemergency % (15days)	Post emergency % (30days)	Survival plants	Pre emergency% (15days)	Post emergency% (30days)	Survival plants
Control	Without	65	25	10	57.7	23.6	18.7
	0	40.2	22.5	37.3	37.6	21.7	40.7
Biochar A	20	14.3	9.2	62.2	17.2	12.3	70.5
	30	7.6	3.4	89	10.2	9.4	80.4
	0	38.9	23.5	37.6	37.3	23.2	39.5
Biochar B	20	6.8	5.2	88	7.9	8.9	83.2
	30	4.1	3.2	92.7	6.2	4.3	89.5
	0	35.7	23.2	41.1	33.6	19.8	46.6
Biochar C	20	3.2	2.1	94.7	6.9	4.2	88.9
	30	0.0	2.1	97.9	3.4	3.2	93.4
LSD. 0.05 sources		1.90	1.08	2.03	0.59	1.03	0.76
LSD. 0.05 rate		2.18	0.44	2.74	0.30	1.15	3.02
Interaction		ns	***	***	***	***	***

Biochar incorporation into soil has been shown to enhance plant growth, to sequester carbon and to improve soil fertility, and moreover to protect plants from various soil borne pathogens (Lehmann and Joseph, 2009; Zimmerman, 2010), they also reported that Biochar soil application delayed *F. oxysporum* and *R. solani* development, hence significantly reduced their disease incidences by up to 85% and 80%, respectively. Biochar incorporation into soil has been shown to enhance plant growth, to sequester carbon and to improve soil fertility, and moreover to protect plants from various soil borne pathogens.

Biochar soil amendment not only promotes the plant growth, but also has a suppressive effect against several soil borne fungal diseases (Graber *et al*., 2014; Jaiswal *et al*., 2015).

3.4. Effect of treatments on microbial community and N-fixers

Table (6) shows that all estimated total microbial counts (bacteria, actinomyces, fungi, and N_2 fixers) were affected by biochar addition compared to control. Exhibit the effects of biochar on bacterial, actinomyces, fungi and nitrogen fixers by colonies forms unites (CFU) /g. dry soil. The data appear that all treatments of biochar with or without mineral fertilizers were significantly increasing the total count of soil microorganisms. Where, the total bacterial count increase after 60 days and decrease in 90 days. The highest significant records were observed in C 30 (biochar town with 30 kgm mineral fertilizers/ fedan), bacterial count, 201.3, 280.4 and 304.8 in periods 30, 60 and 90 days respectively compared with (A , 30) was the lowest effects of treatments, 82.5, 114.4 and 211.3 in 30, 60 and 90 days from treatments respectively, whereas, the untreated recorded the 29.3, 35.4 and 30.2 respectively in the same periods.

The same trend of results was recorded 55.3, 67.4 and 75.8 CFUx10^5 Actinomyces with the C + 30 kg mineral fertilizers compared with 36.5,45.9 and 65.3 with (A,30) and 67.3,95.4 and 100.2 with (B,30) respectively compared with untreated was recorded 21.7, 20.5 and 15.2 CFU x 10^5 actinomyces in 30,60 and 90 days from treatment. The similar results observed with the nitrogen fixers count. Also, we investigated that the court of bacteria, actinomyces and nitrogen fixers increased by increasing the amount of mineral fertilizes combined with biochr whereas, the heist effect showed with the 30 kg +biocher, the 20kg +biochar was less effect and the lowest effect for treatments showed with the (biochar without mineral fertilizers).On the other hand, the effects on total count of fungi significantly decrease by all treatments compared with untreated (control). Where, the heighest decreasing of total fungal count showed with biochar combined with 30 kg mineral fertilizers compared untreated .Also, our observation the best treatment was biochar (C) Followed by biochar (B) and biochar A. These results could be attributed to the positive effect of biochar as an organic amendment on microbial counts through providing beneficial substrates for soil microbes (Elad et al., 2011). Biochar could cause high enhancements in microbial populations in the rhizosphere and marked promotions in plant growth (Rondon et al., 2007). In addition, biochar

Table (6): Effect of biochar on microbial community by (CFU/g dry soil) at different periods.

Treatment	Rate of application	Bacteriax10^6				Actinomycetes x10^5				Fungi x10^3				Nitrogen fixers x10^3			
	Days after treatments	30	60	90	Mean	30	60	90	Mean	30	60	90	Mean	30	60	90	Mean
Control	without	29.3	35.4	30.2	31.63	21.7	20.5	15.2	19.13	95.2	87.4	90.6	91.06	57.2	60.8	75.2	45.33
Biochar A	0	40.3	78.5	70.3	63.03	25.1	28.3	25.2	26.2	103.2	83.7	120.2	65.7	68.8	72.7	89.6	77.03
	20	65.2	99.2	149.4	104.6	29.2	37.8	45.8	37.6	95.7	104.2	76.2	92.03	89.2	120.9	150.4	120.16
	30	82.5	114.4	211.3	136.06	36.5	45.9	65.3	49.2	50.3	64.2	32.3	48.93	119.3	189.7	227.5	178.83
Biochar B	0	42.1	63.2	52.71	52.67	34.2	39.2	35.2	36.2	95.2	87.4	98.2	93.6	66.4	87.8	102.1	85.43
	20	87.2	97.8	160.2	115.06	45.8	69.2	89.3	68.1	78.3	65.9	78.4	74.2	97.6	120.9	2230.3	147.17
	30	112.5	215.1	250.4	230.16	67.3	95.4	100.2	87.6	53.6	42.8	35.3	43.9	140.7	230.7	260.7	210.7
Biochar C	0	50.4	67.2	53.6	67.07	32.2	37.4	34.2	34.9	97.5	83.2	99.4	93.37	69.3	89.4	107.4	88.7
	20	150.4	260.4	290.2	233.67	48.4	59.2	64.4	57.3	86.4	78.5	88.4	84.43	130.2	170.5	198.6	166.43
	30	201.3	280.4	304.8	262.1	55.3	67.4	75.8	66.1	43.7	33.4	45.4	40.83	270.9	290.4	306.9	289.4
LSD0.05Sources		2.86	19.81	1.71	-----	2.50	3.32	0.049	---	1.57	1.39	1.58	----	7.55	13.52	28.66	-----
LSD.0.05 Rates		3.80	25.19	0.87	---	0.73	6.66	0.75	----	0.78	1.36	1.37	----	15.31	16.35	39.31	----
Interaction		***	***	***	----	***	***	***	----	***	***	***	----	***	**	**	----

amendment increased legume growth and yield through improving biologi-cal N2 fixation (Lane et al., 2015). Moreover, reported that incorporation of biochar in soils had strong impacts on micro-bail populations, which could have beneficial functions in improving soil fertility (Ding et al., 2016).

Moreover, they found that microbial growth rates significantly increased withApplication .

3.5. Soil enzyme activities:

Data in Table (7) Revealed that dehydrogen-ase (DHA) and cellulase activities were markedly improved with the increase of biochar types under addition of mineral fertilizers and their highest values were recorded after 90 days. These results indicate that the rhizosphere soil of faba bean without the application of biochar had the lowest values of dehydrogenase (DHA) and Cellulase while the addition of biochar was responsible for higher activities in the estimated enzymes compared to the control treatment, This could be attributed to the positive effect of biochar on the microbial community through providing beneficial substrates for soil microbes (Deenik *et al*., 2010).

The results also show that DHA values in various treatments were gradually increased from the initial time of evaluation (30 days) to reach their maximum records at the (90days) while the DHA values in untreated was increased at 30 and 60 days and decrease again in 90 days. In this respect, Badri *et al*. (2009) showed that root exudates caused significant changes in the natural microbial community and increased their activities.

The release of elements from biochar analysis led to significant increases in soil enzymes compared untreated soil**.** Found that microelements played an important role as major components or as functional, structural or regulator co-factors of large numbers of enzymes. For example, Fe and Mn had vital roles in enzymes function involved in respiration and biosynthesis of

Cells as well as activators for oxidation and reduction, while Zn acts as a co-factor of many enzymes. Total cellulase activities were affected in all soils treated with biochar compared to control soil. These results showed in the same table, where the all treatments of biochar with or without mineral fertilizers recorded significant increase in means cellulase enzyme activity. The results were (144.7, 129.1 with C+ 30, 20Kgm mineral fertilizers

Table 7. Effect of different treatments on soil enzymes activities at different periods from application

Treatments	Rate of Application	Cellulase activity u.mol. Gloucose/g dry soil				Dehydrogenase activity (ug. T.P.F./g dry soil)			
		Day after application				Days after application			
		30	60	90	Mean	30	60	90	Mean
Control	Without	15.6	17.4	16.4	16.47	5.9	11.2	9.4	8.83
	0	59.3	69.5	72.3	67.03	15.4	18.2	24.7	19.43
Biochar A	20	76.8	98.7	102.3	92.63	30.5	38.4	43.2	37.37
	30	87.6	106.5	126.4	106.83	33.4	64.9	87.9	62.07
	0	60.1	79.8	93.2	77.7	25.7	31.2	49.9	35.6
Biochar B	20	98.3	105.4	129.5	111.06	99.7	113.5	137.2	116.8
	30	107.8	139.8	141.4	129.67	114.3	127.8	149.4	130.5
	0	71.5	86.4	106.5	88.13	39.5	58.9	69.7	56.03
Biochar C	20	107.9	133.6	145.8	129.1	135.9	148.2	165.9	150
	30	117.6	146.8	169.7	144.7	189.9	211.6	250.8	217.43
LSD.0.05 sources		4.05	2.27	1.13	----	2.60	2.82	15.63	-----
LSD. 0.05 rate		1.18	4.92	3.88	----	3.24	4.21	21.85	-----
Interaction		**	***	***	----	***	***	***	------

respectively , 141.4,129.5 with B+ 30, 20Kgm mineral fertilizers respectively, and 126.4,102.3 with A+ 30, 20Kgm mineral fertilizers respectively compared with 16.47 with the untreated soil.

Soil microorganisms produce extra cellular enzyme in order to degrade the available substrate in their environment so that it can be utilized for metabolic processes. This enzymatic activity can be used as proximate indicators of organic matter mineralization and nutrient cycling (Burns et al. 2013) as its activity has been proposed to be associated with the organic in puts applied in to soil environment. A number of studies reported stimulation of soil enzyme activity associated with carbon after application of biochar to soil (Yoo and Kang 2012; Gui et al. 2013).

3.6. Nodulation and Nitrogenase activity:

Nodules number, fresh and dry weight (g/plant) showed in table (8). The results showed that all treatments used have significantly increases in the nodules number, fresh and dry weight of it compared with control. The results also showed that the best effect was for Biochar C followed by B and A. Also, the average bioshar + 30 kg has the highest positive impact, followed by bioshar + 20 kg mineral fertilizers and the least bioshar alone. For example, the number of nodules were 67.3, 89.5 and 93.4 in the A, B and C (+30 kg) respectively compared with 20.2 with control. These results are consistent with (David, T. *et al.*, 2015)who reported that the biochar additions at a rate of 15 t ha−1 resulted in an average 3575 % increase in nodule biomass, over the control. The biochar application enhancements of nodulation, N_2 fixation, and nutrient availability, Rondon *et al*. (2007) and Mia *et al*. (2014) they also reported that biochar might increase legume growth and yield due to improving biological N_2 fixation. The lowest values of nodulation parameters were observed in faba bean under no-biochar application. On the other hand, higher values of nodule number and nodule fresh weight were observed, This might result from promoting the efficiency of inoculants or native microorganisms (Mete *et al*., 2015). Also, Guerena et al. (2015) reported that the biochar additions resulted in 35.75% increase in nodule biomass and 21.26% increase in N derived from the atmosphere over the control. In addition, the efficient impact of biochar treatments on nodulation could be attributed to the N_2-fixing capacity of rhizobia and plant growth-promoting substances produced by native and introduced microorganisms (Badri *et al*., 2009). The same table appears the interaction effects of different types of biochar combined with different rates of mineral fertilizers as soil application on Nitrogenase activity in root nodules of faba bean was gradually enhanced with the increase mineral fertilizer rates combined with biochar and the highest readings were observed in soil treated with bichar C + 30 kg mineral fertilizers followed by C + 20 kgm (112.7, 98.4 respectively) compared with untreated was 16.2 mL C_2H_4 g^{-1} dry nodule. These results reflect the beneficial effect of biochar on the native microorganisms and rhizobia to colonize the rhizosphere of legumes. According the analysis of biochar in table (2) microelements such as Fe could play a vital role in activities of many enzymes and also in the structure of the nitrogenase, so it caused marked increases in its activity with high quality of root nodules.

Table 8. Effect of different treatments on Nodules and nitrogenase activity (uL C_2H_4/ g dry nodules) under different treatments.

Treatments	Rate of used	NO. of nodules	Nodules FW(g/plant)	Nodules DW(g/plant)	N_2-ase activity
Control	Without	20.2	1.85	o.oo1	16.2
	0	26.8	2.50	0.004	30.4
Biochar A	20	48.7	3.4	0.04	56.5
	30	67.3	5.2	0.05	71.6
	0	27.1	2.1	0.02	34.2
Biochar B	20	65.8	5.8	0.05	85.7
	30	89.5	8.7	0.07	97.3
	0	27.3	2.4	0.02	43.2
Biochar C	20	79.4	7.2	0.06	98.4
	30	93.4	8.2	0.08	112.7
LSD. 0.05 sources		2.20	0.17	0.007	1.58
LSD.0.05 rates		3.30	0.47	0.008	2.90
Interaction		***	***	Ns	***

3.7. Effect of biochar types alone or combined with mineral nitrogen different rates on faba bean productivity.

Results in Table (9) show that the biochar alone or compined with different rate of mineral nitrogen. . Increase all mean values of growth parameters of faba bean productivity. The maximum mean values of the plant height (cm), No. of branch/plant, No. of pod/plant, weight of pods/plant, weight of 100 seeds (g), weight of seeds yield (ton/fed) and weight of pods yield (ton/fed) in soil treated with biochar C combined with mineral nitrogen different rates compared with other treatments. The effect of biochar types application and different rates of mineral nitrogen fertilizer on the plant growth parameter and yield components were significant increases with increasing rates of mineral nitrogen fertilizer. . The relative increases of mean values were 7.18 % for the plant height (cm); 38.14 % for No. of branch/plant; 49.55 % for No. of pod/plant; 36.92 % for weight of seeds/plant; 30.03 % for weight of Pod/plant; 9.49 % for weight of 100 seeds (g) and 21.05 % for seeds yield (ton/fed) and 24.77 % for weight of pods yield (ton/fed) in soil treated with biochar A combined with different rates of mineral nitrogen fertilizer compared without biochar (control). The relative increases of mean values were 12.70%; 33.20; 52.96 %; 37.23 %; 31.17%; 20.84 %; 26.32 % and 34.86 % for plant height (cm), No. of branch/plant, No. of pod/plant, weight of pods/plant, weight of 100 seeds (g), weight of seeds yield (ton/fed) and weight of pods yield (ton/fed) respectively, in soil treated with biochar B combined with mineral nitrogen different rates compared with control.

Table 9. Effect of biochar types on yield and yield component of faba bean.

Treatments	N rates (kg/fed)	Plant height (cm)	No. of Branch /plant	No. of pod/plant	Weight of seed /plant	Weight of pods /plant	Weight of 100 seeds (g)	Weight of seeds yield (ton/fed)	Weight of pods yield (ton/fed)
Control	40	87.32	4.85	12.35	35.24	41.32	89.32	0.95	1.09
	0	90.14	6.32	14.63	43.14	48.35	94.10	1.04	1.27
Biochar A	20	93.46	6.85	18.45	49.52	53.41	98. 14	1.19	1.36
	30	97.18	6.93	22.34	52.10	59.42	101.5	1.22	1.45
Mean		93.59	6.70	18.47	48.25	53.73	97.80	1.15	1.36
	0	94.52	5.39	15.38	41.59	47.20	103.45	1.03	1.34
Biochar B	20	98.37	6.88	17.69	46.35	51.30	108.00	1.23	1.48
	30	102.34	7.12	23.60	57.14	64.10	112.35	1.35	1.59
Mean		98.41	6.46	18.89	48.36	54.20	107.93	1.20	1.47
	0	95.00	5.75	18.37	43.69	49.63	105.96	1.08	1.48
Biochar C	20	103.41	7.14	24.53	54.10	59.20	110.22	1.33	1.56
	30	108.32	7.36	25.88	58.55	66.84	115.40	1.45	1.63
Mean		102.24	6.75	22.93	52.11	58.56	110.53	1.29	1.56
LSD.0.05 treatments		1.99	Ns	1.23	Ns	Ns	2.67	0.01	0.024
LSD. 0.05 rate		2.86	1.43	1.15	4.16	6.34	1.89	0.02	0.007
Interaction		Ns	Ns	ns	*	Ns	Ns	***	*

While values were 17.09 % ; 39.18 % ; 85.67 %; 47.87 %; 41.72 % ; 23.75 %; 35.79 % and 43.12 % respectively, in soil treated with biochar C combined with mineral nitrogen different rates compared with control. It is worthy to mention that the superiority of faba bean productivity as affected with biochar types different sources followed by Biochar C > biochar B > biochar A > control for all parameters yield and yield components of faba bean. These results are in agreement by Brandstka et al (2010) suggested that the faba bean yield and 100 seeds (g) was significant increase as affected with interaction between biochar application and mineral fertilizer. Biochar could cause high enhancements in microbial populations in the rhizosphere and marked promotions in plant growth (Rondon et al., 2007). Also, biochar amendment increased legume growth and yield through improving biological N2 fixation (Lane et al., 2015). Silber et al (2010) indicated that the biochar application led to high improvements in growth parameters such as 100-seed weight.

3.8. Macronutrients concentration in seeds faba bean:

Data present in Table (10) showed that the concentrations and uptake of macronutrients i.e. N, P and K (%) in faba bean seeds in all studied experimental pilot unit were at low and sufficient limited or the critical concentration and uptake. The increases mean values of N and K concentrations in seeds were 4.10 and 2.99 % for soil treated with biochar C, while the high P concentration in seeds was 0.56 % for soil treated with biochar A combined with different rates of mineral nitrogen. Also, the data show that N, P and K concentration in seeds tend to increases with increasing mineral nitrogen fertilizer combined with biochar type's sources. The P concentration in seeds of faba bean was significant increases with increasing combined with biochar types, while the N and K concentrations in seeds were no signs as affected with biochar types and different rates of nitrogen fertilizer. On the other hand, the uptake of N, P and K in seeds was significant increases with increasing different rates of mineral nitrogen fertilizer combined with biochar types. The highest mean values 52.87, 7.26 and 38.63 (kg/fed) for N, P and K uptake in seeds as affected with biochar C combined with mineral nitrogen rates compared with other treatments. The uptake of N, P and K (kg/fed) was significant as affected by biochar types and different rates of mineral nitrogen fertilizer, while the interaction between biochar types and different rates of mineral nitrogen fertilizer were no significant concentration of N, P and K and uptake of N and K in seeds, but the P uptake was significant increases of mineral nitrogen rates combined with biochar types. The relative increases of mean values were 13.24 % for N; 23.40 % for P and 15.32 % for K concentrations and 37.48 % for uptake N; 50.22 % for uptake P and 39.69 % for uptake K in seeds as affected with biochar A combined with mineral nitrogen fertilizer rates compared with control. Also, the relative increases of mean values were 14.65 % for N; 14.89 % for P and 18.95 % for K concentration and 45.70 % for uptake N; 47.98 % for P and 51.23 % for K uptake in seeds faba bean respectively, as affected by biochar B combined with different rates mineral nitrogen fertilizer compared with control.

Table 10. Macronutrients concentration and uptake in seeds of faba bean.

Treatments	N rates (kg/fed)	Macronutrients concentrations (%)			Macronutrients Uptake (kg/fed)		
		N	P	K	N	P	K
Control	40	3.55	0.47	2.48	33.70	4.46	23.56
Biochar A	0	3.89	0.53	2.75	40.50	5.51	28.60
	20	4.05	0.58	2.89	48.20	6.90	34.39
	30	4.12	0.63	2.93	50.30	7.69	35.75
Mean		4.02	0.58	2.86	46.33	6.70	32.91
Biochar B	0	3.95	0.49	2.82	40.70	5.05	29.05
	20	4.08	0.55	2.98	50.20	6.77	36.65
	30	4.18	0.59	3.05	56.40	7.97	41.18
Mean		4.07	0.54	2.95	49.10	6.60	35.63
Biochar C	0	3.97	0.51	2.89	42.90	5.51	31.21
	20	4.10	0.57	3.01	54.50	7.58	40.03
	30	4.22	0.60	3.08	61.20	8.70	44.66
Mean		4.10	0.56	2.99	52.87	7.26	38.63
LSD.0.05 treatments		Ns	0.032	ns	5.10	0.19	2.02
LSD. 0.05 rate		Ns	0.021	ns	3.46	0.25	0.75
Interaction		Ns	Ns	ns	Ns	**	Ns

The corresponding relative increases of mean values N, P and K concentrations and uptake in seeds were 15.49 for N; 19.15 for P and 20.56 % for K concentrations and 56.88 % for N uptake; 62.78 % for P uptake and 63.96 % for K uptake in seeds faba bean respectively, as affected with biochar C combined with mineral nitrogen fertilizer rates compared with control.

These results reflected to applied biochar types led to improve nutrient concentration and uptake in faba bean seeds, especially the plants treated with biochar C increased in N and K concentrations and uptake than biochar A and B. These results are in agreement with Khaled and Jeff (2019) these found that the application of biochar with or without mineral fertilizers was increased N, P and K uptake in plants. Ibrahim et al. (2017) found that the application of biochar to soil led to a significant increase of N, P and K contents in straw and seeds. This result could be explained by the ability of biochar to enhance the availability of soil nutrients and their contents in faba bean plants. Hunt et al. (2010) reported that biochar application had a marked contribution increasing nutrients in plants. Guerena et al. (2015) suggested that the biochar application resulted in a 35.75% increase in nodule biomass and 21.26% increase in N derived from the atmosphere over the control.

3.9. Micronutrients concentration and uptake in seeds:

The data showed that applied biochar types combined different rates of nitrogen fertilizer caused increases of micronutrients i.e. Fe, Mn and Zn concentrations or uptake in seeds with increasing different rates of nitrogen fertilizer combined with biochar types (table 11). The maximum of mean values Fe, Mn and Zn concentrations and uptake in seeds were biochar C combined with different rates of mineral nitrogen fertilizer.

Table 11. Micronutrients concentration and uptake in seeds of faba bean.

Treatments	N rates (kg/fed)	Micronutrients concentrations (mg/kg)			Micronutrients Uptake (g/fed)		
		Fe	Mn	Zn	Fe	Mn	Zn
Control	40	82.10	55.34	22.14	78.00	52.57	21.03
Biochar A	0	86.31	58.42	26.85	69.76	60.76	27.92
	20	89.17	61.37	29.37	106.11	73.03	34.95
	30	93.41	63.52	31.52	113.96	77.49	38.45
Mean		89.63	61.10	29.25	96.61	70.43	33.77
Biochar B	0	88.75	59.88	27.89	91.41	61.68	28.73
	20	93.25	60.47	32.55	114.70	74.38	40.04
	30	97.26	65.48	33.47	131.30	88.40	45.18
Mean		93.09	61.94	31.30	112.47	74.82	37.98
Biochar C	0	89.18	60.18	29.14	96.31	64.99	31.47
	20	92.14	63.58	33.52	122.55	84.56	44.58
	30	98.34	67.32	36.14	142.59	97.61	52.40
Mean		93.22	63.69	32.93	120.48	82.39	42.82
LSD.0.05 treatments		1.17	Ns	Ns	3.26	5.31	2.39
LSD. 0.05 rate		0.60	2.65	3.16	5.14	6.52	2.43
Interaction		Ns	ns	Ns	*	Ns	*

The biochar type's sources application had a significant effect on Fe concentration, while Mn and Zn concentrations in seeds. Uptake of Fe, Mn and Zn contents in seeds were significant as affected with biochar types. The effect of different rates of mineral nitrogen fertilizer on Fe, Mn and Zn concentration and uptake in seeds of faba bean was significant increases with increasing different rates of mineral nitrogen. The interaction between biochar types and mineral nitrogen rates were no significant affected for Fe, Mn and Zn concentration, while the Fe and Zn uptake were significant increases with increasing mineral nitrogen fertilizer. The corresponding relative increases of mean values of Fe, Mn and Zn concentrations and uptake in seeds were 9.17 % and 23.86 % for Fe ; 10.41 % and 33.97 % for Mn and 32.11 % and 60.58 % for Zn respectively , as affected with biochar A combined with mineral nitrogen rates compared with control (without biochar). The relative increases of mean values Fe, Mn and Zn concentrations and uptake were 13.39 and 44.19 % for Fe; 11.93 and 42.32 % for Mn and 41.37 and 80.60 % for Zn, respectively as affected with biochar B combined with mineral nitrogen rates compared with control. As well As, the relative increases of mean values were 13.54 and 54.46 % for Fe; 15.09 and 56.72 % for Mn and 48.74 and 103.61 % for Zn concentration and uptake respectively, as affected with biochar C combined with mineral nitrogen fertilizer compared with control.

It is evident from the concentrations and uptake distribution patterns of Fe, Mn, and Zn that it could be arranged for seeds faba bean into the following orders: Biochar C > biochar B > Biochar A > control alone or combined with mineral nitrogen fertilizer.

Finally, it is concluded that the concentrations and uptake of Fe, Mn, and Zn in seeds faba bean, reflect their available contents in soil and biochar types under different rates of mineral nitrogen fertilizer used. These results are in agreement by Tanveer et al. (2019) found that the Biochar application increased the plant nutrient availability. Hunt et al. (2010) reported that biochar application had a marked contribution to increasing nutrients in plants. This could be explained by the ability of biochar to enhance the availability of soil nutrients and their contents in faba bean plants.

4. Conclusion

This study has the importance of application different rate of nitrogen fertilizers with four rates combined with types of biochar in faba bean. During the experiment, we observed that biochar had the greatest effect on improving the soil properties and vegetative plant growth. Biochar application was significantly increased the morphological attributed of the plant compared with control. Also, biochar increase all counts of microbial, soil enzymes, nodules and nitrogenaze enzyme. Bichar has decreasing effects on pathogenic fungi. Finally, based on the biochar types were the greatest interaction when soil amended with the combination of high rates of mineral nitrogen fertilizer.

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الملخص العربي

تأثير أنواع مختلفة من البيوشار علي الخواص الكيميائية للتربة والتجمعات الميكروبية والفطريات الممرضة وانتاجية الفول البلدي

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تم إجراء هذه التجربة في تربة رملية من الأراضي الخاصة في رومانا، محافظة شمال سيناء، مصر خلال موسمين شتويين متعاقبين ٢٠١٧ / ٢٠١٨ و ٢٠١٨ /٢٠١٩، لدراسة تأثير ثلاثة أنواع من البيوشار ، (أ) الناتج من سيقان الذرة وقش الارز ومخلفات الفول البلدي والقطن. النوع الثاني (ب) ناتج من مخلفات الاشجار. والنوع الثالث (ج) ناتج من مخلفات المدن ، مع ثلاثة مستويات من سماد اليوريا (٠ ، ٢٠ ، ٣٠ كجم ن / للفدان) ، بالإضافة إلى الكنترول الذي استخدم فيه الجرعة الموصى بها من اليوريا لاختبار تأثير الانواع المختلفة من البيوشار سواء كانت مختلطة أو غير مختلطة بالسماد النيتروجيني علي انتاجية الفول البلدي تحت ظروف التربة الملحية. تم زراعة صنف الفول جيزة (٨٤٣) في ١٢ نوفمبر موسمي ٢٠١٧ و ٢٠١٨ وتم تصميم التجربة استخدت ثلاثة مكررات ,(N% 46) لكل معاملة . وقد أظهرت النتائج ان البيوشار بانواعه الثلاثة المختلط بالاسمدة النيتروجينية اظهر تأثيرا ايجابيا علي كل مختبرات الدراسة.

كما أن البيوشار (ج بالاضافة الي ٣٠كم نيتروجين معدني) اظهر اعلي فعالية ايجابية (ادي الي زيادة في كل الاعداد المختبرة). ومن ناحية اخري ، فأن نفس المعاملة قد ادت الي نقص نسبة الاصابة بمرضي اعفان جذور وذبول الفول وان نسبة النباتات الحية كانت ٩٧.٩% و ٩٣.٤% للمرضين علي التوالي. كما ادت ايضا الي نقص في اعداد الفطريات الممرضة.