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# Effect of soil amendment with biochar on Cd, Zn accumulation and growth of faba bean grown in sandy soil

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## Abstract

Agricultural soil is one of the most important sources of food contamination with heavy metals. This contamination occurs through contaminated irrigation water or the unwised use of pesticides. Cadmium (Cd) is one of the most dangerous heavy metals that can be found in food chain. This study aimed to investigate the impact of soil amendment with rice husk biochar on the toxicity of Cd on faba bean plants. Three amendment rates of biochar were applied (0.5, 1 and 2%). The concentrations of Cd were 0.01, 0.1 and 1 mg/ liter of irrigation water. Data for growth measurments were collected at 60,90 and 112 days of caltivation, while the nutrient analysis and metals uptake were performed only at 112 days of caltivation. The soil amendment rate of 1% biochar affected the growth of faba bean positivly. The plant hight, number of leaves and flowers were increased by 12.15%, 8.13% and 65.61%, respectively. however the number of branches, pods and chlorophyll content were not changed significantly. Fresh root weight, pod weight, root length, dry weight of shoot and root were not changed significantly except fresh shoot weight was increased by 33.81% compared to control. 1% of biochar increased Zn concentration in root by (5%) on the other hand Zn concentration in shoot and Cd concentration in shoot and root decreased compare to control as follow respectively (36.6, 53.09 and 46.39). data in sandy soil analysis showed that concentration 2% of biochar increased Zn concentration (7.65%) and decreased concentration of cadmium (88.31%) compared to control. Overall, this study indicated that the use of rice husk biochar at a high application amandment rate (1% or 2%) was most effective to decrease Cd uptake and translocation in beans.

Keywords: Abiotic stress; Cadmium (Cd); Rice Husk Biochar (RHB); Heavy metals; Environment;

**INTRODUCTION**

Faba bean is one of the most important legume crops in the world.. Faba bean is one of the most important winter crops for human consumption in the Middle East and has been assume as meat and skim-milk substitutes. The faba bean is the world's fourth most significant Legume crop after beans, Pisum, and chickpeas. Faba beans are used as seeds and a green vegetable(Punia, 2019). They are also a good source of several nutrients, including K, Ca, Mg, Fe, and Zn (Longobardi *et al.*, 2015)**.** Faba bean seeds also contain several other bioactive compounds, such as polyphenols (Turco *et al.*, 2016), carotenoids and carbohydrates (Landry *et al.*, 2016).

Heavy metals such as Cd, Cu, Ni, Co, Cr, Pb, and As have been detected in agricultural soils in various parts of the world. This might be due to a variety of reasons, including the use of phosphatic fertilizers, the application of sewage sludge, industrial output, mining operations, and poor agricultural irrigation methods. Heavy metal contamination of soil has become a significant global environmental concern in recent years. Plants respond to heavy metal toxicity in a variety of different behaviors.

Immobilization and the expression of more general stress response mechanisms like ethylene and impact on photosynthesis are examples of such responses. Heavy metals are non-biodegradable and therefore display long-term persistence in soils, which can result in toxicity for plants, animals and humans(Bolan *et al.*, 2014). Heavy metals such as Cd hardly effect on plant growth. Cd causes obvious damage symptoms such as chlorosis, growth inhibition, browning of root tips, and eventually death (Abbas *et al.*, 2017). Cadmium is a widespread toxic element of occupational and environmental concern because of its toxic effect: extremely protracted biological half-life (approximately 20–30 years in humans), low rate of excretion from the human body and storage predominantly in soft tissues (primarily, liver and kidneys). It is an extremely toxic pollutant of continuing concern because environmental levels have risen steadily due to continued worldwide anthropogenic mobilization(Sarkar *et al.*, 2013). In plants Cd is an easily absorbed and rapidly translocated heavy metal that is transferred symplastically via the root cortex to the shoot, changes in photosynthetic activity, alterations in stomatal movement, enzymatic activities, protein metabolism, and membrane functioning. Cd is one of the elements that may accumulate in plants to amounts greater than 0.01 percent of shoot dry weight without generating hazardous effects (Tudoreanu and Phillips, 2004).

(Liua *et al.*, 2020) & (Zheng *et al.*, 2020) reported that pyrolysis is one of the methods used to get rid of plants that contain heavy metals because it effectively stabilizes heavy metals and produces biochar that is re-used in agriculture. Final products of pyrolysis include solid components combined with soil, liquid ingredients (bio-oil and tar), and gaseous components (condensable and non-condensable vapour gas). One of the most recent innovations is the production of biochar from agricultural

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leftovers using pyrolysis technology, which uses the pyrolyzed residues as recalcitrant adsorbent materials to extract heavy metals from wastewater and immobilize metallic pollutants in soils. Biochar applications include carbon sequestration, improving agricultural soil fertility, treating agricultural soil pollution, and recycling agricultural products / waste that could pollute the environment. The effectiveness of biochar at eliminating pollutants depends on its surface area, pore size distribution, and ion exchange capacity (Zheng, 2020). The physical engineering and molecular structure of biochar can be one of the factors influencing the practical application of soil and water (Ahmad *et al.*, 2014; Han *et al.*, 2018). Recent research has shown that biochar are efficient soil additions in that they increase soil agronomic qualities. They are also capable of remediating organic and inorganic pollutants. Biochar application provides agronomic advantages such as enhanced physical, chemical, and biological characteristics of soils (Sohi *et al.*, 2010; Park *et al.*, 2011). Rice husk biochar (RHB) was created by pyrolyzing rice husk (RH) for 15 minutes at 450 ℃ (Mahmoud *et al.*, 2011). The main objective for this work were to Study the effects of biochar and cadmium on the morphological characters of faba bean plants, Study cadmium and zinc concentrations in faba bean shoots and roots as affected by application in sandy soils, Study the bioaccumulation of cadmium in plant, Effect of Cd on Chlorophyll content, Effect of Cd on the macronutrients Ca, Mg, N and K in plants.

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## MATERIALS AND METHODS

### 1. Soil collection and preparation

Soil samples were collected from the new lands in Nubaria, Alexandria Governorate. After obtaining the soil, part of the soil was taken to make analysis and identify some of its chemical and physical properties. Soil samples were sterilized in autoclave at a temperature of 121.6 ˚C in 15 psi for an hour. The soil was then aerated before packing into pots. Part of the soil was taken to make analysis and identify some of its chemical and physical properties.

### 2. Biochar

Biochar was purchased from North Africa for Chemicals Company, Alexandria, Egypt. The biochar is made from rice husks at a temperature of 450°C for 6 hours under limited-oxygen conditions. The obtained rice husk biochar (RHB) passed through a 500-micron sieve before being used in experiments and properties study.

### 3. Faba bean seeds and pots experiment

The faba bean variety Seeds of Nubaria1 were used for pot experiment obtained from Seeds Production Unit, EL-Mansheya, Alexandria Governorate. soil was potted by 4 kg w\w soil per pot of 25 Cm diameter with the application of the different concentrations of biochar under study ( Rice husk) , which are 0.5, 1 and 2%**,** (Yao *et al.*, 2017; Alvarez-Campos *et al.*, 2018) the soil was irrigated 24 hours before planting, cadmium contaminated water treatments were applied after two weeks of planting.

**4. Cadmium concentrations**

Cadmium sulphate hydrate 98% ($CdSO_4.8H_2O$) LOBACHEMIE it was use as a source of heavy metals in irrigation water.it apply in different concentrations such as 0.01, 0.1 and 1 mg\l. the recommended concentration was chosen by the Food and Agriculture Organization (FAO) and the World Health Organization (WHO) to apply and apply ten times the concentration and 100 times the concentration.

**5. Plant growth parameters measurements**

All plant parameters were measured three times during the growing season. Shoot height of all treatments were measured in cm during the plant growth time as well as number of leaves, flowers, and pods. Root length of all treatments were recorded after harvesting the plants by the end of growth period (16 week).

Fresh and dry weight of plants were recorded. The three parts of the plant were separated, the pods and shoots were gathered for each replicate and weighed immediately after harvest, The plant was then washed numerous times with distilled water, air-dried, and weighed. Parts for each replicate were gathered in paper bags and oven dried at 80 ° C for 72 hours and weighed. Parts of the dry plants were kept for elemental analysis.

**6- Determination of available cadmium and zinc in plant samples**

Two grams of the plant sample were weighed and placed in a crucible and were burned in the muffle furnace for two hours at a temperature 600°C, the crucible was brought out to cool down, 5 ml of concentrated hydrochloric acid were added and the crucible was placed in the laminator with light heating until all the acid evaporated, then 10 ml of dilute 1: 3 dilute hydrochloric acid was added then filtered and the filtrate solution was taken for evaluation.

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**7- Determination of total chlorophyll content**

After 80 days of planting, the chlorophyll content of the plant is measured using a device SPAD 502 Plus Konica Minolta Japan, where a reading of each treatment was taken three times for each leaf of a plant out of a total of three leaves for each plant, where the first, third and fifth leaf were taken.

**8- Soil sampling**

After the plants were harvested, 30 grams of each pots soil were collected to measure pH and EC.

**9- Determination of pH & EC in soil samples**

Samples were taken from sandy soil and clay soil after planting, and the sample was prepared for estimation as follows: 20 grams of air-dried soil was potted in the flask with 20 ml of distilled water Shaked for 30 min, after that PH was estimated in the samples and then it was filtered in Whatman No.102 filter paper and the filtrate were taken for determination using EC.

**10- Determination of available cadmium and zinc in soil samples**

48 Samples were taken from sandy soil before and after planting, and the sample was prepared for estimation as follows: 10 grams of soil sample were taken after drying in the air, and 20 ml of Diethylene triamine Pentaacetic acid (DTPA) extracting solution were placed in a beaker and placed on a shaker (MODEL:VRN-360) for two hours, after which it was filtered in Whatman No.42 filter paper and the filtrate was taken for determination using an atomic absorption spectrophotometer **(Baker, 1981; Risser and Baker, 1990).**

**11- Determination of Ca, Mg, K and N in Shoot**

A weight of 2 grams was prepared from each sample of the selected treatments were determined according to (Pearson's, 1981) this work done by Central lab for Environmental and Biological Analysis-High Institute of public Health, Alexandria University.

## 12- Calculation of BCF, TF and BAF in plant

Bioconcentration factor (BCF), Translocation factor (TF) and Bioaccumulation factor (BAF) of heavy metal (Cadmium) in harvested plant (*Vicia faba*) was calculated. As recorded by (Niu *et al.*, 2007; Maiti and Jaiswal, 2008).

$$\text{Bioconcentration factor (BCF)} = \frac{Metal\ concentration\ in\ root}{Metal\ concentration\ in\ soil}$$

$$\text{Translocation factor (TF)} = \frac{Metal\ concentration\ in\ shoot}{Metal\ concentration\ in\ root}$$

$$\text{Bioaccumulation factor (BAF)} = \frac{Metal\ concentration\ in\ plant\ (shoot+root)}{Metal\ concentration\ in\ soil}$$

BCF is defined as the concentration of a heavy metal in the roots (mg/kg) divided by the concentration of the same heavy metal in the soil (mg/kg). The concentration of a heavy metal in above-ground tissue (mg/kg) divided by the concentration of the same heavy metal in roots (mg/kg) yields TF.

## 13- Experimental design and Statistical Analysis

The experiment was a factorial design ‘’ 2 Factors ‘’ with two factors (Biochar levels and Cadmium levels) in complete randomized design (RCBD) with 16 treatments in four replicates. Analysis of variance (ANOVA) was carried out on the pots experiment, Determination of cadmium and zinc in plant samples, Determination of cadmium and zinc in soil samples and Determination of Ca, Mg, K and N in Shoot, by using the statistical analysis system (SAS) software computer program (SAS Institute, 1988). Means of treatments were compared with the value of revised LSD at 0.05 level of probability.

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## Result and discussion

- Data in table 1 Studying the effect of biochar and cadmium treatments on vegetative growth parameters faba bean plants cultivated in sandy soil after 60 days indicated that plant height reduced, the highest reduction (29.28 cm) was detected after 1 mg/l Cd treatment compared to control. Biochar amendments signifcantly equilabriated the effect of Cd treatments except for (0.5 % Biochar & 0.1 mg/l Cd, and 1% Biochar & 1 mg/l Cd) (29.91 and 27.79 respectively) (Table 4-6). On the contary treatments have increased the number of leaves (12.88, 14.13 leaf\plant), except treatments (0% Biochar & 0.01 mg\l Cd, 0.5% Biochar & 0mg\l Cd and 2% Biochar & 0 mg\l Cd) which decreased the number of leaves (11.38, 11.88 and 12.00 leaf/plant, respectively) compared to control. the number of flowers were increased after Biochar application by 1% (5.75 flowers/plant). The number of branches was decrease in all treatments compared to control with number of branches ranged (1.38 & 2.25 branches) as the treatment 1% Biochar &1 mg/ml Cd (1.38 branch/plant) was the least compared to control 2.63 branch/plant.

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**Table1 : Effect of Biochar application on faba bean plants growth parameters**

| Biochar (%) | Cadmium (mg/l) | Plant height | Number of leaves | Number of flowers | Number of branches |
|---|---|---|---|---|---|
| 0 | 0.00 | 35.13 [a] | 12.56 [a] | 0.00 [a] | 2.63 [a] |
| | 0.01 | 29.61 [b] | 11.38 [a] | 2.00 [a] | 1.63 [a] |
| | 0.10 | 26.76 [b] | 12.88 [a] | 3.25 [a] | 2.13 [a] |
| | 1.00 | 29.28 [b] | 13.25 [a] | 2.75 [a] | 1.63 [a] |
| 0.5 | 0.00 | 32.25 [ab] | 11.88 [a] | 0.00 [a] | 2.00 [a] |
| | 0.01 | 32.10 [ab] | 13.00 [a] | 0.00 [a] | 2.00 [a] |
| | 0.10 | 29.91 [b] | 12.88 [a] | 2.75 [a] | 1.75 [a] |
| | 1.00 | 34.81 [ab] | 14.13 [a] | 4.50 [a] | 2.13 [a] |
| 1 | 0.00 | 33.48 [ab] | 13.13 [a] | 5.75 [a] | 1.88 [a] |
| | 0.01 | 33.00 [ab] | 13.38 [a] | 4.50 [a] | 2.13 [a] |
| | 00.1 | 31.78 [ab] | 13.38 [a] | 0.00 [a] | 2.00 [a] |
| | 1.00 | 27.79 [b] | 12.50 [a] | 2.75 [a] | 1.38 [a] |
| 2 | 0.00 | 28.23 [b] | 12.00 [a] | 2.25 [a] | 2.25 [a] |
| | 0.01 | 31.15 [ab] | 13.38 [a] | 1.50 [a] | 2.13 [a] |
| | 0.10 | 31.44 [ab] | 13.75 [a] | 1.50 [a] | 1.75 [a] |
| | 1.00 | 34.36 [ab] | 12.88 [a] | 4.25 [a] | 1.88 [a] |

**cultivated in Cd treated sandy soil after 60 days of planting**

- Data in table 2 illustrate that biochar effect on all plant parameters except number of branches and number of pods there is no significant effect on both of them, especially concentrations 1 and 2% of biochar increase plant height, number of leaves and number of flowers.

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**Table 2: Biochar concentration and its effect on plant parameters after 90 days of planting in sand soil**

| Biochar concentrations (%) | Plant height | Number of leaves | Number of flowers | Number of pods | Number of branches |
|---|---|---|---|---|---|
| 0 | 41.27[a] | 16.22[a] | 30.06[b] | 5.25[a] | 2.41[a] |
| 0.5 | 41.81[a] | 16.02[a] | 40.75[a] | 4.38[a] | 2.66[a] |
| 1 | 43.84[a] | 17.37[a] | 42.13[a] | 6.19[a] | 2.59[a] |
| 2 | 45.97[a] | 17.82[a] | 44.75[a] | 5.38[a] | 2.66[a] |

Values are means of four replicates .Values of the same column followed by the same letter (s) are not significantly different at $P \leq 0.05$ of LSD. The experiment was analyzed in two-way ANOVA.

- Data in Table 3 illustrate that biochar effect on all plant parameters significantly except number of pods and number of branches, especially concentrations 1 and 2% of biochar significantly increase number of leaves and number of pods, and it did not have a significant effect on the rest of plant parameters that did not affect them.

**Table 3 Biochar concentration and its effect on some plant parameters after 112days of planting in sandy soil**

| Biochar concentrations (%) | Plant height | Number of leaves | Number of flowers | Number of pods | Number of branches |
|---|---|---|---|---|---|
| 0 | 47.80[c] | 18.06[b] | 34.00[b] | 6.56[a] | 3.03[a] |
| 0.5 | 48.56[bc] | 18.45[b] | 60.25[a] | 6.56[a] | 3.50[a] |
| 1 | 53.16[ab] | 19.53[ab] | 53.25[a] | 7.94[a] | 3.06[a] |
| 2 | 54.82[a] | 20.48[a] | 60.25[a] | 7.06[a] | 3.34[a] |

Values are means of four replicates Values of the same column followed by the same letter (s) are not significantly different at $P \leq 0.05$ of LSD. The experiment was analyzed in two-way ANOVA.

Biochar application (0.5, 1, and 2 %) to sand soil treated with cadmium did not exhibit significant effect on plant root, shoot, pod fresh weight except for 2% biochar (41.88, 48.13 and 8.75 gm, respectively) even in the presence of 0.1 mg/l Cd. Similar results were obtained in case of root length and root dry weight (38.63 cm and 12.95 gm, respectively). similarly, Biochar 2% was the highest (8.00 gm) significant effect on shoot dry weight Table 4.

- Data in table 4 illustrate that biochar effect on all parameters significantly except root length, dry shoot weight and dry root weight, especially concentrations 1 and 2% of biochar significantly increase all plant parameters.

**Table 4 Biochar concentration and its effect on some plant parameters after112 days of planting in sandy soil**

| Biochar concentrations (%) | Fresh Root Weight | Fresh shoot Weight | Pod weight | Root length | Dry shoot Weight | Dry root Weight |
|---|---|---|---|---|---|---|
| 0 | 32.03[a] | 31.88[b] | 4.78[a] | 33.00[a] | 8.90[a] | 6.46[a] |
| 0.5 | 27.81[a] | 39.22[ab] | 2.56[a] | 35.03[a] | 9.21[a] | 5.68[a] |
| 1 | 35.91[a] | 42.66[a] | 4.53[a] | 32.19[a] | 10.41[a] | 6.41[a] |
| 2 | 31.88[a] | 44.53[a] | 6.19[a] | 31.97[a] | 10.39[a] | 5.80[a] |

Values are means of four replicates. Values of the same column followed by the same letter (s) are not significantly different at $P \leq 0.05$ of LSD. The experiment was analyzed in two-way ANOVA.

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- Data in Table 5 illustrate that biochar and cadmium effect on chlorophyll content in plant significantly, especially concentrations 1 and 2% of biochar and concentration 0.1 mg\l and 1 mg\l of cadmium significantly increase plant content of Chlorophyll.
- Biochar concentration (0.5, 1 and 2%) did not exhibit significant effect on faba bean plants chlorophyll content compared to 0% (control). on the parallel, Cd treatment (0.01 mg/l) has significantly decreased plants chlorophyll content (33.61 mg/g FW) compared to the other concentrations.

| Cadmium concentrations (mg\l) | Chlorophyll content (mg\g) |
|---|---|
| 0.00 | 39.26[a] |
| 0.01 | 33.61[b] |
| 0.10 | 38.39[a] |
| 1.00 | 38.46[a] |

**Table 5Cadmium concentration and its effect on plant content of chlorophyll after 80 -90 days of planting in sand soil**

Values are means of four replicates. Values of the same column followed by the same letter (s) are not significantly different at $P \leq 0.05$ of LSD. The experiment was analyzed in two-way ANOVA.

- Frist of all Cd treatments (0, 0.01, 0.1 and 1 mg/kg) in absence of Biochar did not significantly affect root and shoot Zn content except the treatment 0.10 mg/kg (556.39 mg\kg). Additionally, Biochar application (0.5, 1 and 2%) did not exhibit significant effect on faba bean root ant shoot cultivated in Cd treated clay soil Zn content except the treatments (1% biochar&0.01 mg/kg Cd and 1% biochar& 0.10 mg/kg Cd) 333.1 and 117.45, respectively of root tissues and the treatment (1% biochar &0.10 mg/kg Cd). On the parallel, Cd treatments in the absence of Biochar

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significantly increased both root and shoot tissues Cd content, the highest were 43.40 and 15.96mg\kg of root and shoot, respectively. Biochar application 0.5, 1 and 2% failed to significantly decrease root Cd content (17.19, 36.51 and 4.36 mg\kg) in case of 0.5 % biochar with (0.01, 0.1and 1 mg/kg Cd), respectively; (11.56 and 16.23mg\kg) in case of 1% Biochar with (0.1and 1 mg/kg Cd), respectively and (4.30 and 6.20mg\kg) in case of 2% Biochar and (0.1and 1 mg/kg Cd), respectively in root tissues (Table6). Similar results were recorded with shoot Cd content except the treatment (2% biochar & 0.1mg/kg Cd)

| Biochar (%) | Cadmium (mg/l) | Root | | Shoot | |
|---|---|---|---|---|---|
| | | Zn(mg\kg) | Cd(mg\kg) | Zn(mg\kg) | Cd(mg\kg) |
| 0 | 0.00 | 76.170 [a] | 0.08 [h] | 177.67 [f] | 0.03 [g] |
| | 0.01 | 55.74 [a] | 6.08 [f] | 279.56 [e] | 2.40 [f] |
| | 0.10 | 54.30 [a] | 19.38 [c] | 556.39 [b] | 10.35 [c] |
| | 1.00 | 61.10 [a] | 43.40 [a] | 266.12 [e] | 15.96 [a] |
| 0.5 | 0.00 | 54.24 [a] | 0.08 [h] | 185.74 [f] | 0.02 [g] |
| | 0.01 | 84.07 [a] | 4.36 [f] | 335.37 [d] | 1.99 [fg] |
| | 0.10 | 74.65 [a] | 17.19 [cd] | 435.44 [d] | 8.22 [d] |
| | 1.00 | 51.00 [a] | 36.51 [b] | 500.16 [c] | 13.06 [b] |
| 1 | 0.00 | 73.67 [a] | 0.04 [h] | 138.80 [g] | 0.01 [g] |
| | 0.01 | 333.1 [a] | 3.33 [gh] | 118.35 [g] | 0.49 [g] |
| | 00.1 | 117.45 [a] | 11.56 [e] | 687.02 [a] | 4.65 [e] |
| | 1.00 | 77.72 [a] | 16.23 [d] | 177.67 [f] | 5.75 [e] |
| 2 | 0.00 | 90.49 [a] | 0.02 [h] | 279.56 [e] | 0.01 [g] |
| | 0.01 | 69.52 [a] | 0.34 [gh] | 556.39 [b] | 0.21 [g] |
| | 0.10 | 55.32 [a] | 4.30 [f] | 266.12 [e] | 2.038 [fg] |
| | 1.00 | 61.99 [a] | 6.20 [f] | 185.74 [f] | 4.29 [e] |

**Table 6: Effect of Biochar application on faba bean root and shoot content of Cd and Zn cultivated in Cd treated sandy soil after 112 days of planting**

Values are means of four replicates. Values of the same column followed by the same letter (s) are not significantly different at P≤ 0.05 of LSD. The experiment was analyzed in two-way ANOVA.

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- Table 7 shows that treatment of 2% & 1 mg\l gives the highest record 2.73 mg\kg compared to control while treatment of 1% + 0 mg\l and 2% + 0 mg\l shows the best results compared to control. Biochar application did not signifcantly affect sand soil Zn available content, soil Cd availble content significantly increased by Cd treatments (0.01, 0.1 and 1mg/kg) and biochar application did not affect Cd content except with 0.01 mg/kg with (0.5, 1, and 2% Biochar).

| Biochar (%) | Cadmium (mg/l) | Sandy soil | |
|---|---|---|---|
| | | Zn(mg\kg) | Cd(mg\kg) |
| 0 | 0.00 | 2.38 [a] | 0.014 [g] |
| | 0.01 | 2.081 [a] | 1.75 [f] |
| | 0.10 | 2.17 [a] | 7.62 [d] |
| | 1.00 | 1.72 [a] | 45.70 [a] |
| 0.5 | 0.00 | 2.06 [a] | 0.013 [g] |
| | 0.01 | 2.12 [a] | 0.74 [g] |
| | 0.10 | 1.50 [a] | 7.26 [d] |
| | 1.00 | 1.24 [a] | 33.57 [b] |
| 1 | 0.00 | 1.33 [a] | 0.02 [g] |
| | 0.01 | 1.29 [a] | 0.80 [g] |
| | 00.1 | 1.04 [a] | 3.87 [e] |
| | 1.00 | 1.53 [a] | 26.66 [c] |
| 2 | 0.00 | 2.27 [a] | 0.02 [g] |
| | 0.01 | 1.83 [a] | 0.61 [g] |
| | 0.10 | 2.18 [a] | 2.65 [f] |
| | 1.00 | 2.73 [a] | 3.14 [ef] |

**Table 7: Available cadmium and zinc contents of sandy soil treated with biochar and cadmium**

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Values are means of four replicates. Values of the same column followed by the same letter (s) are not significantly different at P≤ 0.05 of LSD. The experiment was analyzed in two-way ANOVA.
Data in table 8 shows that the estimation of the basic fertilizer elements after planting was found that the sandy soil, there were no significant differences between the treatments.

**Table 8: Determination of Ca, Mg, K and N in Shoot**

| Treatments | Sandy soil | | | |
|---|---|---|---|---|
| | N | Ca | K | Mg |
| 0.01 mg\l Cd | 2.82[a] | 4824.3[a] | 373.63[a] | 134.4[a] |
| 0.01 Cd+ 1% BC | 2.96[a] | 5732.1[a] | 377.46[a] | 133.77[a] |

Values are means of four replicates. Values of the same column followed by the same letter (s) are not significantly different at P ≤ 0.05 of LSD. The experiment was analyzed in two-way ANOVA.

**Determination of BCF, TF and BAF in sand and clay soil.**

Data in table 9 shows that BCF (Bioconcentration factors), TF(translocation factors) and BAF(Bioaccumulation factors) were calculated to detect Cd translocation in Faba Bean plants. Data in table 4-45 shows that the biochar soil amended with concentration of 2% was the most effective rate on Cd accumalation. The BCF was 7.049 at treatment of 0.1 mg\l Cd as compared to 0.008 at 0 mg\l cd in the soil amended with 2% biochar. the biochar soil amended with concentration of 2% was the most effective rate on Cd accumalation. The TF was 0.691 at treatment of 1 mg\l Cd as compared to 0.147 at 0.01 mg\l cd in the soil amended with 1% biochar. the biochar soil amended with concentration of 2% was the most effective rate on Cd accumalation. The BAF was 10.39 at treatment of 0.1 mg\l Cd as compared to0.011 at 0 mg\l cd in the soil amended with 2% biochar.

**Table 9: Bioaccumulation and bioconcentration factors (BFs), from soil to roots, and translocation factors (TFs), from roots to shoots, of heavy metals in faba bean grown in soil amended with different boichar concentration in sand soil**

| Biochar (%) | Cadmium (mg/l) | Sandy soil | | |
|---|---|---|---|---|
| | | BCF | TF | BAF |
| 0 | 0.00 | 5.714 | 0.375 | 7.857 |
| | 0.01 | 3.474 | 0.394 | 4.845 |
| | 0.10 | 2.543 | 0.534 | 3.901 |
| | 1.00 | 0.949 | 0.367 | 1.298 |
| 0.5 | 0.00 | 6.154 | 0.25 | 7.692 |
| | 0.01 | 5.892 | 0.456 | 8.581 |
| | 0.10 | 2.368 | 0.478 | 3.5 |
| | 1.00 | 1.0876 | 0.357 | 1.476 |
| 1 | 0.00 | 2 | 0.5 | 3 |
| | 0.01 | 4.163 | 0.147 | 4.775 |
| | 00.1 | 2.987 | 0.402 | 4.188 |
| | 1.00 | 0.608 | 0.354 | 0.824 |
| 2 | 0.00 | 0.008 | 0.5 | 0.011 |
| | 0.01 | 17 | 0.617 | 27.5 |
| | 0.10 | 7.049 | 0.474 | 10.390 |
| | 1.00 | 1.974 | 0.691 | 3.341 |

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