Assiut Univ. J. of Botany and Microbiology ***Printed*** **ISSN:** *1687-4927*
48(2), pp.89-113(2019)

VARIATIONS IN RESPONSE OF TWO PLANTS AND TWO MICROALGAL SPECIES TO THE DIFFERENT CONCENTRATIONS OF CEMENT KILN DUST

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Received: 13/10/2019 **Accepted:** 14/11/2019 **Available Online:**1/12/2019

Cement kiln dust (CKD) can use as fertilizer in agriculture and as media for algal growth. In this study, different concentrations of CKD (0.005, 0.01, 0.05, 0.1 and 0.5 gm.100 ml^{-1}) used for plants crop growth, and (0.0001, 0.0005, 0.001, 0.005 and 0.01 gm.100 ml^{-1}) concentrations of CKD for algal growth. The study shown that, the germination and growth of both faba beans (*Vicia faba*) and barley (*Hordeum vulgare*) improved by low concentrations (0.005 and 0.01 gm.100 ml^{-1}) of CKD. Also, the concentration (0.001 gm.100 ml^{-1}) of cement kiln dust can be used instead of the algal growth media (BG11) for *Oscillatoria* sp. and *Chlorella* sp. cultures.
Keywords: - "Cement Kiln Dust; CKD; *Chlorella* sp.; *Oscillatoria* sp. and total chlorophyll".

INTRODUCTION

Cement manufacturing is one of the large, important and dangerous industries in the world (Elbaz et al., 2019). As with the largest manufacturing industries, large waste materials are generated. This waste material is called cement kiln dust (CKD). Cement kiln dust pollution is one of ecological dangerous problem causing imbalance of the environment (Shah, Ilahi & Rashid, 1989 and Tomar *et al.*, 2018). General, CKD is mixture of particulate mineralogical and chemically compounds. The properties of the CKD are dependent on the raw materials used, fuels, kiln pyro-processing type, overall equipment layout, also on the type of the cement being manufactured (Klemm, 1993, Taubert 2008). Typical chemical composition of CKD (% weight by weight) as following: - $CaCO_3$ 55.53, Fe_2O 2.13, SiO13.6, KCl 1.4, CaO 8.1, MgO 1.3, K_2SO 5.94, N a_2SO 1.34,

$CaSO_4$ 5.24, KF 0.4, Al_2O_4 4.53 and others 0.7 (Haynes and Kramer, 1982).

The CKD consists of $CaCO_3$ and SiO_2 in similar to the cement kiln raw feed, but the amount of sulfate, chloride and alkalis is usually higher in the cement kiln dust (Taubert 2008). There are many studies on the using of the CKD again into the clinker making cycle. However, it is not happened because of the restrictions on the content of alkali in the cement. Also the common reasons are the limitations on handling the dust and the chemical structure in the dust that would be measuring in the final product of cement and that may be making the product not compatible with the standards quality consensus (Taubert 2008). Over the past several years, more studies achieved in the structure and the beneficial uses of cement kiln dust, thus its disposal from accumulation on land (Bhatty, 2004, Maslehuddin *et al.,* 2008). The CKD one of the causes for the imbalances of the environment and it contributed to reduction of the production (Stern, 1976).

There are many commercial applications of CKD; these applications depend on structure also on physical and the chemical characteristics of the CKD. Some of these applications are agriculture, animal feed, and the soil stabilization. Also used in sewage and water treatment (Maslehuddin *et al.,* 2008).

Limited studies occurred on the effect of pollution with cement dust on the growth and physiology of plants (Iqbal & Shafüg 2001). Cement dust pollution reduced the number of flowers (Prasad & Inamdar 1990). Gupta & Mishra 1994 studied the toxic effect of cement kiln dust on some plants and on the stomatal closing of *Iphonia grantioides* Boiss. The growth of poplar trees was reduced by cement production (Lerman & Darley, 1975). Stratmann & van Haut (1966) observed that quantities of dust ranging from (1 to 48 g/m^2) per day that falling on the soil caused a shift in the pH to the alkaline side, which was good for growth of pasture grass but bad for growth of oats. In the parts which have highly cement dust, a cement plants caused reduction in leaves as one of the impacts of cement dust (Darley *et al.,* 1966). Also, there are many changes in the structure and the composition of the seedling, shrub, sapling and tree strata was observed when they are comparing the two forest communities (dusted and non-dusted one) in the vicinity (Brandt & Rhoades 1972).

There are many toxic compounds such as magnesium, lead, fluoride, zinc, copper, beryllium, sulfuric acid and hydrochloric acid were produced by cement plants (Andrzej, 1987). Some investigators reported that no harmful effects of CKD at the levels from 1.5 to 7.5 g/m^2/days, while others investigators reported that shifted of the concentrations from 1.0 to 48 g/m^2/days caused shifts in the soil alkalinity which may be favorable to one crop but may be harmful to another (Lerman & Darley, 1975). According to Iqbal & Shafüg 2001, there are variation in the response of the plants, species and varieties to the application of cement kiln dust. It's not necessary for plants to showing similar response to the different pollutants. For that, it was recommended that *Azadirachta regia* should be cultivated around the cement plants due to its ability to grow and resistance to the cement dust toxicity (Iqbal & Shafüg 2001).

Algae are one of the important organisms in biofuel production. There are many forms of biofuel which can produce by algae such as hydrogen and biodiesel. The production of biofuel from algae required growing algae on large scale. Algae needs only water, light, carbon dioxide and mineral elements for their growth and enrichment. In addition, algae has the ability of reduce oxides of carbon, nitrogen and sulphur (CO_X, N_X and S_X; respectively), thus cleaning these waters and turn them more hygienic according to (Karemore *et al.,* 2013). Furthermore, fresh clean water is not necessarily prerequisite, but low quality water, such as sewage or wastewater is rather better as these waters contain a lot of nutrients. Cement dust containing all requirements for algal growth and enrichment. That mean algae can grow and enrichment on the nutrient in the cement kiln dust. Many studies have shown that microalgae can tolerate to some degree to NOx and SOx, and even use these components as nutrients (Lee *et al.,* 2000, Yang *et al.,* 2004a, Yang *et al.,* 2004b, Jin *et al.,* 2008, Douskova *et al.,* 2009, Chiu *et al.,* 2011 and Lara-Gil *et al.,* 2013). However ‹these cannot be generalized to all the algal species, and there are several strategies to increasing the tolerance developed for example, increasing initial cell concentration (Olaizol 2003, Jin *et al.,* 2003, Radmann *et al.,* 2008 and Lara-Gil *et al.,* 2013).

In *Desmodesmus abundans*, the addition of cement kiln dust (CKD) to the culture medium was highly significant increase in the carbon assimilation, and also can optimize the sulfur content in culture media (Lara-Gil *et al.,* 2013). Cement kiln dust provided other beneficial growth components. Both of the NO_x and So_x components might be harmful to microalgae (Lara-Gil *et al.,* 2013). Recently studies found that nitrite and sulfite did not inhibit the growth at the tested concentrations (0–1,067 ppm (w /v) NO^{-2} and 0.254 ppm (w/v) SO_3^{-2} however, bisulfite was toxic above 39 ppm. Within a narrower range of both the NOx and Sox can use as a nutrient source. In an aqueous system, the dissolves of nitrogen oxide (NOx) it can oxidize into nitrite (NO^{-2}) that depending on the pH according to (Ohkawa et al., .2001). Ohkawa *et al.,* 2001 also reported the sulfite (SO_3^{-2}) or bisulfite (HSO^{-3}) can be produced from dissolved sulfur dioxide (SO_2). There are many studies reported that, sulfur dioxide (SO_2) once enters the aqueous system; it easily oxidizes into sulfate (Negoro *et al.,* 1991, and Yang *et al.,* 2004b and Lara-Gil *et al.,* 2013). That means it can be easily used for growth of algae and used as nutrient (Lara-Gil *et al.,* 2013). Overall, the production of high biomass and growth rates of the algae were greater in low concentrations of cement kiln dust (Lara-Gil *et al.,* 2013).

This study has been carried out to overcome the problem of the accumulations of cement kiln dust in the cement manufacturers. And find out an efficient economical means of using cement kiln dust. So, the study try to use cement kiln dust for enhance the germination and growth of the two crop plants as fertilizer. Also, illustration if can use CKD instead of the artificial media (BG11) for growth the microalgae.

MATERIALS AND METHODS

In the first of this study, must know the structure of cement kiln dust. We got it from one of cement manufactures plant in Upper Egypt.

- **Analysis of cement kiln dust**

The structure of cement kiln dust was quantitative analysis using XRF- quantmeter (ARL 9900 series intellipower X-ray Analyzer-free lime channel inside) as (% weight by weight).

- **Determination of effect of the different concentrations of CKD on algal growth**

Two algal species (*Chlorella* sp. and *Oscillatoria* sp.) used in this study. They isolated from Assiut region (Egypt). The two microalgae species were grown on BG11 media for enrichment. Then 50 ml of algae centrifuged and then washed with sterile distilled water to remove all traces media. The series of cement kiln dust concentrations were used for algal growth (0.0001, 0.0005, 0.001, 0.005 and 0.01 gm.100 ml^{-1}). Fivty ml of sterile CKD in each conical (250 ml) was used for grown of the two microalgae in compared with the control one (BG11). Cultures incubated at the atmosphere condition at temperature 28±2 ºC, at 100 µmol photons $m^{-2}s^{-1}$ of continuous PAR light, and 100 rpm agitation using a MiniOrbital Shaker (VWR, USA) for two weeks. Then determine the growth parameters.

- ***Optical density determination***

The optical density (OD750 nm) of algal growth has been determined according to Zhao *et al.*, (2005).

- ***Dry weight determination (mg/ml)***

For determination of dry weight (20 ml) algal suspension filtered through a glass fiber filter. Then the filter paper with algal cells dried overnight in an oven at 80 °C. After cool they were weighed and then the dry mass calculated.

- ***Photosynthetic pigments determination (µg/ml)***

Photosynthetic pigments were extracted in hot methanol for 10 minutes, then the pigments (total chlorophyll **effect** and carotenoid) determined according to Marker (1972).

- **Determination the effect of the different concentrations of CKD on two crop plants**

Two crop plants used in the study (faba beans and barley). Seeds of the two crop plants sterile and germinated in sterile petri dishes, and constant number of seeds used in each petrdish. The concentrations used in the study are (0.005, 0.01, 0.05, 0.1 and 0.5 gm.100 ml^{-1}) for plant germination. After autoclaved CKD concentrations take 20 ml of CKD concentrations in each petri dish, and compared with the control which germinated in sterile distallwater. Each petrdish contains 10 seeds, and they were irrigated daily with sterile distilled water and three replicates were used for each treatment. The age of experiment is about three weeks.

- ***Percentage of seed germinations determinations* (**Number of germinated seeds to the number of total seeds in petri dish calculated as percentage of seed germination **(%)**).
- ***Shoot and Root length*** (The length of shoot and root determined by **cm)**.
- ***Shoot/Root ratio* (**The length of shoot to the length of root calculated as ratio).
- ***Vigor index***
  The vigor index of seedlings was calculated with the following equation
  Vigor index = (shoot length + root length) × germination percentage/100.according to (Dahindwal *et al.,* 1991).
- ***Photosynthetic pigments:***
  The fractions of pigments (total chlorophyll and carotenoids) were estimated using the method recommended by Lichtenthaler (1987). Chlorophylls and carotenoid concentrations were calculated as mg/g FW.
- ***Fresh weight:***
  Fresh plants were separated into shoots and roots, then the fresh weight of root and shoot determined.
- ***Dry weight:***
  The roots and shoots have been placed in oven at 80^{o}C for 72 h for determining the dry weight (DW).
- ***Water content:***
  Water content in root and shoot were calculated as the follow equation: - Water content= fresh weight –dry weight.

RESULTS

Cement kiln dust (CKD) is one of the most dangerous problem which found in the manufacture of cement in the world. For that in this research, study to find biological uses for cement kiln dust to dissolve the problem of the accumulation in the cement plants. The objective of the study was evaluating the effect of five different concentrations of CKD on the germination of two different crop plants and on the growth of two different algal species.

In this research, two microalgal species one chlorophyta (*Chlorella* sp.) and anther cyanophyta (*Oscillatoria* sp.) used to study the outcome of different concentrations of cement dust on the growth of algae instead of artificial media (BG11) to products of biofuel which can recycle again in the manufacture of cement. Also used low concentrations of CKD for germination of two different crop plants one of them dicot (faba beans) and another is moncot (barley) that for reduction the cost of agriculture by using CKD instead of commercial filterizor. The outcome of this study as the following.

The quantitative assessment of the structure of cement kiln dust must occur to check the category of influence of cement dust on the crop plant growth and algal growth. Cement kiln dust is rich in many oxides elements as shown in the table as (% weight by weight). According to the analysis, the cement kiln dust contains high amount of K, Ca and S which can use as a nutrient for plant and algae growth.

Table:- The structure of cement kiln dust sample under investigation (% weight /weight).

Compounds	**SiO_2**	**Al_2O_3**	**Fe_2O_3**	**CaO**	**MgO**	**SO_3**	**Na_2O**	**K_2O**	**Cl**
Average	12.33	2.91	2.55	49.67	0.61	9.80	2.79	4.03	4.17

Effect of CKD on microlagal growth:-

Chlorophyta species *Chlorella* sp. propagated by treatment with lower concentrations of cement dust. The optiacl density at (0.0005 and 0.001 $gm.100ml^{-1}$) concentrations of cement dust not change in matched with the control (BG11 media) as showing (Fig. 1). However the higher concentrations (0.05 and 0.1 $gm100.ml^{-1}$) of CKD induced aggressive effect on the optical density of *Chlorella* sp. The lowest concentration (0.0001 $gm100.ml^{-1}$) of cement dust induced the similar content of chlorophyll in compared with the control media of *Chlorella* sp. while, the higher (0.005 and 0.01 gm100.ml^{-1}) concentrations dropped the chlorophyll content up to 10% in related to the control (Fig. 1). Nearly, very slightly declined in carotenoid content at all concentrations of cement dust comparing with control media (Fig. 1). *Oscillatoria* sp. slightly different in the response to growing on cement kiln dust comparing with *Chlorella* sp.

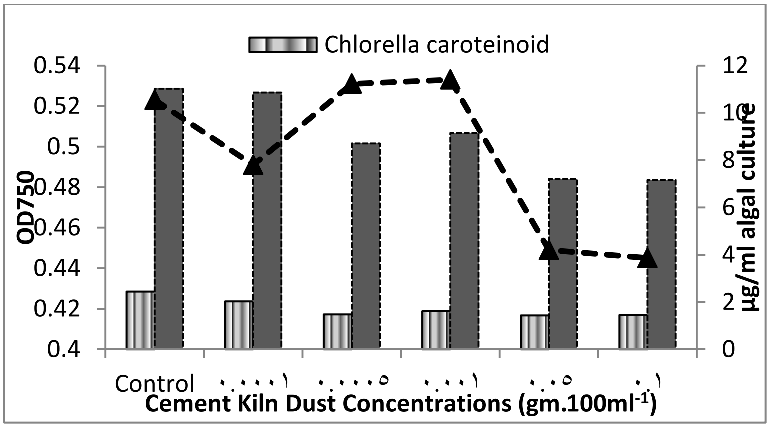

Figure (1):- Optical density, total chlorophyll and carotenoid of *Chlorella* sp. under different concentrations of cement kiln dust (control, 0.0001, 0.0005, 0.001, 0.05 and 0.1 gm.100 ml^{-1}).

Almost the concentrations of cement dust given the matching optical density comparing with control media (BG11) and slightly improved at the concentration (0.001 gm.100 ml^{-1}) of *Oscillatoria* sp. as in (Fig. 2). But the highest concentration (0.01 gm.100 ml^{-1}) of cement dust had a aggressive outcome on optical density of *Oscillatoria* sp. in comparison with the control and ather concentrations of CKD. Highly enlargement in chlorophyll content is noted at lower concentration (0.0001gm.100 ml^{-1}) more than fivefold comparing with the control (Fig. 2). Also the concentrations (0.0005 and 0.001 gm.100ml^{-1}) induced highly improvement of chlorophyll content to about twofold more than control in *Oscillatoria* sp (Fig. 2). While the higher concentrations induced drop about 50% of chlorophyll content than that in the control in *Oscillatoria* sp. Carotenoid content was slightly improved at all concentrations of cement dust excluding at higher concentration (0.1 gm.100ml^{-1}) compared to control in *Oscillatoria* sp. (Fig. 2).

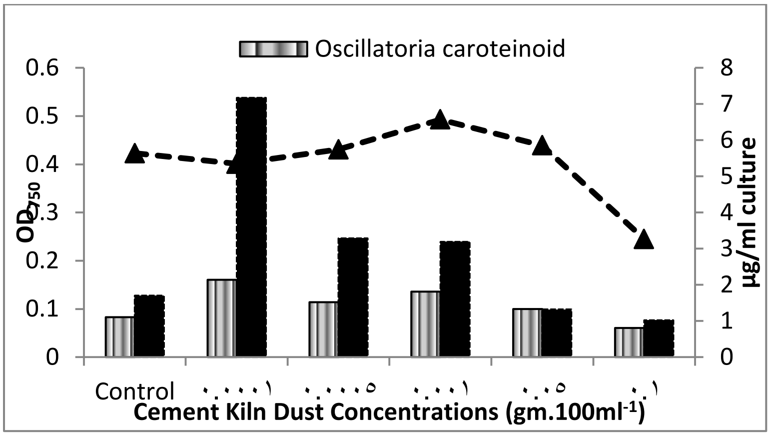

Figure (2):- Optical density, total chlorophyll and carotenoid of *Oscillatoria* sp. under different concentrations of cement kiln dust (control, 0.0001, 0.0005, 0.001, 0.05 and 0.1 gm.100 ml^{-1}).

In this study, dry weight of *Chlorella* sp. improved as increasing of cement dust concentration up to 0.001 to about 20% more than the dry weight of the control (Fig. 3). The higher concentrations of cement kiln dust (0.05 and 0.1 gm.100 ml^{-1}) declined dry weight to about 30% less than the control (Fig. 3).

In *Oscillatoria* sp., the lowest concentration of cement dust (0.0001 gm.100 ml^{-1}) has the similar dry weight as in the control (BG11) media. The other higher concentrations of CKD induced very slightly decrease in the dry weight of *Oscillatoria* sp. related to the control one (Fig. 3).

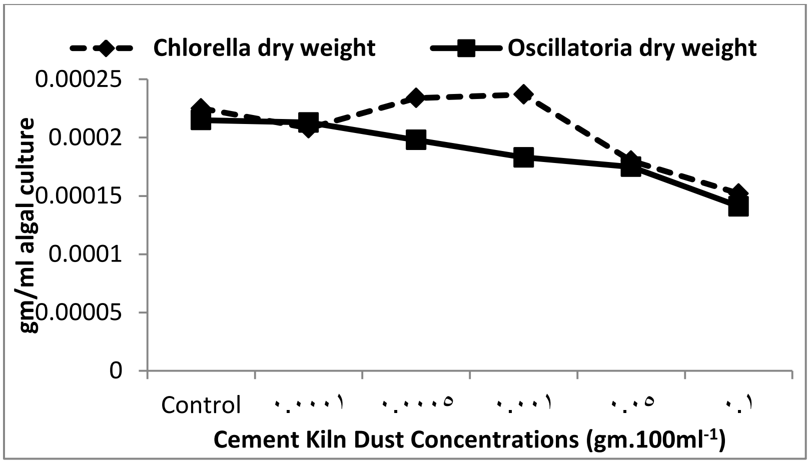

Figure (3):- Dry weight (gm/ml algal culture) of *Chlorella* sp. and *Oscillatoria* sp. under different concentrations of cement kiln dust (Control, 0.0001, 0.0005, 0.001, 0.05 and 0.1gm.100 ml^{-1}).

Effect of CKD on crop plants:-

In faba beans, the time required for seeds germination in CKD retarded to about one or two days in compared to the control. The percentage of the seed germination was slightly affected by cement dust to be 90% in comparison to control (100%). Shoot length improved at all cement dust concentrations to about fourfold at the high concentrations (0.05, 0.01 and 0.5 gm.100 ml^{-1}) in comparing with the control as shown in (photo 1). The same response of the root length was induced by the different concentrations of CKD as in the shoot length. Shoot/root ratio slightly affected by different concentrations of CKD (0.001, 0.05, 0.01 and 0.5 gm.100 ml^{-1}) in comparison to the control (Fig. 4).

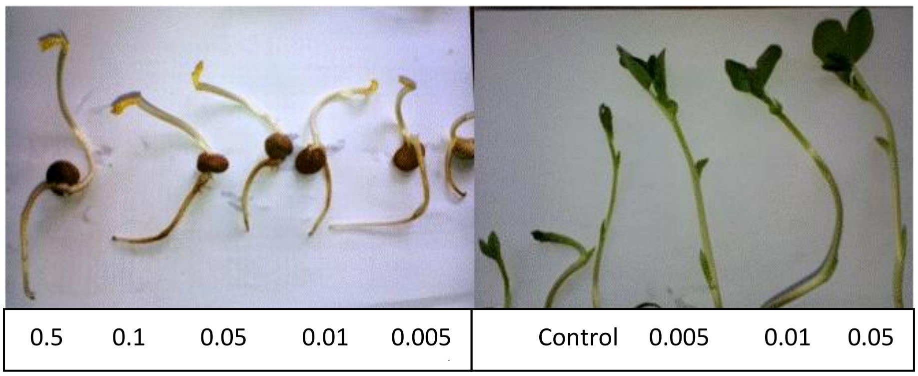

Photo (1):- Faba beans under different concentrations of cement kiln dust (Control, 0.005, 0.01, 0.05, 0.1 and 0.5 gm.100 ml^{-1}) at two different age stages.

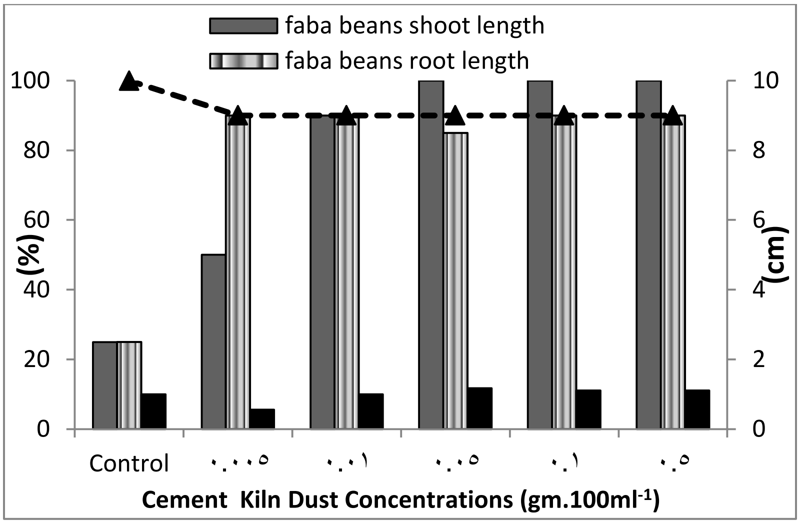

Figure (4):- Percentage of seed germination, shoot length, root length and shoot to root ratio of faba beans under different concentrations of cement kiln dust (Control, 0.005, 0.01, 0.05, 0.1 and 0.5 gm.100 ml^{-1}).

The lower concentrations of CKD of barley did not induce any effect on the seed germination percentage up to (0.05 gm.100 ml^{-1}) concentration in compared to the control (water) which induced 100% seed germination. The percentage of seed germination was decreased to about 50% by the higher concentrations (0.1 and 0.5 gm.100 ml^{-1}) of CKD in comparison with the control (Fig. 5).

The barley shoot length was amplified by increasing cement dust concentrations up to (0.1 gm.100 ml^{-1}) concentration. Highly shoot length was noticed at the (0.01 gm.100 ml^{-1}) concentration of cement kiln dust. High increasing of cement dust induced an aggressive effect on barley shoot length to about less than half lowered than control (Fig.5) and as shown (photo 2).

The root length of barley was slightly affected by the addition of cement dust up to (0.1 gm.100 ml^{-1}) concentration. The most declines in root length were noted at the highest concentration (0.5 gm.100 ml^{-}

1) in comparison with the control. Their no variation in the root/shoot ratio at all the concentrations of CKD except at the highest concentration (0.5 gm.100 ml^{-1}), the shoot/root ratio declined (Fig. 5).

Photo (2):- Barley under different concentrations of cement kiln dust (Control, 0.005, 0.01, 0.05, 0.1 and 0.5 gm.100 ml^{-1}) at two different age stages.

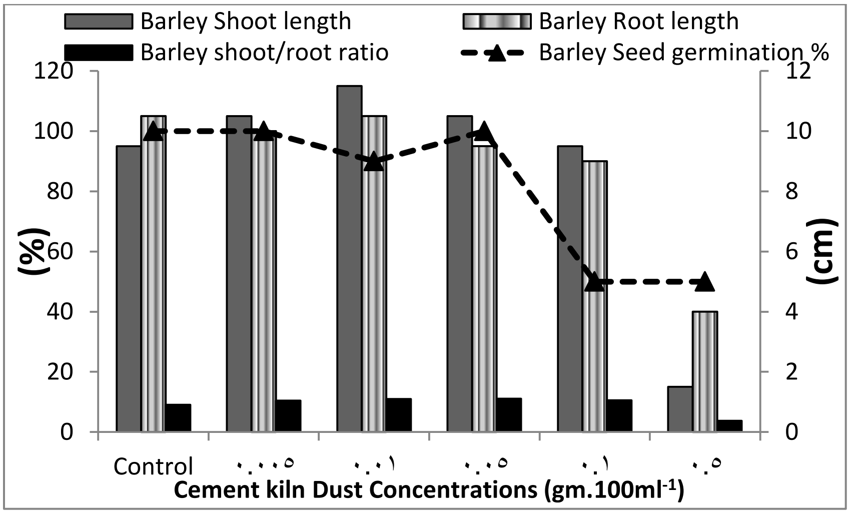

Figure (5):- Percentage of seed germination, shoot length, root length and shoot to root ratio of barley under different concentrations of cement kiln dust (Control, 0.005, 0.01, 0.05, 0.1 and 0.5 gm.100 ml^{-1}).

The vigor index value in faba beans increased by increasing of the CKD concentrations up to (0.05) concentration, then kept constant value at the other concentrations as showing (Fig. 6). In barley the vigor index kept constant value only at the lower concentrations

(0.005, 0.01 and 0.05 gm100.ml^{-1}) while the vigor index value decreased at the highest concentration of CKD (0.5 gm100.ml^{-1}) a lower than in control as showing figure 6.

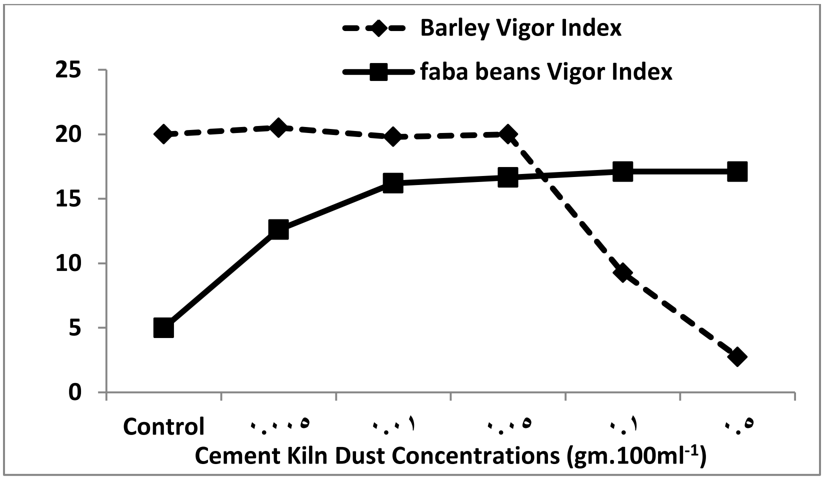

Figure (6):-Vigor index of barley and faba beans under different concentrations of cement kiln dust (Control, 0.005, 0.01, 0.05, 0.1 and 0.5 gm.100 ml^{-1}).

The lower concentrations of cement kiln dust (0.005 and 0.01 gm100.ml^{-1}) didn't have any effects on the total chlorophyll content of barley plant and the total chlorophyll content slightly decreased by the highest concentrations treatments as shown in figure7. Carotenoids content enhanced by treatments (0.01 and 0.05 gm100.ml^{-1}) of cement kiln dust in comparing with control and the carotenoid content in other concentrations and control have equal values as figure 7.

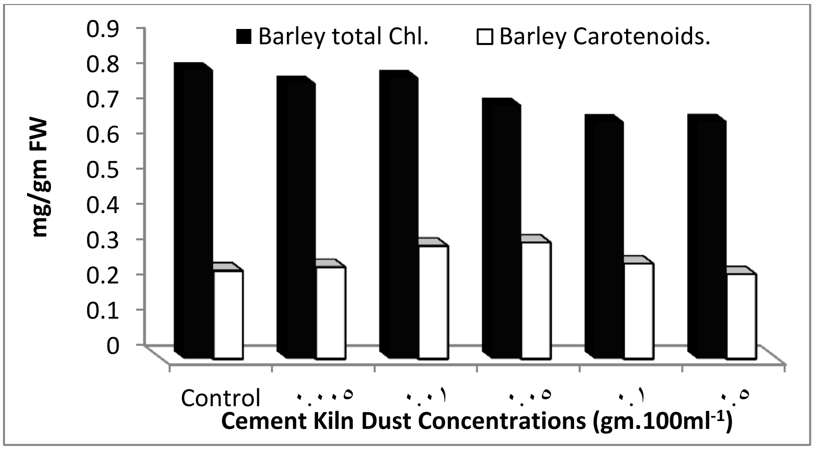

Figure (7):-Total chlorophylls and carotenoid of barley under different concentrations of cement kiln dust (Control, 0.005, 0.01, 0.05, 0.1 and 0.5 gm.100 m^{-1}).

Total chlorophyll increased at all concentrations of CKD in comparing with the control. Carotenoids content slightly improved by the treatment plant with CKD in compared with control (Fig. 8).

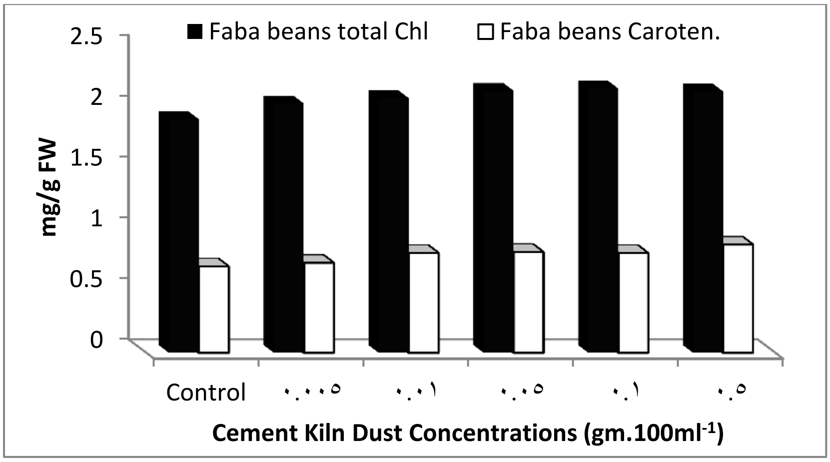

Figure (8):- Total chlorophylls and carotenoids of faba beans under different concentrations of cement kiln dust (Control, 0.005, 0.01, 0.05, 0.1 and 0.5 gm.100 ml^{-1}).

Fresh and dry weight of shoot and root at the lowest concentrations (0.005 and 0.01 $gm100.ml^{-1}$) of CKD induced the same level in comparing with control. Slightly increased of fresh and dry weight of shoot and root at higher concentrations of CKD in barley (Fig. 9).

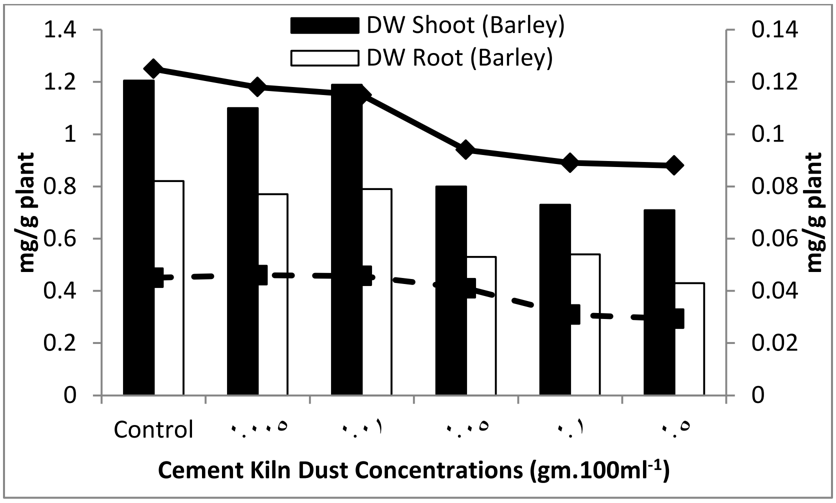

Figure (9):- Fresh and dry weight of shoot and root of barley under different concentrations of cement kiln dust (Control, 0.005, 0.01, 0.05, 0.1 and 0.5 gm.100 ml^{-1}).

In figure 10, the highest concentrations of CKD (0.05, 0.1 and 0.5 gm100.ml^{-1}) improved the fresh and dry weight of shoot and root of faba beans in comparing with control. The lowest concentrations of CKD (0.005 and 0.01 gm100.ml^{-1}) didn't induce any change in the fresh and the dry content in comparison with control (Fig. 10).

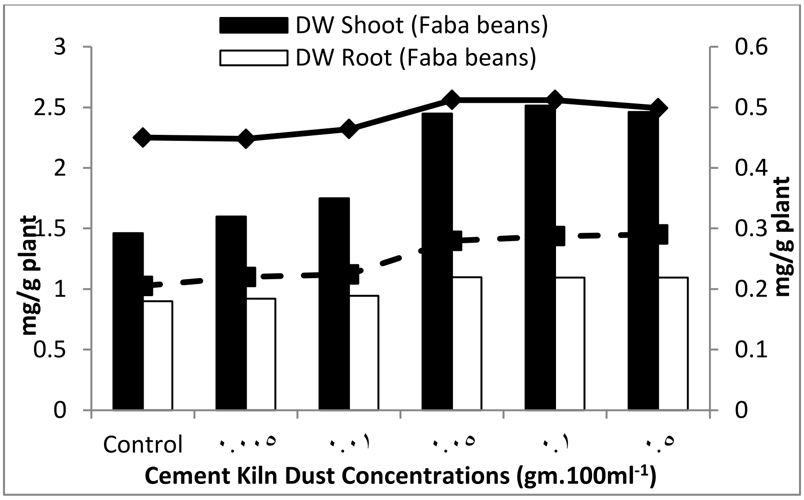

Figure (10):- Fresh and dry weight of shoot and root of faba beans under different concentrations of cement kiln dust (Control, 0.005, 0.01, 0.05, 0.1 and 0.5 gm.100 ml^{-1}).

The water content of the shoot and root kept constant at lower concentrations of CKD and at the two studied plants (Fig. 11). While, the water content was improved by the higher concentrations of CKD in comparison with the control (Fig. 11).

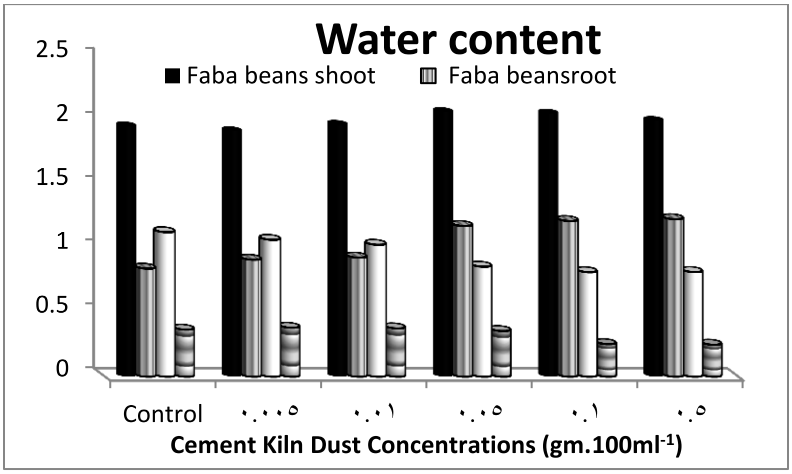

Figure (11):- water content of shoot and root of barley and faba beans under different concentrations of cement kiln dust (Control, 0.005, 0.01, 0.05, 0.1 and 0.5 gm.100 ml^{-1}).

DISSCUSION

Production of large amount cement kiln dust is the most problem of the manufacture of cement. For this study, it has been concerted to be creating a biological uses of CKD for reducing of its accumulation in cement manufacturers. According to the analysis, the Cement kiln dust is rich in K, Ca and S which can recycle as a nutrient for plant and also for the microalgae growth.

Algae is one of the most important organisms for biofuel production over all the world. Beacause of the high cost of the media that used for growing algae. For that CKD was recycled for growing algae to reduce the cost of the production of the biofuel from microalgae. Also the content of heavy metals in CKD was neglected at the very low concentrations (0.0001, 0.0005, 0.001, 0.005 and 0.01 gm.100 ml^{-1}) which used in this study. The result of this study compatable with Lafond and Simard 1999, that noted the low CKD applications will not be increasing the heavy metal contents.

The lowest concentration (0.001) of CKD induced the similar value of total chlorophyll as in control (BG11) in *Chlorella* sp. While in *Oscillatoria* sp. highly improvement of total chlorophyll to about four folds in was induced in comparing with the control (BG11) at the lowest concentrations of CKD (0.0001 $gm100.ml^{-1}$). Lara-Gil *et al.*, (2013) reported that when CKD was mixed with BG11, produced six times more chlorophyll than the control in isolate *Desmodesmus abundans*. That may be attributed to; that the constituents of CKD are CaO, SiO_2, K_2O, SO_3 and Fe_2O_3 which may be stimulated the microalgae growth that agree with (Huntzinger *et al.*, 2009 and Lara-Gil *et al.*, 2013).

In both of the two microalgae, the low concentrations did not effect on the dry weight of algal culture and saved it at the similar level as in control one (BG11). That may be due to, CKD contains of many minerals that can use as a nutrient for microalgae as CaO, MgO, K_2O, Fe_2O_3, and others which can use by algae instead of synthetic media. Also, at the lower concentrations of CKD were slightly or no negative impact of heavy metal. The study results agree with (Lara-Gil *et al.*, 2013, and Elbaz *et al.*, 2019) that reported that when using of 300 ppm CDK, has been induced improvement in growth of *Desmodesmus abundans* that because of all components of CKD are beneficial for the mitigation system (Lara-Gil *et al.*, 2013). But at the highest concentration (0.1$gm100.ml^{-1}$) of CKD has a belligerent effect on the growth parameters (total chlorophyll and dry weight) in both of the two used microalgae species. That may due to the enlargement of concentrations of CKD was companied by increasing of the heavy metal and oxides that be toxic at higher concentrations. Padovani (2003) reported that cement dust contains significant amounts of nitrogen oxides (NOx, SOx ،and particulate dust) . These components documented to effected on the growth of microalgae at different levels (Kurano *et al.*, 1995 Maeda *et al.*, 1995 ؛Yoshihara *et*

al., 1996 ؛ Lee *et al.,* 2000 , Yang *et al.,* 2004 a ،b ؛Jin *et al.,* 2008 and Lara-Gil *et al.,* 2013).
In faba beans and barley, cement kiln dust concentrations retarded the time of germination to about one or two days after the control. That may be due to increasing of the external osmotic potential of the cement dust solution and which retard the rate of diffusion of water and subsequently the time of the germination late than control (water).

All the concentrations of CKD increased the rate of growth (shoot length, root length, vigor index, fresh, dry weight and total chlorophyll) in faba beans. That may be attributed to CKD rich in nutrient which vital for plant growth according to this analysis. In contrast to Prasad & Inamdar (1990), which found that cement dust kiln reduced chlorophyll content, protein, starch and yield in ground nuts *Arachis hypogaea*. No changes observed in the ratio of shoot to root that may be due to the increased in shoot length companied with increasing in root length of faba beans.

That means CKD could use as fertilizer for crop plants as faba beans and may be better than commercial fertilizer. Especially it has been reported that phosphate fertilizers can supply Cd to crop production, and Cd may accumulations in plant (Avril, 1992 and Lafond and Simard 1999). Furthermore, Ca supplied by CKD may have displaced Cd into the soil solution.

The lower concentrations of CKD are encouraging for vegetative growth (shoot length, root length, shoot root ratio, vigor index, fresh and dry weight of shoot and root) of barley up to (0.1gm.100 ml^{-1}). While at high concentrations of CKD (0.5 gm.100 ml^{-1}) was reduced the vegetative growth. That may be due to slightly appearing of the effect of the traces of heavy metal in CKD, that compatible with Tomar *et al.* (2018). There are traces of toxic metals such as chromium and copper are common in some of types of cement and are damaging to living systems (Omar & Jasim 1990). And also reduction in the total chlorophyll content of barley has been appearing at higher concentrations of CKD treatments that are agreed

with Prasad & Inamdar, 1990 that was found cement dust kiln reduction chlorophyll content.
That means the concentration of CKD is one of the main factors that is controlling the plants response. The results obtained closely conformed with those reported by Stratmann & Van Haut (1966) that dusted plants with dust ranging from 1 to 48 g/m^2 day $^{-1}$ was unfavorable to oats. The heavy metals present in the cement dust can play an important role in the distribution of the various metabolic processes. The yield and growth, metabolic processes of winter barley were found to be affected by the cement dust (Borka, 1986 and Greszta *et al.*, 1988).

That means the response of faba beans different completely than that in barley. The lower concentrations of CKD (0.005 and 0.01 $gm.100ml^{-1}$) kept nearly all growth parameters equal to that in control in faba beans but improved growth parameters in barley. Although the high concentrations (0.05, 0.1 and 0.5 $gm.100\ ml^{-1}$) improved growth parameters in faba beans only. The studied reported that barley more sensitive to higher concentrations than faba beans. That agreed with Lal & Ambasht (1981) that reported variation in the response of plants and physiological behavior of Carissa carandas was found to be the highly affected which followed by *Azadirachta indica* and *Delonix regia*, respectively. On the basis of the study, can conclude that the growth of plants was affected by cement dust through a different dose of CKD, which might be due to the presence of some toxic that appear its effect in the high concentrations. A significant reduction in plant cover of *Carissa carandas* in comparison with the other species suggests that *Carissa carandas* is more sensitive to CKD than the other species studied (Iqbal& Shafig 2001).

From this study can report that the effect of CKD differ not only with different concentrations, but also with different plants and species. Also CKD did not have an aggressive effect on plant growth at study concentrations rang. That means faba beans and barley treated with cement kiln dust don’t suffer from the CKD treatment to the same level. That appeared in the improvements of water content of barley at lower concentrations of CKD while improvement occurred at higher concentrations in faba beans. Also the pigment content nearly there's no negative impact.

Finally, cement kiln dust can be replacing the artificial media for microalgae growth. The low concentrations of CKD, which are suitable for microalgal growth (*Oscillatoria* sp. and *Chlorella* sp.) are (0.0001, 005 and 0.001 gm.100 ml^{-1}). Also, the result reported that CKD can use instead of commercial fertilizer. Plants can grow in concentrations of CKD (0.001 and 0.05 gm.100 ml^{-1}) and these concentrations more than the concentrations that microalgae can grow on it (0.0001, 0.005 and 0.01 gm.100 ml^{-1}). Barley is more sensitive to the higher concentration of CKD (0.5 gm.100 ml^{-1}) than faba beans which can grow in all studied concentrations.

RECOMMENDATION

Complete analysis of cement kiln dust (CKD) structure should be carried out in detail. It would be possible to recommend cement kiln dust to use at low concentrations as fertilizer for some plants and nutrient growth media for algal species.

ACKNOWLEDGMENT

This study was supported by Botany and Microbiology Department, Faculty of Science, Assiut University.

REFRANCES

Andrzej J (1987). Bees and their products as indicators of environment pollution. Med Weter 43(6): 352-356.

Avril, C. (1992). Les apports en Cd aux terres par les intrants agricoles et leur gestion. Agrosol 5: 39-45

Bhatty, J. I.; Miller, F.M.; and Kosmatka, S. H. (2004) ‹*Innovations in Portland Cement Manufacturing* ‹SP400‹ Portland Cement Association, Skokie, Illinois, USA.

Borka G (1986). Effects of cement dust on the growth development‹ major metabolic processes and yield of winter barley Òin situÓ and under controlled conditions. Acta Agron Hungary 35(1/2): 45-52.

Brandt CJ, Rhoades RW (1972). Effects of limestone dust accumulation on composition of a forest community. Environmental Pollution 3:217-225

Chiu S-Y, Kao C-Y, Huang T-T, Lin C-J, Ong S-C, Chen C-D, Chang J-S، Lin C-S (2011) Microalgal biomass production and on-site bioremediation of carbon dioxide, nitrogen oxide and sulfur dioxide from flue gas using Chlorella sp. cultures. Bioresour Technol 102:9135–9142.

Darley GDEF, Drugger WM, Mudd JB, Ordin L, Taylor OC, Stephe ER (١٩٦٦). Plant damage by pollution derived from auto mobiles. Arch Environment Health 6: 700-761.

Dhindwal AS, Lather BPS, Singh J (1991). Efficacy of seed treatment on germination, seedling emergence and vigor of cotton (Gossypium hirsutum) genotypes. Seed Res 19:59-61.

Douskova I, Doucha J, Livansky K, Machat J, Novak P, Umysova D، Zachleder V, Vitova M (2009) Simultaneous flue gas bioremediation and reduction of microalgal biomass production costs. Appl Microbiol Biotechnol 82:179–185.

Elbaz A. A., Aboulfotoh A. M., Dohdoh A. M., Wahba A. M. (2019): Review of beneficial uses of cement kiln dust (CKD), fly ash (FA) and their mixture J. Mater. Environ. Sci., Volume 10, Issue 11, Page 1062-1073.

Greszta J, Braniewsk S, Chrzanowski E, Noseki A, Chlodnx J، Zwozinkski RJ (1988). Influence of dusts from chosen industrial plants on particular links of Ecosystem of Niepobomiece Forest. Ekology Pol 35(2): 291-326.

Gupta AK, Mishra RM (1994). Effect of lime kilnÕs air pollution on some plant species. Pollution Research 13(1): 1-9.

Haynes, B.W., and Kramer, G.W. (1982) ،*Characterization of U.S. Cement Kiln Dust, Bureau of Mines*، United States Department of Interior, Washington, DC, USA, Information Circular #8885.

Huntzinger DN, Gierke JS, Kawatra SK, Eisele TC, Sutter LL (2009) Carbon dioxide sequestration in cement kiln dust through mineral carbonation. Environmental Sci Technol 43:1986–1992.

Iqbal M.Z., Shafüg M. (2001) Periodical Effect of Cement Dust Pollution on the Growth of Some Plant SpeciesTurk J Bot٢٤-١٩. ٢٥

Jin H-F, Santiago DEO, Park J, Lee K (2008) Enhancement of nitric oxide solubility using Fe(II) EDTA and its removal by green algae *Scenedesmus sp*. Biotechnol Bioprocess Eng 13:48–52.

Karemore p. A. Pal R.and Sen R. (2013) Strategic enhancement of algal biomass and lipid in *Chlorococcum infusionum* as bioenergy feedstock Algal Research Volume 2, Issue 2, 113-121.

Klemm,W. A., (1993) "Cement Kiln Dust: A Look at its Uses and Characteristics "،International Cement Seminar ،Primedia Publishing, Chicago, Illinois, USA.

Kurano N, Ikemoto H, Miyashita H, Hasegawa T, Hata H, Miyachi S (١٩٩٥) Fixation and utilization of carbon dioxide by microalgal photosynthesis. Energy Convers Manag 36:689–692.

Lafond J. and Simard R. R. (1999) Effect of cement kiln dust on soil and potato crop quality 1999 Amer J.Potato Res 75:83-90.

Lal B, Ambasht RS (1981). Impact of cement on the mineral and energy concentration of *Psidium guayava*. Environmental Pollution (Series A) 29: 241-249.

Lara-Gil Javier A. & Mario M. Álvarez & Adriana Pacheco (2013) Toxicity of flue gas components from cement plants in microalgae CO٢ mitigation systems Science+Business Media Dordrecht 2013

Lee JN, Lee JS, Shin CS, Park SC, Kim SW (2000) Methods to enhance tolerances of Chlorella KR-1 to toxic compounds in flue gas. Appl Biochem iotechnol 84:329–342.

Lerman SL, Darley EF (1975). Particulates, In. Responses of Plants to Air Pollution. pp. 141. New York: Academic Press.

Lichtenthaler **H.** K. (1987**)**. Chlorophyll Fluorescence Signatures of Leaves during the Autumnal Chlorophyll Breakdown J. of Plant Physiology Volume 131, Issues 1–2, Pages 101-110.

Maeda K, Owada M, Kimura N, Omata K, Karube I (1995) CO٢ fixation from the flue gas on coal-fired thermal power plant by microalgae. Energy Convers Manag 36:717–720.

Marker, AFH. 1972. "The use of acetone and methanol in the estimation of chlorophyll in the presence of phaeophytin." *Freshwater Biology* 2 (4):361-385.

Maslehuddin M. ،O.S.B. Al-Amoudi b ،M. Shameem a ،M.K. Rehman a ،M. Ibrahim (2008) Usage of cement kiln dust in cement products – Research review and preliminary investigations a Construction and Building Materials 22 : 2369–2375.

Negoro M, Shioji N, Miyamoto K, Micira Y (1991) Growth of microalgae in high CO٢ gas and effects of SOx and NOx .Appl Biochem Biotechnol 28–29:877–886.

Ohkawa, S., Naruo, K., Miwatashi, S. & Kimura, H. (2001). World Patent WO2001/074 811.

Olaizola M (2003) Microalgal removal of CO٢ from flue gases: changes in medium pH and flue gas composition do not appear to affect the photochemical yield of microalgal cultures. Biotechnol Bioprocess Eng 8:360–367.

Omar JM, Jasim F (1990). Some observations on the use of electrothermal atomic absorption spectorpotometry for the determination of chromium and copper in portland cement. Microchemistry Journal 41(3): 348-355.

Oss HG, Padovani AC (2003) Cement manufacture and the environment part II: environmental challenges and opportunities. J Industrial Ecol ١٢٦ –٧:٩٣

Prasad MSV, Inamdar JA (1990). Effect of cemet kiln dust pollution on groundnut. Indian Bot Cont 7(4): 159-162.

Radmann EM, Camerini FV, Santos TD, Costa JAV (2011) Isolation and application of SOx and NOx resistant microalgae in biofixation of CO ٢from thermoelectricity plants. Energy Convers Manag 52: ٣١٣٦–٣١٣٢.

Shah FH, Ilahi I, Rashid A (1989). Effect of cement dust on the chlorophyll contents, stomatal clogging and biomass of some selected plants. Pakistan Journal Sci Indust Research 32(8): 542-545.

Stern AC (1976). Air Pollution. Measurement, Monitoring and Surveillance of Air Pollution, 3rd ed., Academic Press, New York.

Stratmann, Van Haut (1966). In: Darley EF. Studies on the effect of cement kiln dust on vegetation. Air Pollution Control Association Journal 165(3): 33-39.

Taubert D. H., Director, Promotion & Technical Service, Capitol Cement (Presented at 2008 IEEE/PCA 50th Beneficial uses of cement kiln dust (2008) Cement Industry Technical Conf., Miami, FL, May 19-22.

Tomar D., Abrar Ahmad Khan and Gufran Ahmad: (2018) Response of potato plants to foliar application of cement dust, tropical plant research j. 5(1): 41–45.

Wayne S. Adaska, P.E., Director, Public Works, Portland Cement Association.

Yang S, Wang J, Cong W, Cai Z, Ouyang F (2004a) Utilization of nitriteas a nitrogen source by *Botryococcus braunii* . Biotechnol Lett 26: ٢٤٣–٢٣٩.

Yang S, Wang J, Cong W, Cai Z, Ouyang F (2004b) Effects of bisulfiteand sulfite on the microalga *Botryococcus braunii* . Enzyme MicrobTechnol 35:46–50.

Yoshihara KI, Nagase H, Eguchi K, Hirata K, Miyamoto K (1996) Biological elimination of nitric oxide and carbon dioxide from flue gas by marine microalga NOA-113 cultivated in a long tubular photobioreactor. Journal Ferment Bioenergy 82:351–354.

Zhao, Yinhong, Yunming Shi, Weixing Zhao, Xu Huang, Donghui Wang, Neil Brown, Jerry Brand, and Jindong Zhao. 2005. "CcbP, a calcium-binding protein from Anabaena sp. PCC 7120, provides evidence that calcium ions regulate heterocyst differentiation." Proceedings of the National Academy of Sciences of the United States of America 102 (16):5744-5748.

الإختلاف في أستجابة نوعين من النباتات و نوعين من الطحالب لتركيزات مختلفة من غبار الأسمنت

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وتستهدف الدراسات العالمية إلى كيفية استخدام غبار الأسمنت في العمليات البيولوجية وذلك للتخلص منه بسبب خطورته التى تهددا البيئة. من خلال دراستنا يمكن استخدامه كأسمدة في الزراعة ووسائط غذائى لنمو الطحالب. قد قمنا باستخدم تركيزات مختلفة (٠.٠٠٥ ، ٠.٠١ ، ٠.٠٥ ، ٠.١ و ٠.٥ جم لكل ١٠٠ ملى) من غبار الاسمنت لنمو كل من الفول والشعير. وكذلك

استخدمنا التركيزات الاتيه لنمو الطحالب (٠.٠٠٠١ ، ٠.٠٠٠٥ ، ٠.٠٠١ ، ٠.٠٠٥ و ٠.٠١ جم لكل ١٠٠ ملى). وجدنا انه يمكن الاستفادة من التركيزات المنخفضه من غبار الاسمنت مثل (٠.٠٠٥ و ٠.٠١) لتحسين نمو وإنبات كل من الفول والشعير. ويمكن استخدام التركيز (٠.٠٠١) كوسائط غذائى لنمو بعض الطحالب مثل (الاوسيلاتوريا والكلورلا) بديلا عن الاوساط الغذائية الاصطناعية.