International Multidisciplinary Research Journal 2011, 1/1:31-36
ISSN: 2231-6302
Available Online: http://irjs.info/
IRMJ-Ecology

Cement dust pollution on growth and yield attributes of groundnut (*Arachis hypogaea* L.)

D. Raajasubramanian[1], P. Sundaramoorthy[1,2*], L. Baskaran[1], K. Sankar Ganesh[1], AL.A. Chidambaram[1] and M. Jeganathan[1]

[1]*Department of Botany, Annamalai University, Annamalainagar-608 002,Tamilnadu – India*
[2]*P.G. Research Department of Environmental Science, Government Arts College, Ariyalur, Tamilnadu – India*

Abstract: Increased concentration of cement dust pollutants causes invisible injuries like progressive decline in the physiological process such as photosynthetic ability and respiration rate of leaves. Similarly, visible injuries such as closure leaf stomata, a marked reduction in growth and productivity were observed due to cement dust. The present study particularly discriminate the effect of cement dust deposition on soil and over the vegetation and its consequences effect on groundnut crop, which is popularly grown in and around the vicinity of cement industry. The present research work focused on growth biochemical and yield responses of groundnut due to cement dust deposition. The cement dust artificially sprayed on the plant surface with different levels. All the morphological and biochemical and yield parameters were analyzed. Morphological parameters Root length, Shoot Length, Total leaf area, fresh and dry weight were inhibited in high dose of cement deposition when compare control plant. Biochemical parameters such as chlorophylls Carotenoid Protein Amino acid and total sugar were decreased in cement sprayed plants when compare in untreated plant. The highest amount of all biochemical content which present in control set and lowest one recorded in 20g/pot sprayed with cement dust. pH and Iron, calcium, magnesium, phosphorus, potassium and manganese that are prominent in cement dust were found to be higher in concentration in the polluted soil. And zinc, copper and nitrogen were lower concentration. This indicates the extent to which the soil was polluted by cement dust, in addition to that the pH of gradually increased due the effect of cement dust when compare to control soil. Alkaline nature of cement dust reduce the absorption of mineral substances form the soil its leads to changes in the plant physiology and morphology.

INTRODUCTION

Now a day, cement industry caused environmental pollution problems, the pollutants of the cement industry produced the adverse impact on Air, Water and Land. Cement industry is the one of the 17 most polluting industries listed by Central Pollution Control Board. During the last decades, the emission of dust from cement factories has been increased alarmingly due to expansion of more cement plants to meet the requirement of cement materials for construction of building. In comparison with gaseous air pollutants, many of which are readily recognized as being the cause of injure to various types of vegetation. Relatively little known and limited studies have been carried out on the effect of cement dust pollution on the growth of plants (Iqbal and Shafig, 2001). Cement contains 3-8% aluminium oxide, 0.5-0.6% iron-oxide, 60-70% calcium oxide, 17-25% silicon oxide, 0.1-4% magnesium oxide and 1-3% sulphur trioxide (Ade-Ademilua and Umebese, 2007). The pH of the cement-polluted soils was alkaline but that of the polluted soil was more alkaline. Similar studies on cement dust pollution show elevated levels of soil pH (Adamson *et al.*, 1994; Mandre, 1997; Mandre *et al.*, 1998). Cement dust is a mixture of Ca, K, Si and Na which often include heavy metals like As, Al, Cd, Pb, Zn, Fe, and Cr. Majority of these elements in excess amounts are potentially harmful to the biotic and abiotic components of the environment (Gbadebe and Bankole, 2007). Likewise, increased concentration of cement dust pollutants causes invisible injuries like progressive decline in the physiological process such as photosynthetic ability and respiration rate of leaves. Similarly, visible injuries such as closure leaf stomata, a marked reduction in growth and productivity were observed due to cement dust. Farmer (1993) reported that cement dust pollutants block the stomata, reduction in number of annual crops. Sato et al., (1993) also reported that due to cement dust decreased the productivity and concentration of chlorophyll in a number of crops. The aim of the present research work is to find out the influence of cement dust on growth and yield component of groundnut (*Arachis hypogaea* L.) popularly

Received: April 28, 2011; Revised May 17, 2011; Accepted May 17, 2011.

*Corresponding Author, Tel: +91-9487782195; +91-9976961593

Email: ppsmoorthy@yahoo.com, draajasubramanian@yahoo.com

grown in and around the cement factory area of Ariyalur District of Tamil Nadu.

MATERIALS AND METHODS

Study area

The study area located 3 kms away from Ariyalur and about 90 km far from the chidambaram and it lies at 11° latitude and 79° longitude. The cement factory was started in 1978 where the cement manufacturing type is dry process. The basic raw material for cement is lime stone, river sand, coal, and gypsum. There is a hub of (nine) cement industries operating in the Ariyalur region and each industry is having three pairs smokestacks with different heights, it emits potentially harmful hazardous material like coal dust along with gaseous pollutants and particulate pollutants spread around the 12 km radius from the factory.

Survey of vegetation

The area around the cement factory is cultivatable with dry and wetland farming. The crop like chilies, green grams, groundnut, rice, black gram and sorghum cultivars are cultivated in the area. The soil is black clay loamy with calcareous deposit. The average rainfall is about 2.89 cm. The maximum rainfall is during October to November due to low pressure of northeast monsoon.

Collection of material

Cement dust

The cement exhaust dust collected from the cement kiln smokestacks of the Tamil Nadu Cement Corporation Ltd., (TANCEM) Ariyalur, Tamil Nadu, India, were used for analyzing the influence of cement dust on crop.

Seed material

The healthy and vigor experimental crop seeds of groundnut (*Arachis hypogaeae L.* var. JL-24) were procured from Oil Seeds Regional Research Station of Tamil Nadu Agricultural University situated in Virudhachalam, Cuddalore District of Tamil Nadu, India.

Pot culture experiment

Healthy seeds of Groundnut were selected and treated for surface sterilization 0.2% of $Hgcl_2$ for 20 minutes then thoroughly washed with tap water. The earthen pots were used for pot culture experiment, though the cement dust thoroughly mixed with the garden soil at the concentration of 200g/Kg soil. Exactly 15 seeds were sown in earthen pots containing garden soil with and without cement dust. The seedlings were raised in the cement dust free soil was treated as control. The seedlings were raised under the natural photoperiod with day and night temperature in the range of 30˚-32˚c and 23˚-25˚c. After germination the seedlings were thinned down to 10/pot for healthy growth of the seedlings. Foliar application of cement dust was done from the 7^{th} day at the concentration (Control, 1, 5, 10, 15, 20g dust/pot) of cement dust regularly by using a hand sprayer. Physic-chemical analysis if soil were carried out before sowing and after harvesting the crop by the standard method (Piper, 1.966).

Methods of cement treatment

The cement kiln exhaust dust collected from the cement kiln smokestacks of the Tamil Nadu Cement Corporation Ltd., (TANCEM) Ariyalur, Six sets of pot culture experiments were maintained among six sets one set maintained as control. The various amount [Control, 1, 5, 10, 20, and 40 g/plant] of cement dust uniformly sprinkled at 2-day intervals from the age of 10th day onwards up to harvesting. Irrigation was done at regular interval.

Morphometry studies

The morphological parameters like such as shoot length (cm), root length (cm), total leaf area (cm2), fresh weight (g) and dry weight (g) and yield (g) were observed and recorded at 30, 60 and 90 days.

Total leaf area (cm2)

The leaf area was calculated by measuring the length and breadth of the leaf was described by Yoshida *et al.* (1972).

Leaf area (cm^2) = K × length × breadth

Where, K = Kemp's constant (for dicot leaves) = 0.66

Biochemical analysis

The seedlings and the plant materials were collected from both germination studies (7^{th} day) and pot culture experiments (30^{th} and 60^{th} days). The leaf, root of plants were separated and used for the biochemical's analyses such as chlorophyll (Arnon, 1949), carotenoid (Krik and Allen, 1965), protein (Lowry *et al.*, 1951), amino acid (Moore and Stein, 1948), reducing sugar (Nelson, 1944), non-reducing sugar (Nelson, 1944) and total sugar.

Estimation of Photosynthetic pigment

0.5 g of fresh leaf material was taken and ground with help of pestle and mortar with 10 ml of 80% acetone. The homogenate was centrifuged at 800 rpm for 15 minutes. The supernatant was saved and the residue was re-extracted with 80 per cent acetone. The supernatant was saved and used for estimation of chlorophyll. The absorbance was read at 645nm for Chlorophyll 'a' and 663nm for chlorophyll 'b' in Spectrophotometer. Simultaneously, the carotenoid content of the extract was read at 480 nm. The results were obtained by the formula proposed by Arnon (1949) for total chlorophyll and Krick and Allen (1965) for carotenoid content.

Estimation of Protein

The protein content was quantified by the method of Lowry et al., (1951). 0.5 g of plant materials (Root and Shoot) were weighted and ground in a pestle and mortar with 10 ml of 20 per cent TCA (Trichloro Acetic Acid). The homogenate was centrifuged for 15 minutes at 800 rpm. The supernatant was discarded. To the pellet, 5 ml of 0.1 N NaOH was added and centrifuged for 5 minutes. The supernatant was saved and made upto 10 ml of 0.1 N NaOH. This extract was used for the estimation of protein. 1 ml of the extract was taken in a 10 ml test tube and 5 ml of reagent C was added. This solution was mixed thoroughly and kept in darkness for 10 minutes. After that, 0.5 ml Folin-phenol reagent was added. It was kept in dark for 30 minutes. The sample was read at 660 nm in UV-Spectrophotometer.

Estimation of Amino Acid (Moore and Stein, 1948)

0.5 grams of plant materials were taken and ground with 10 ml of 80 per cent ethanol in a pestle and mortar. The homogenate was centrifuged at 800 rpm for 10 minutes and the supernatant was saved. The supernatant made upto 10 ml with 80 per cent ethanol. 1 ml of extract was taken and 1 ml of ninhydrin reagent were added and mixed thoroughly in a Folin-Wu tube and the content was heated for 20 minutes in a boiling water bath at 100°C. After 20 minutes, the content was removed from the water bath cooled under running water. The content was mixed thoroughly made upto 10 ml with diluting solution. Then, the solution was read at 570 nm in UV-Spectrophotometer.

Estimation of Reducing Sugar (Nelson, 1944)

0.5 gram of plant material was weighed and macerated in a pestle and mortar with 10 ml of 80 per cent ethanol. The homogenate was centrifuged for 10 minutes at 800 rpm. The supernatant was saved. Then, ethanol is evaporated in a water bath at 50°C. The extract was made up to 20 ml with distilled water. 1 ml of extract was taken in a 25 ml marked test tube. One ml of the reagent 'C' was added. Then, the mixture was heated for 20 minutes at 100°C in boiling water, cooled and one ml of arsenomolybdate reagent was added. The solution was thoroughly mixed and diluted to 25 ml with distilled water. The sample was read at 520 nm in UV-Spectrophotometer.

Estimation of Non-Reducing sugar (Nelson, 1944)

Non-reducing sugars present in the ethanol extract (extraction as in reducing sugar) were hydrolysed with sulphuric acid to reducing sugars. Reducing sugars present in the hydrolysates were estimated Nelson's method. The differences between the total sugars and the reducing sugars estimated without hydrolysis corresponds to the non-reducing sugars.1 ml of extract was taken in a test tube and evaporated to dryness on a water bath for 15 minutes. To the residue, 1 ml of distilled water and 1 ml of 0.1 N sulphuric acid were added. The mixture was hydrolysed by incubating at 49°C for 30 minutes in a thermostat. The solution was neutralized with 0.1 N NaOH (5 ml) methyl red as indicator. To this, 1 ml of reagent C (copper reagent) were added and heated for 20 minutes cooled and 1 ml of arsenomolybdate reagent were added. The content was made upto 25 ml and the absorbance was read at 495 nm in Spectrophotometer.

Soil analysis

The soil samples were collected before sowing and after harvesting from each pot by standard agriculture method. These soil samples were used for the analyses of various properties such as pH, electrical conductivity, nitrogen, phosphorus, potassium, zinc, copper, iron, calcium, magnesium and manganese. The physicochemical properties of cement dust

polluted soil carried out standard method (Piper, 1966). The available soil nutrients before sowing and after harvesting recorded in the table.

RESULT AND DISCUSSION

The present study particularly discriminate the effect of cement dust deposition on soil and over the vegetation and its consequences effect on groundnut crop, which is popularly grown in and around the vicinity of cement industry. Deposition of cement dust over the surfaces of the groundnut crops leaf reflects changes in morphological and biochemical content of the plant when compared with non- cement dusted plant. Fig.1 and 2 showed morphological parameter such as shoot length, root length, total leaf area of groundnut under cement dust pollution all morphological parameters were reduced when compared with control crop due to increase concentration of cement dust. The highest growth parameters were recorded in control crop and lowest biomass growth showed in 20g/pot treated crop. Pollution stress responsible for alternation of growth parameters (Sagar, Gregory and Paul, 1982). Harmful substances which is present in the cement dust plays vital role to retard the growth of plant. The effect of cement kiln dust on the growth of mustard was studied by Uma and Rao (1993) it reveals growth of mustard was gradually decreased with increase in cement dust deposition due to the presence of harmful substances. Similar results were observed by Uma and Ramana Rao (1996). In general plants able to synthesis their own food with the help of light, here light energy can be converted in to chemical energy with the help of photosynthetic organ. In our planet autotrophs is the only living being to generate energy from the solar light, generated energy can be utilized for their growth and energy will be supplied to all dependent living organism which is present in the food web. Cement dust deposited over the surfaces of the leaf in interfere the absorption light quantity, it cause reduction in photosynthesis. This has also been reported by Anju Sirohi and Singh (1991). Similar result was observed by Izquierdo and Hosfield (1983).

Figs 3-7 shows the biochemical content of the crop such as total chlorophyll, carotenoid, total, protein, aminoacid and total sugar. All the biochemical parameters were progressively decreased with increased amount of cement dust when compared with non cement dusted crop. The highest amount of all biochemical content which present in control set and lowest one recorded in 20g/pot sprayed with cement dust. The progressive decline of metabolites such as protein, aminoacid, chlorophyll, carotenoid, and total sugar probably due to decrease in chlorophyll content similar results were observed by (Prasad and Inamdar 1990). Chlorophyll content might be reduced due to chloroplast damage by incorporation of cement kiln dust over the surfaces of the leaf tissue it's responsible for alteration of leaf pH, because the pH of cement is higher, so it cause chloroplast damage (Singh and Srivastra,2002). The changes in chlorophyll content due to the shading effect caused by cement dust and damage to photosynthetic apparatus. Reduction of total chlorophyll has been found in leaves in leaves of various annuals plants and conifers covered by cement dust (Pandey and Kumar, 1996) similar work was studies by Nunes etal., (2004). The cement kiln dust decrease chlorophyll content, confirming the findings by Prasad and Inamdar (1990). Particularly cement dust is alkaline nature, it changes the soil nature and it became an alkaline. Alkalization and high amount of Ca content of the cement polluted soil environment inhibited assimilation of Mg, Mn and Fe by plants which was together with light deficiency (Mandre and

Tuulmets, 1997). The reduction in protein content might be due to the result of decreased photosynthesis and damage of chloroplast. On the other hand decreases protein content could be attributed either by break down of existing protein or due to reduced denovo synthesis by disruption in the process of photosynthesis pathway (Singh and Jyoti, 1999). The reduction in protein, starch, yield and phytomass of groundnut due to cement dust (*Arachishypogae*.L) (Prasad and Inamdar 1990). Protein synthesis decreased due to the low chlorophyll and reduced leaf area surface similar findings was reported by Baszynski etal (1980). Sugar is a most important constituent and as a source of energy for all living beings. The reduction in total sugar reflects the interference of light absorption caused by deposition of dust over the surfaces of leaf. Reduction in sugar content of crop around the cement dust polluted area can be attributed to increased respiration and decreased Co2 fixation because of chlorophyll deterioration (Tripathi and Gautham, 2007).

Fig.8-10 showed yield parameters such as number of pod, 100seeds weight and yield of groundnut under cement dust pollution all yield parameters were reduced when compared with control crop due to increase concentration of cement dust. The highest yield parameters were recorded in control crop and lowest biomass growth showed in 20g/pot treated crop. The reduction of yield due to the low level and lock of photosynthesis (Sagar, Gregory and Paul, 1982).

Table 1, shows pH and Iron, calcium, magnesium, phosphorus, potassium and manganese that are prominent in cement dust were found to be higher in concentration in the polluted soil. And zinc, copper and nitrogen were lower concentration. This indicates the extent to which the soil was polluted by cement dust, in addition to that the pH of gradually increased due the effect of cement dust when compare to control soil. Alkaline nature of cement dust reduce the absorption of mineral substances form the soil its leads to changes in the plant physiology and morphology. Prolonged cement impact and alkalization of the environment cause change in the availability of several plant essential nutrients particularly N and Mn concentration the polluted environment are lower than the control. Plants absorption of nutrients drastically decreased due to the high amount of Ca, K content present in the alkaline soil (Mandre, 1995). A similar result was observed by several authors and stressed the imbalance of nutrients as an important factor in the survival and development of plants (Marschner, 1986; Karblane, 1996). Photosynthesis as well as optimum quantity of mineral substances essential for structural as well as physiological functioning of the plants. Reduction of photosynthesis leads to affects all the physiological activities of crop one way and on the other hand absorption of mineral substances deficiency also plays most important role for changing the growth and biochemical content of plant, it leads to affect the yield of crop. Due to alkaline nature of cement dust, it affects the absorption of mineral substances from the soil.

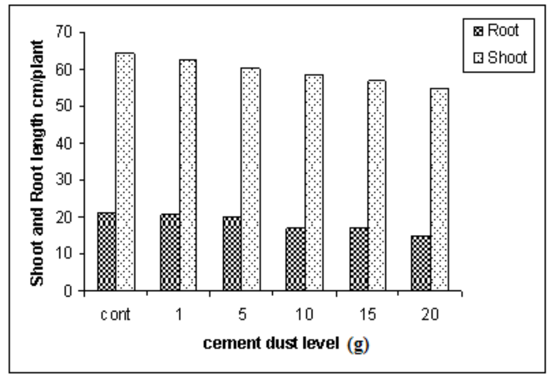

Fig.1. Effect of different level of cement dust pollution on shoot and root length of groundnut (*Arachis hypogaea* L.)

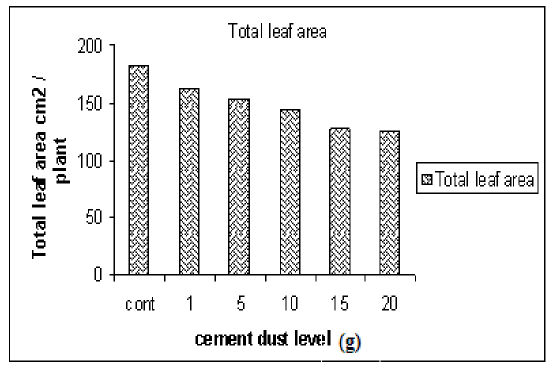

Fig.2. Effect of different level of cement dust pollution on total leaf area of groundnut (*Arachis hypogaea* L.)

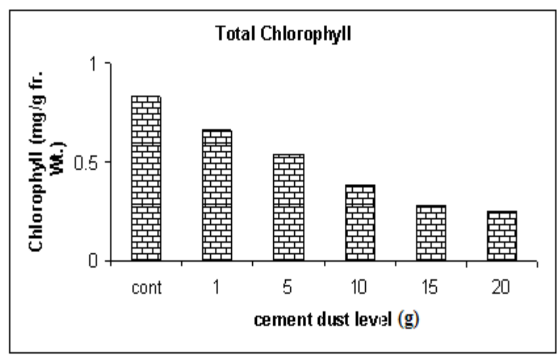

Fig.3. Effect of different level of cement dust pollution on total chlorophyll content of groundnut (*Arachis hypogaea* L.)

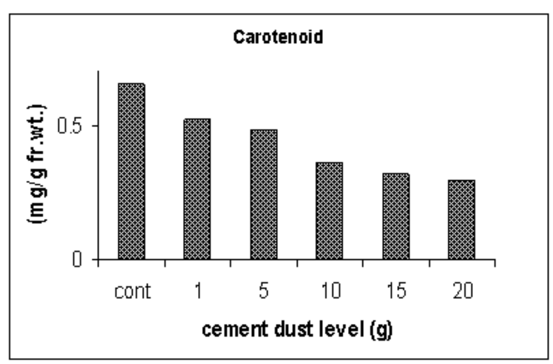

Fig.4. Effect of different level of cement dust pollution on carotenoid content of groundnut (*Arachis hypogaea* L.)

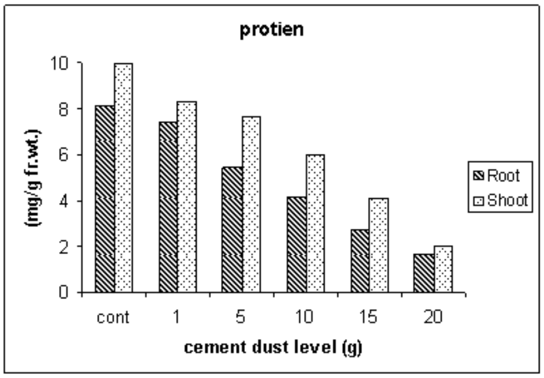

Fig.5. Effect of different level of cement dust pollution on protein content of groundnut (*Arachis hypogaea* L.)

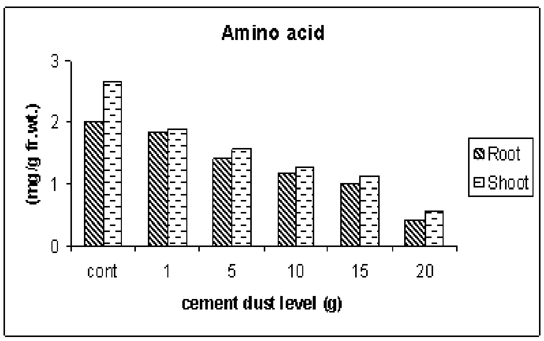

Fig.6. Effect of different level of cement dust pollution on amino acid of groundnut (*Arachis hypogaea* L.)

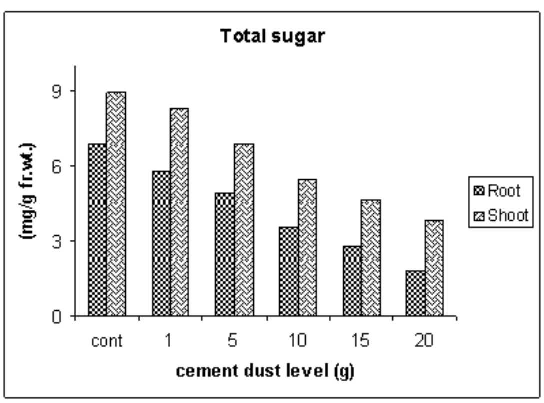

Fig.7. Effect of different level of cement dust pollution on total sugar of groundnut (*Arachis hypogaea* L.)

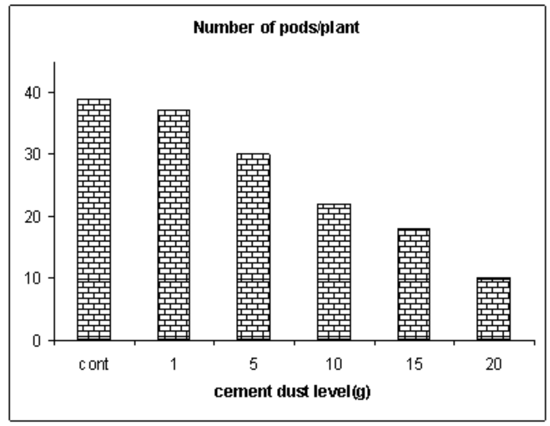

Fig.8. Effect of different level of cement dust pollution on yield number of pods/plant of groundnut (*Arachis hypogaea* L.)

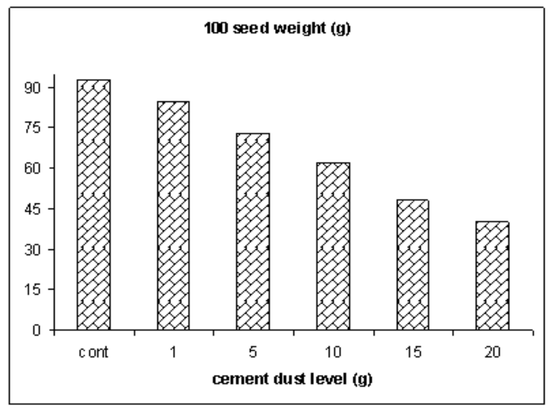

Fig.9. Effect of different level of cement dust pollution on yield 100seed weight of groundnut (*Arachis hypogaea* L.)

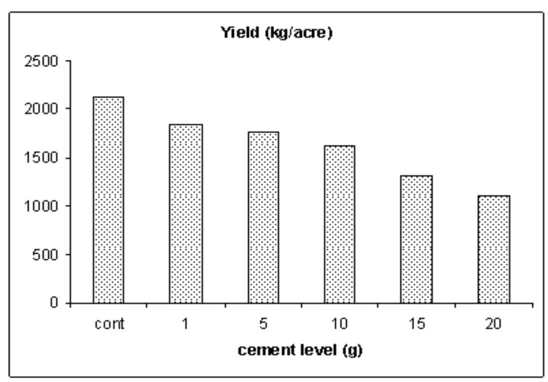

Fig.10. Effect of different level of cement dust pollution on yield (kg/acre) of groundnut (*Arachis hypogaea* L.)

Table-1: Physico-chemical analysis of soil before sowing and after harvesting

Amount of cement dust sprayed (g/plant)	Soil properties								
	pH	EC (d Sm^{-1})	N (kg/acre)	P (kg/acre)	K (kg/acre)	Zn (ppm)	Cu (ppm)	Fe (ppm)	Mn (ppm)
Before sowing									
Normal soil	7.1	0.31	70.0	14.2	35	1.76	2.99	24.59	1.95
After harvesting									
Control	7.4	0.30	41.0	5.0	108	3.49	1.31	21.9	1.47
1	7.6	0.35	40.0	6.0	95.0	2.63	2.11	23.3	1.75
5	7.7	0.30	38.0	7.5	100	1.89	3.04	31.1	1.78
10	7.9	0.35	36.0	6.0	88.0	3.41	1.72	23.8	1.63
25	8.0	0.30	35.0	5.0	90.0	4.48	1.64	26.2	2.16
50	8.2	0.41	30.0	7.5	93.0	1.80	1.18	33.3	1.82

REFERENCES

Adamson, E., H. Adamson and R. Seppelt, 1994. Cement dust contamination of *Ceratodon purpureus* at Case, est Artartica-damage and capacity of recovery. J. Bryol., 18: 127-137.

Ade-Ademilua, O.E. and C.E. Umebese, 2007. The growth of *Phaseolus vulgaris* L. cv. Ife Brown (Leguminosae) in a cement site rich in heavy metals. Pak. J. Biol. Sci., 10: 182-185.

Anju Sirohi and D, Singh, 1991. Effect of environmental pollution on the morphology and leaf epidermis of *Rumes dentalus* L. Geiobios., 18: 2-3.

Baszynski, T., Warchodowa, M., Krupa, Z., Tukendorf, A., Krol, M and Wolinska, D, 1980.Z.Pflansenphysiol. 99, 295.

Farmer, A.M. 1993. The effect of dust on vegetation – A review. Environ. Pollut. 79: 63-75.

Gbadebe, A.M., and Bankole, O.D. 2007. Analysis of potentially toxic metals in airborne cement dust around Sagamu, South Western Nigeria. Journal of Applied Science 7 (1): 35-40.

Iqbal, M.Z and Shafig, M. 2001. Periodical effect of cement dust pollution on the growth of some plant species. Turk. J. Bot., 25: 19-24.

Izquierdo, J.A., and G.L, Hosfield 1983. The relationship of seed filling to yield among dry bean with differing architectural forms J. Am. Soc. Hort. Sci., 108: 106-111.

Karblane, H., 1996. Taimede toitumise ja vaÈ etamise kaÈ siraamat. EV PoÄ llumajandusministeerium, Tallinn

Mandre, M., 1995. Changes in the nutrient composition of trees. In: Mandre, M. (Ed.) Dust pollution and forest ecosystem. A study of conifers in an alkalized environment. Publ. Institute of Ecology, 3 Tallin, pp.44-65.

Mandre, M., 1997. Changes in a forest landscape affected by alkaline industrial dust. Oil Shale, 14: 409-418.

Mandre, M., and L. Tuulmets, 1997. Pigment changes in Norway spruce induced by dust pollution. Water Air Soil pollut. 94:247-258.

Mandre, M., K. Ots, J. Rauk and L. Tuulmets, 1998. Impacts of air pollution emitted from the cement industry on forest bioproduction. Oil Shale, 15: 353-364.

Marschner, H., 1986. Mineral nutrition of higher plants. Academic press, London.

Nunes , A., Brugnoli, E., Maguas, C., and Correia, O, 2004. Effect of dust deposition on foliar absorbance of Mediterranean species. Rev. Biologia Lisboa. 22:143-151.

Piper, C.S. (1966): In soil and plant analysis. Hans. Bombay India.

Pnadey, D.D and S, Kumar, 1996. Impact of cement dust pollution on biomass, chlorophyll, nutrients and grain characteristics of wheat. Environ Ecol. 14:872-875.

Prasad, MSV., and Inamdar, JA, 1990. Effect of cement kiln dust pollution on ground nut. Indian Bot. cont 7(4):159-162.

Sagar, V.K., Gregory, C.P and Paul, S.J, 1982. Air pollution an important issue in plant health. Plant disease 66:429-434.

Sato, R.N., Kene, HK., Nalamwar, RV., Ulemale, RB. 1993. Effect of cement dust pollution on growth and yield of cotton. Ann. Plant Physiology 7: 73-77.

Singh, N., and Jothi, S, 1999. Reduction in protein contents in a few plants as indicator of air pollution. Poll. Res., 18:281-283.

Singh, R.B., and A.K, Shrivastava, 2002. Cytotoxic effect and biological damages in *Clitoria ternatic* by cement dust Nat. Environ. Pollu. Res., 1: 457-461.

Tripathi, A.k and Mukesh Gautam, 2007. Biochemical parameters of plants as indicators of air pollution. J. Environ. Biol., 28:127-132.

Uma, C.H., and T.V.R, Rao, 1993. Morphobiochemical changes due to cement kiln dust pollution in mustard. Indian Bot.Cong., 16: 131-135.

Uma, C.H., and T.V.R, Rao, 1996. Effect of cement kiln dust pollution on *Hibiscus cannabinus* L. Geobios., 23: 59-64.

Zerrouqi, Z., Sbaa, M., Oujidi, M., Elkharmouz, M., Bengamra, S., Zerrouqi, A. 2008. Assessment of cement's dust impact on the soil using principal component analysis and GIS.