# GROWTH RESPONSE OF *Hibiscus cannabinus* TO THE EFFECT OF CEMENT

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## ABSTRACT

The impact of cement dust pollution on the growth performance of *Hibiscus cannabinus* was investigated. The seeds of *Hibiscus cannabinus* were obtained from reliable source, and grown on soil contaminated with different concentrations (0%, 5%, 10% 15%, 20% and 25%) of cement. All methods followed the approaches of previous authors of related subjects. Findings revealed that the cement dust affected the time of germination, although the extent varied with concentration. There were significant variations in the plant height, leaf length, stem girth, leaf width, leaf area and the chlorophyll content among the level of treatment at 0.05 level of probability. Inhibition of *H. cannabinus* growth attributes (plant height, stem girth, leaf length, leaf area) was more pronounced in 25% concentration followed by 20%, 15%, 10% and 5% cement concentration as compared with the control (0%). Similarly, the number of leaves decreases as the concentration increases; hence, the effect of cement dust pollution is concentration dependent. The morphological parameters of the species studied showed that the cement dust pollution affected the structure of the plant, and significant reductions were observed as concentration increases. This study revealed that cement dust pollution had significant effect on the growth and chlorophyll content of *H. cannabinus* especially at higher concentration (25%).

**Keywords:** *Hibiscus cannabinus,* growth attributes, Chlorophyll contents, cement dust

## INTRODUCTION

Cement is one of the most widely used materials for construction throughout the world (El-Sherbeny and Najm, 2016). The continuous production of cement plays hazardous roles in the availability of air pollutants such as Sulphur dioxide, Nitrogen oxide and hazardous dust that are continuously disturbing our environment. This pollutants from the cement factories affects the entire ecosystem within the vicinity of the factories including depositions of pollutants on the soil and vegetation (Amal and Migahid, 2011; Kumar and Thambarani, 2012). Plants growing in the vicinity of cement industry are greatly affected by the pollutants emitted from this industry, so these plants could be used as air pollution monitoring (El-Sherbeny and Najm, 2016).

Air pollution has become a major threat to the survival of plants in the industrial areas (Gupta and Mushra, 1994). The cement industry also plays a vital role in the imbalances of the environment and produces air pollution hazards (Stern, 1976). Cement manufacturing process generate a tremendous amount of dust particles (coarse and fine), which decrease the surrounding air quality. Their emission of considerable amounts of toxic gasses and particulate matters into the atmosphere is causing significant air pollution (Adak *et al*., 2007). Cement contains oxide of sulphur and nitrogen, which damage vegetation by affecting their gas exchange processes (Bennett *et al*., 1975; Gookzik *et al*., 1985).

Cement dust-induced toxicity is an emerging environmental and horticultural problem that limits fruit harmful for human and animal consumption (Smith, 2012). Recently works showed that cement dust decreases the productivity and concentration of chlorophyll in a number of annual non-leguminous crops (Liu *et al*., 1997), Research studies revealed that plants growing in urban areas are affected greatly by these pollutants (Uaboi-Egbemi *et al*., 2009). Now it is necessary to identify some principles that may indicate these and the need for mitigation measures (Prajapali and Tripathi, 2008). Raajasubramanian *et al.* (2011) while working on effects of cement dusts on growth and yield attributes of *Arachis hypogaea* reported that physiological disorders such as reduction of photosynthesis and respiration rates of leaves in addition to the reduction in growth rate and productivity were recorded as a result of the dust produced from the cement industry.

It's a well-known fact from previous studies (Ade-Ademilua and Obalola, 2008; Kolawole *et al*., 2021) that cement dust has a severe effect on our environment and also on the physiology of the plant species grown around heavily polluted areas. Consequently, the present study seeks to investigate the effect of cement dust pollution on the growth performance and chlorophyll contents of *Hibiscus cannabinus* - an important vegetable consumed by man.

## MATERIALS AND METHODS

### Study Area

The experiment was carried out in Biological garden of the Federal University of Kashere situated on Latitude $9^{0}52'$N, and Longitude $11^{0}0'$E (Figure 1) in Akko Local Government, Gombe State (Kolawole *et al*., 2021).

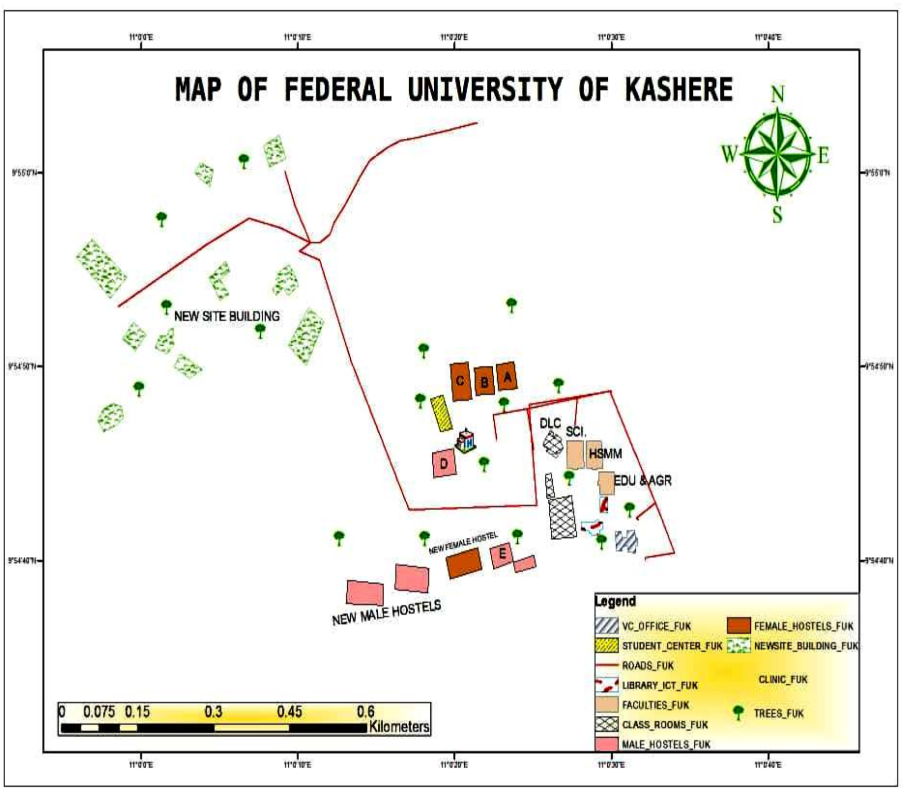


**Figure 1:** Location map of the study area

**Collection and Seed Planting**

The seeds of *H. cannabinus* were obtained from the Ministry of Agriculture, Gombe State while the loamy soil utilized for planting was obtained from the local farmers in Kashere. In practice, eighteen (18) planting pots of the same size were filled with 5 kg of loamy soil each, and we have 5 treatments and 1 control. The five treatments were mixed with cement at (50g, 100g, 150g, 200g, and 250g) each, and the sets were kept in a separate place in the greenhouse. The seeds of *H. cannabinus* were sown in each of the 18 pots. Watering was carried out every day (Ade-Ademilua and Obalola, 2008).

**Aerial Plant Pollution**

Forty (40) grams of the cement was blown over the plant grown in polluted soil using an electric blower at 7 days interval from the time the seedlings were a-week old. Cement dust was blown from both ends of the greenhouse. Aerial pollution of the plants was carried out throughout the period of the experiments using the method of Ade-Ademilua and Obalola (2008) modified by Kolawole *et al.* (2021).

**Measurement of Growth parameters**

Measurements started two (2) weeks after planting and lasted for ten (10) weeks with an interval of two weeks. The morphological parameters measured include: Plant Stem Height, Leaf Length and Breadth, Stem Girth and Leaf Area. The stem height, leaf length and breadth were measured with a standard meter rule while the stem girth was measured with an Electronic Digital Caliper (Titan 23175 model). The leaf Area was calculated according to Pearcy *et al*. (1989) and Kolawole *et al*. (2018).

Leaf Area = (L X B) K, Where L= length of leaf, B=maximum width and K= 0.72

The leaves of each replicates were also counted and recorded at 10 weeks after planting. Likewise, samples of the shoots and roots were carefully collected, dried to a constant weight and weighed in grams using a metler balance.

The completely randomised design (CRD) format was used for this research work with five treatments and control. All methods and procedures follow Ogunkunle *et al*. (2013) and Kolawole *et al*. (2018).

**Leaf chlorophyll content**

The chlorophyll contents of *H. cannabinus* were estimated after ten weeks of planting following the method of Hipkins and Baker (1986), modified by Adenipekun and Oyetunji, (2009) and Ogunkunle *et al*. (2013). Two grams of the fresh leaves were weighed using an electric Metler balance and made into a fine pulp by grinding in a ceramic mortar with 5ml of 80% v/v aqueous acetone. The mixture was extracted with another 20ml of 80% v/v aqueous acetone in dim light and filtered with Whatman No. 1 filter paper. Three ml of filtrate was taken into a cuvette and the absorbance (A) was read in a spectrophotometer at 645, 653 and 663nm. The readings were taken three times for each treatment and the chlorophyll content (mg/l) in each of the samples was calculated using the following equations:

Chlorophyll a (Chl. a) = 12.7(A663) – 2.69(A645)

Chlorophyll b (Chl. b) = 22.9(a645) – 4.68(A653)

Total Chlorophyll (Chl.t) = 20.2(A645) +8.02(A663)

**Data Analysis**

Data generated were subjected to analysis of variance (ANOVA) to show differences among the means and were separated using Duncan's Multiple Range Test (DMRT) at $P<0.05$, and finally the results were carefully tabulated.

## RESULTS

### Plant Height

The result revealed that the plant height of *H. cannabinus* differed within the different level of concentration with 0% (control) level of concentration having the highest height while 25% concentration had the least height (Table 1). Statistically 0% and 5% level of concentration produced significantly higher height at 0.05 level of probability than 10%, 15%, 20% and 25% levels of concentration.

**Table 1:** Plant height (cm) of *Hibiscus cannabinus* treated with cement.

| Cement concentration (%) | 2 WAP | 4 WAP | 6 WAP | 8 WAP | 10 WAP |
|---|---|---|---|---|---|
| Control | $26.20{\pm}0.76^{c}$ | $26.20{\pm}0.75^{d}$ | $34.33{\pm}0.67^{d}$ | $33.20{\pm}3.89^{c}$ | $38.70{\pm}4.34^{c}$ |
| 5 | $14.85{\pm}0.82^{b}$ | $21.17{\pm}1.09^{c}$ | $23.13{\pm}0.67^{c}$ | $24.50{\pm}1.54^{b}$ | $26.73{\pm}1.59^{b}$ |
| 10 | $14.20 \pm 1.55^{a}$ | $17.47{\pm}1.09^{b}$ | $19.57{\pm}0.81^{b}$ | $20.75{\pm}1.15^{ab}$ | $23.73{\pm}2.71^{ab}$ |
| 15 | $13.83{\pm}0.49^{b}$ | $14.83{\pm}0.85^{ab}$ | $16.67{\pm}1.24^{ab}$ | $17.50{\pm}o.98^{a}$ | $19.77{\pm}1.32^{ab}$ |
| 20 | $12.83{\pm}058^{b}$ | $14.83{\pm}0.58^{ab}$ | $16.46{\pm}0.75^{ab}$ | $17.60{\pm}0.55^{a}$ | $18.33{\pm}0.67^{a}$ |
| 25 | $12.13{\pm}1.44^{b}$ | $13.13{\pm}1.44^{a}$ | $15.33{\pm}1.29^{a}$ | $15.87{\pm}1.38^{a}$ | $17.43{\pm}2.05^{a}$ |

Means with same letters superscripts along the same column are not significantly different at $p<0.05$. **WAP**- Weeks After Planting

### Stem girth

This investigation showed that the highest stem girth in *H. cannabinus* was recorded in plant grown without the cement dust (control) while the plant with 25% level of concentration has the least stem girth. Statistically there is higher significant difference in 0% concentration than 5%, 10%, 15%, 20% and 25% level of concentration at 0.05 level of probability (Table 2).

**Table 2:** Stem girth (mm) of *Hibiscus cannabinus* and treated with cement dust

| Species | Cement concentration (%) | 2WAP | 4WAP | 6WAP | 8WAP | 10WAP |
|---|---|---|---|---|---|---|
| *Hibiscus cannabinus* | Control | $2.29 \pm 0.05^{c}$ | $2.29 \pm 0.05^{c}$ | $3.12 \pm 0.04^{a}$ | $2.45 \pm 0.03^{c}$ | $3.43 \pm 0.15^{c}$ |
| | 5 | $1.38 \pm 0.10^{a}$ | $2.17 \pm 0.03^{ab}$ | $2.14 \pm 0.06^{a}$ | $2.21 \pm 0.08^{a}$ | $2.37 \pm 0.12^{b}$ |
| | 10 | $1.34 \pm 0.02^{a}$ | $2.03 \pm 0.16^{abc}$ | $2.07 \pm 0.07^{a}$ | $2.09 \pm 0.01^{a}$ | $2.35 \pm 0.00^{b}$ |
| | 15 | $1.88 \pm 0.05^{c}$ | $1.97 \pm 0.05^{bc}$ | $2.00 \pm 0.12^{a}$ | $2.09 \pm 0.11^{a}$ | $2.08 \pm 0.10^{b}$ |
| | 20 | $1.77 \pm 0.12^{b}$ | $1.77 \pm 0.12^{a}$ | $1.70 \pm 0.07^{a}$ | $2.07 \pm 0.08^{a}$ | $1.77 \pm 0.17^{a}$ |
| | 25 | $1.52 \pm 0.06^{b}$ | $1.62 \pm 0.06^{ab}$ | $1.50 \pm 0.12^{c}$ | $2.00 \pm 0.05^{a}$ | $1.56 \pm 0.10^{a}$ |

Means with same letters superscripts along the same column are not significantly different at $P<0.05$

### Leaf length

The result at 2,4,6,8 and 10 WAP (weeks after planting) showed that plant height differed within the different level of concentration with 0% (control) level of concentration having the highest height while (25% concentration) had the least height. Statistically 0% level of concentration produced significantly higher height at 0.05 level of probability than 5%, 10%, 15%, 20% and 25% level of concentration (Table 3).

### Leaf area

The result at 2,4,6,8 and 10 WAP (weeks after planting) showed that leaf area differed within the different level of concentration with 0% level of concentration having the highest height while (25% concentration) had the least height (Table 4). Statistically, 0% level of concentration produced significantly higher height at 0.05 level of probability than 5%, 10%, 15%, 20% and 25% concentration. Whereae, Figure 2 and 3 present the chrorophyll content and number of leaves of *Hibiscus cannabinus* treated with cement at 10WAP. Figure 4 if the fresh and dry weight of shoots of *Hibiscus cannabinus* treated with cement at 10WAP, while Figure 5 is the result of fresh and dry weight of roots of *Hibiscus cannabinus* treated with cement at 10WAP.

**Table 3:** Leaf length (cm) of *Hibiscus cannabinus* and treated with cement.

| Samples | Cement concentration (%) | 2WAP | 4WAP | 6WAP | 8WAP | 10WAP |
|---|---|---|---|---|---|---|
| *Hibiscus cannabinus* | Control | $3.67 \pm 0.22^{c}$ | $3.84 \pm 2.22^{c}$ | $4.67 \pm 0.27^{b}$ | $4.63 \pm 0.40^{b}$ | $5.13 \pm 0.67^{c}$ |
| | 5 | $3.00 \pm 0.23^{a}$ | $3.70 \pm 0,15^{c}$ | $3.67 \pm 0.09^{a}$ | $3.70 \pm 0.17^{a}$ | $3.97 \pm 0.03^{ab}$ |
| | 10 | $3.10 \pm 0.15^{b}$ | $3.70 \pm 0.22^{c}$ | $3.63 \pm 0.43^{a}$ | $3.23 \pm 0.25^{a}$ | $3.43 \pm 0.81^{b}$ |
| | 15 | $3.00 \pm 0.12^{bc}$ | $3.10 \pm 0.12^{bc}$ | $3.33 \pm 0.31^{a}$ | $3.13 \pm 0.19^{a}$ | $2.70 \pm 0.17^{ab}$ |
| | 20 | $2.70 \pm 0.10^{bc}$ | $3.00 \pm 0.10^{bc}$ | $2.83 \pm 0.31^{a}$ | $3.20 \pm 0.15^{a}$ | $2.26 \pm 0.15^{ab}$ |
| | 25 | $1.90 \pm 0.35^{b}$ | $2.70 \pm 0.35^{b}$ | $2.43 \pm 0.18^{a}$ | $2.11 \pm 0.07^{a}$ | $2.13 \pm 0.27^{a}$ |

Means with same letters superscripts along the same column are not significantly different at $P<0.05$

**Table 4:** Leaf area (cm) of *Hibiscus cannabinus* treated with cement dust pollution

| Species | Cement concentration (%) | 2 WAP | 4 WAP | 6 WAP | 8 WAP | 10 WAP |
|---|---|---|---|---|---|---|
| *Hibiscus cannabinus* | Control | $2.17 \pm 0.29^{c}$ | $2.43 \pm 0.03^{b}$ | $2.78 \pm 0.21^{b}$ | $3.34 \pm 0.34^{b}$ | $3.25 \pm 0.10^{c}$ |
| | 5 | $1.74 \pm 0.26^{b}$ | $2.67 \pm 0.03^{b}$ | $2.57 \pm 0.37^{a}$ | $3.00 \pm 1.00^{a}$ | $2.73 \pm 0.10^{ab}$ |
| | 10 | $1.82 \pm 0.18^{a}$ | $2.69 \pm 0.23^{b}$ | $3.21 \pm 0.31^{a}$ | $2.09 \pm 0.35$a | $2.30 \pm 0.178^{b}$ |
| | 15 | $1.97 \pm 0.30^{bc}$ | $2.80 \pm 0.27^{ab}$ | $2.48 \pm 0.33^{a}$ | $3.17 \pm 0.44^{a}$ | $1.99 \pm 0.08^{ab}$ |
| | 20 | $2.07 \pm 0.12^{bc}$ | $2.27 \pm 0.19^{ab}$ | $2.37 \pm 0.08^{a}$ | $2.19 \pm 0.43^{a}$ | $1.99 \pm 0.32^{ab}$ |
| | 25 | $1.95 \pm 0.07^{b}$ | $2.56 \pm 0.17^{a}$ | $2.76 \pm 0.09^{a}$ | $2.52 \pm 0.20^{a}$ | $1.20 \pm 0.06^{a}$ |

Means with same letters superscripts along the same column are not significantly different at $P<0.05$

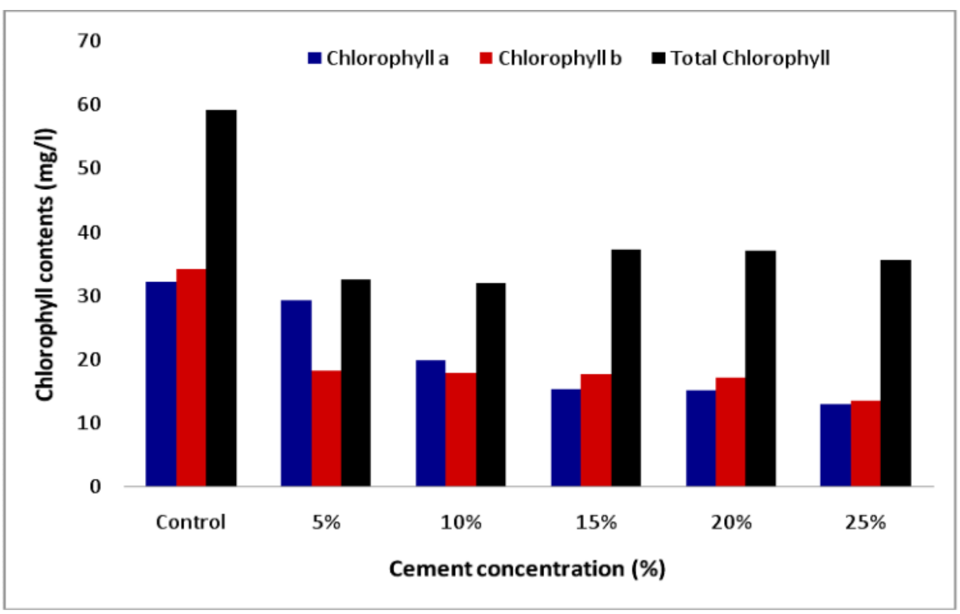


**Figure 2:** Chlorophyll contents (mg/l) of *Hibiscus cannabinus*

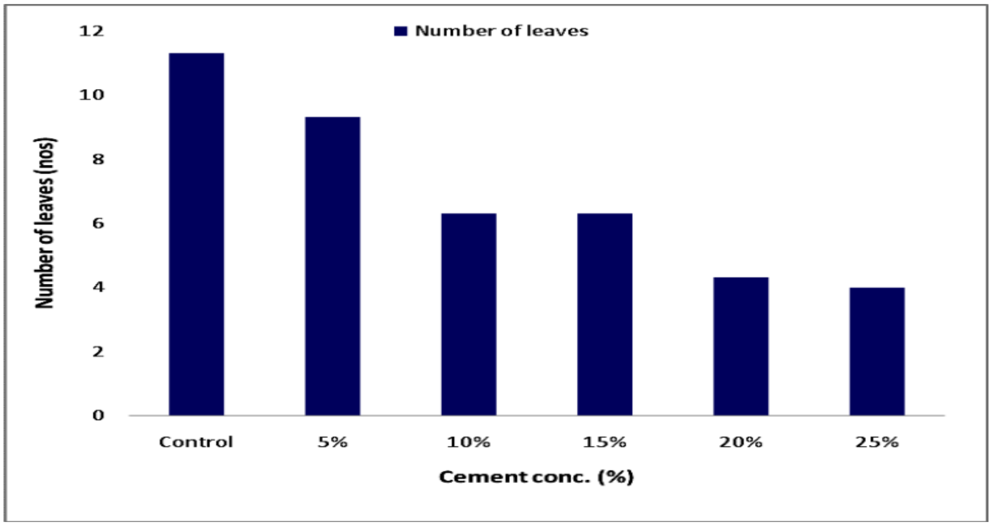


**Figure 3:** Number of leaves of *Hibiscus cannabinus* treated with cement at 10WAP

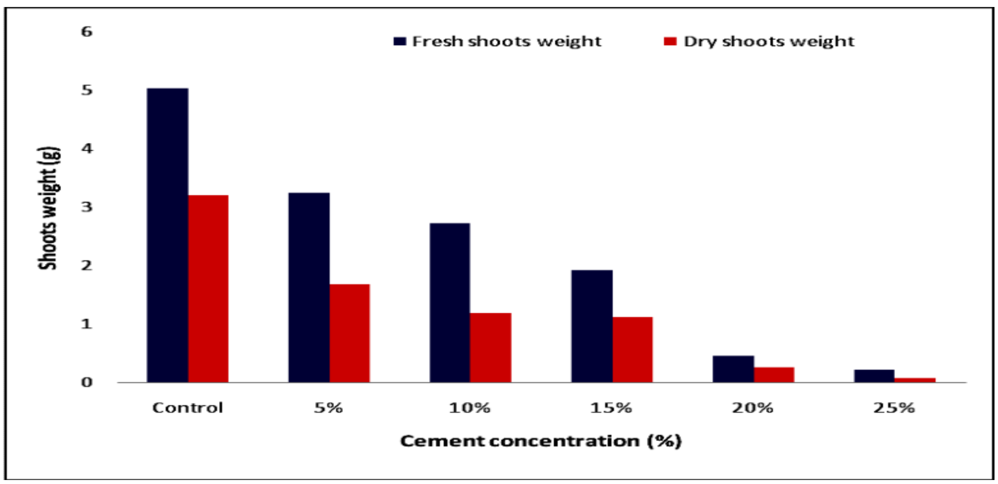


**Figure 4:** Fresh and dry weight of shoots of *Hibiscus cannabinus* treated with cement at 10WAP

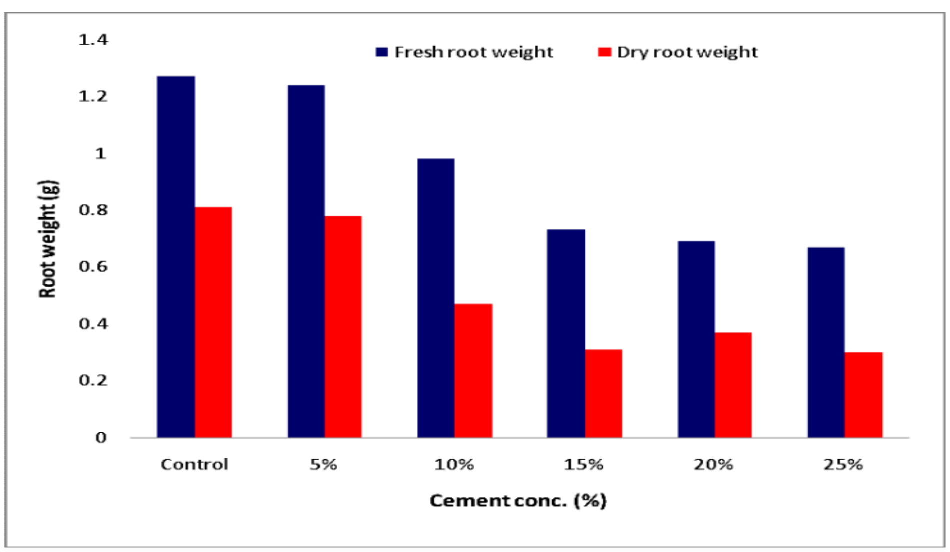


**Figure 5**: Fresh and dry weight of roots of *Hibiscus cannabinus* treated with cement at 10WAP

## DISCUSSION

The cement industry is an energy intensive and significant contributor to climate change. The major environment health and safety issues associated with cement production are emissions to air and energy use. Cement manufacturing requires huge amount of non-renewable resources like raw material and fossil fuels. It is estimated that 5-6% of all carbon (IV) oxide greenhouse gases generated by human activities originates from cement production (Potgieter, 2012). Raw material and Energy consumption result in emissions to air which include dust and gases. The exhaust gases from a cement kiln contains nitrogen oxide (NO), carbon dioxide, water, oxygen and small quantities of dust, chlorides, fluorides, sulfur dioxide, carbon monoxide (Marlowe and Mansfield, 2002); and it is a known fact that these pollutants are hazardous to the environment and human health. Due to infrastructural and other developmental activities, cement industry is flourishing and resulting in the environmental deterioration and in turn degradation of the human health worldwide. The gaseous and particulate emissions from cement plants are degrading air quality and thus creating considerable environmental pollution especially air pollution (Syed *et al*., 2013). Recent studies and researches have listed the cement industry as one of the major contributors in global warming and climate change.

Reduction in seedling growth with increasing concentrations of cement dust solution has also been observed by Singh (2000). On the basis of this study, it could be concluded that growth of plants was found to be more affected by cement dust, which might be due to the presence of different toxic pollutants in cement dust. The morphological behavior of *Hibiscus cannabinus* was found to be highly affected with respect to high concentration of the cement dust. It is clear that the cement dust pollution is an operative ecological factor causing deteriorations in the quality of our environment (Rashid *et al*., 1989); and in this study, we identified that the cement dust pollution had significant effect on the growth and chlorophyll content of the plant, especially at higher concentration (25%).

## CONCLUSION

The present study has clearly revealed the impact of cement dust on the growth of *H. cannabinus*. Given the significant reduction in the chlorophyll content and morphological parameters as the concentration of the pollutant increases, we suggest that *H. cannabinus* should not be cultivated around cement industrial units, especially in areas with high concentrations.

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