
ABSTRACT

The study aimed to evaluate the seasonal variation in dust accumulation on leaves and leaf pigment content of leaves of two tree species viz; *Cassia fistula* and *Eucalyptus globulus* growing in the vicinity of Jaypee cement plant Rewa (M.P.). The impact of cement dust was observed via biochemical attributes (chlorophyll contents) from leaves of *Cassia fistula* and *Eucalyptus globulus*. The result showed maximum dust deposition in winter followed by summer and rainy for both plant species. It was seen that total chlorophyll decreased with the increasing dust load of selected cement dusted plant species and compared with non-dusted plant species. The result shows significant correlation (negative) between dust load and pigment content in all three seasons. Thus plants can be used in the subsiding of cement dust pollution by acting as natural filters.

Keywords: Cement dust, Chlorophyll, Seasonal variation, Dust accumulation and Leaf pigment.

I. INTRODUCTION

With the industrial revolution along with population explosion and uncontrolled urbanization has added various types of impurities to natural environment and deteriorated the environmental quality. Environmental pollution is a global challenge or one of the most important environmental problems of the present times as it is a cause of threat to life of mankind and varied ecosystems. Cement industry is recognized as one of the most important industries besides steel and power, and its consumption pattern reflects the economic development of any nation. Cement is the most widely used building material throughout the world. The cement manufacturing process involves taking raw materials viz. limestone, iron-ore and clay, grinding and mixing them in proportion so that after mild-heating it drives off water and carbon dioxide present in the limestone. This is then heated at a very high temperature to form clinker. The clinker is cooled and then ground with gypsum and other adhesive to form cement.

From the point of view of air pollution, the cement, all over the world, is placed in a unique and somewhat contradictory situation. Investigated changes in biochemical contents in *Cassia occidentalis* in response to automobile pollution and observed critical reduction in chlorophyll a, chlorophyll b and total chlorophyll substance (Kumari and Prakash, 2014). Photosynthetic pigments were quantified and a reduction in the photosynthetic pigments of plant leaves growing in higher polluted site as compared to none or less polluted ones was recorded (Giri et al; 2013). Verma and Chandra, 2015 found that chlorophyll measurement is an important tool to evaluate the effects of air pollutants on plants as it plays an important role in the metabolism of plants and reduction in the photosynthetic pigments corresponds directly to plant growth.

Present research work was undertaken to study the impact of leaf dust deposition on chlorophyll content of two tree species viz; *Cassia fistula* and *Eucalyptus globulus* growing in the vicinity of Jaypee Cement Plant, Rewa (M.P.) and to evaluate the relationship between dust deposition and chlorophyll content of leaves.

II. MATERIALS AND METHODS

Selection of Site-The campus of Jaypee Cement Plant, Rewa (M.P.) was selected as polluted site for the present study. The cement plant (JRP) is located about 15 km from Rewa city.

Selection and sample collection of plant- Two common tree species viz. *Cassia fistula* and *Eucalyptus globulus* growing in the vicinity of JP Cement plant, Rewa and APS University campus as control site were



selected for the study during November 2017 to July 2018 for their dust deposition and Chlorophyll estimation of leaves.

Dust load deposition: - For the estimation of dust load and total leaf area 10 leaves were taken from each tree species. These leaf samples were washed in pre weighed empty petri plates containing 50ml of distilled water with the help of brush & forceps. The amount of dust was calculated by taking the initial and final weight of petri plates in which the leaf samples were washed. Dust load was calculated by using the formula –

$$\text{Dust content (mg/cm}^2\text{)} = \frac{W_2 - W_1}{A}$$

Where, W_1 = Weight of petridish without dust

W_2 = Weight of petridish with dust

A = Total area of leaf in cm^2

Extraction of chlorophyll–This was done according to the method described by Arnon, 1949. One gram of fresh leaves were blended and then extracted with 20 – 40 ml of 80% acetone and left for 15 minutes. The liquid portion was taken into another tubes and was then centrifuged at 5000 – 10000 rpm for 5 minutes. The supernatant of the sample was transferred and the absorbance was then taken at 645 nm and 663 nm using a spectrophotometer. The absorbance at 645nm and 663nm against the solvent (acetone) blank was also taken.

Estimation of chlorophyll content: - The concentrations of chlorophyll ‘a’, chlorophyll ‘b’ and total chlorophyll were calculated using the following equation:

Chlorophyll ‘a’ : $12.7(A_{663}) - 2.69(A_{645})$

Chlorophyll ‘b’ : $22.9(A_{645}) - 4.68(A_{663})$

Total Chlorophyll : $20.2(A_{645}) + 8.02(A_{663})$

III. RESULTS

The present study was conducted to assess the impact of cement dust deposition and Chlorophyll estimation of leaves of two selected tree species viz., *Cassia fistula* and *Eucalyptus globulus* growing under ambient field conditions at various sites located at different distances from the cement kiln of Jaypee Cement plant, Rewa (M.P.). Similar observations were also made for the respective tree species growing in the campus of A.P.S University, Rewa, a control site.

The results of dust deposition on the leaves of two tree species under study, growing at polluted and controlled sites during analysis are summarized in figure 1 and figure 2. It was observed both the tree species showed higher dust deposition in winter followed by summer and lowest in rainy season. The average seasonal dust accumulation in two tree species under study is presented in Table 1. It shows *Cassia fistula* ($0.382 \pm 0.160 \text{ mg/cm}^2$) to have maximum and *Eucalyptus globulus* ($0.266 \pm 0.130 \text{ mg/cm}^2$) to have minimum dust accumulation. Figure (1-2) shows that dust fall on the leaves of tree species growing in polluted sites was high compared to those growing in the control site in all the seasons. Seasonal variation in the chlorophyll pigments i.e. total chlorophyll, chlorophyll ‘a’ and chlorophyll ‘b’ in the leaves *Cassia fistula* and *Eucalyptus globulus* are presented in Table 2 and 3. The results showed that both the tree species exhibited maximum pigment contents during rainy season followed by summer and winter season. In general in all plants chlorophyll a is present in the highest quantity more than chlorophyll b.

The present investigation showed changes in the levels of total chlorophyll content in the trees exposed to atmospheric dust fall. In both tree species chlorophyll a, chlorophyll b, and total chlorophyll, were lower in exposed leaves than in control leaves in all seasons. Maximum concentration of chlorophyll pigments was found in *Eucalyptus globulus* (37.016 mg/g) and minimum in *Cassia fistula* (18.206 mg/g) in rainy season at polluted site.

The Pearson correlation coefficient (r) values of dust deposit with total chlorophyll content in polluted and controlled site are presented in Table 4. The table shows significant negative correlations between dust load and pigment content i.e. -0.90928 at polluted site and -0.99037 at controlled site for *Cassia fistula*. Similarly; -0.99998 at polluted site and -0.99933 at controlled site for *Eucalyptus globulus*.

Figure 1 Seasonal Variation of Dust Accumulation(mg/cm²) in *Cassia fistula*

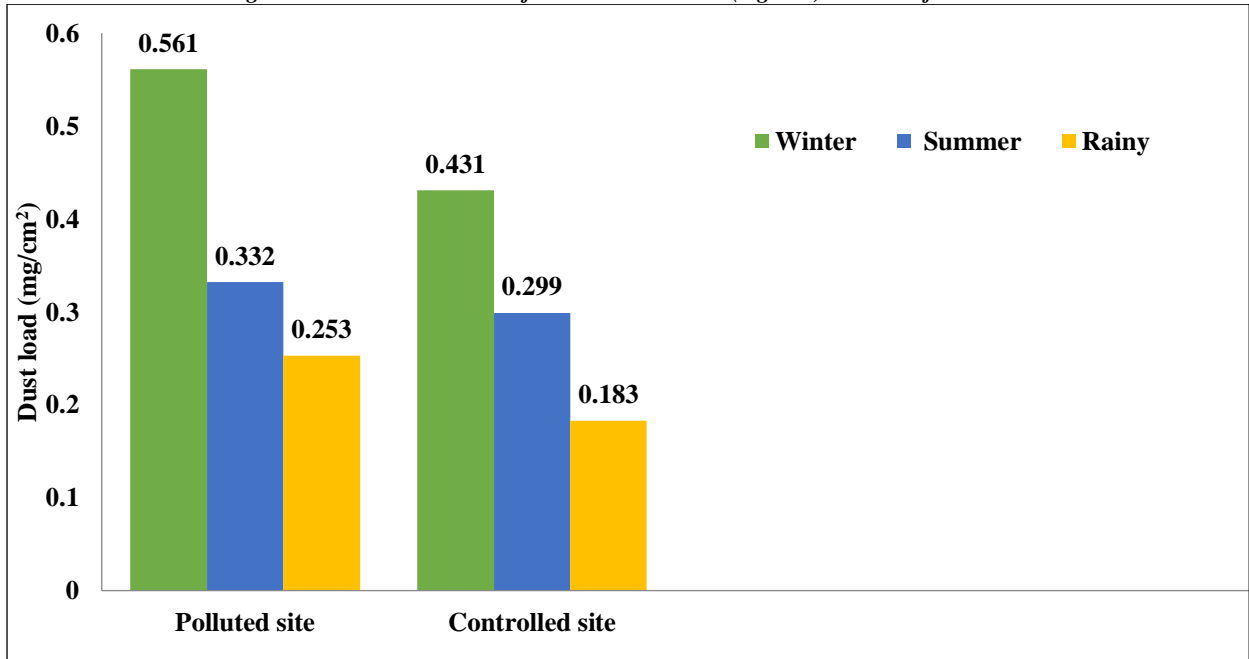


Figure 2 Seasonal Variation of Dust Accumulation (mg/cm²) in *Eucalyptus globulus*

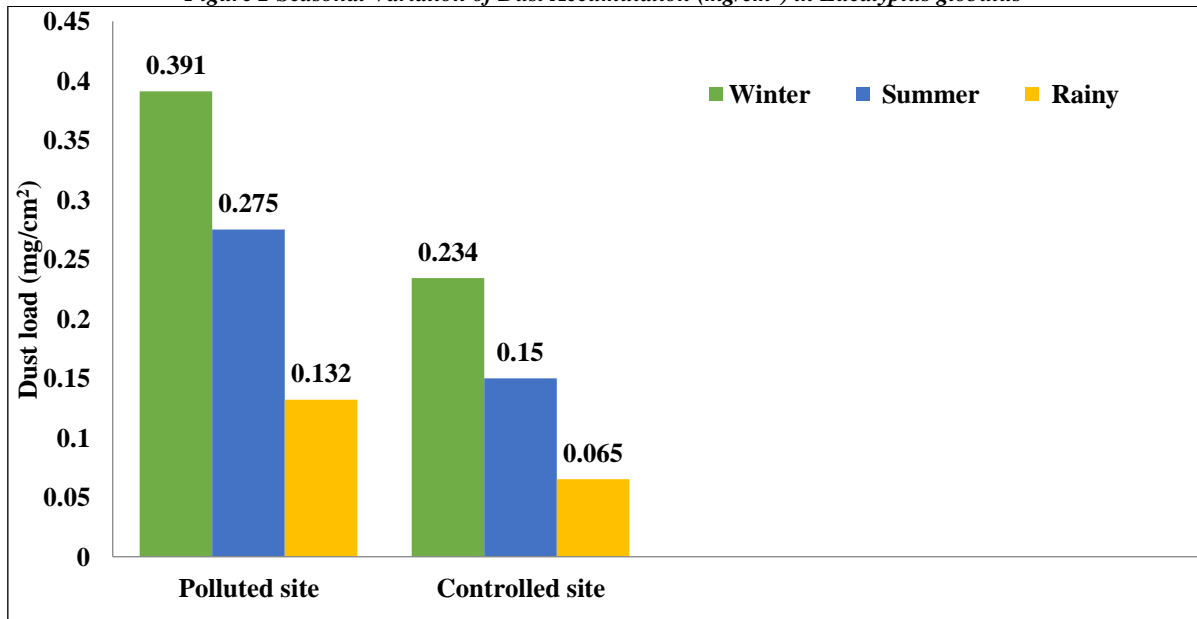


Table-1 Seasonal Average of Dust Accumulation (mg/cm²) in selected Tree species under study

Tree Species	Dust Deposited (mg/cm ² leaf area)	
	Polluted	Controlled
<i>Cassia fistula</i>	0.382 ± 0.160	0.304 ± 0.124
<i>Eucalyptus globulus</i>	0.266 ± 0.130	0.150 ± 0.085

Table-2 Seasonal contents of Chlorophyll 'a', 'b', total Chlorophyll(mg/g) in leaves of *Cassia fistula* growing at polluted and controlled sites

Seasons Sites	Winter			Summer			Rainy		
	Chl 'a'	Chl 'b'	TC	Chl 'a'	Chl 'b'	TC	Chl 'a'	Chl 'b'	TC
Polluted	8.232	1.521	9.753	10.421	2.598	13.019	13.849	4.361	18.206
Controlled	9.213	5.341	14.554	20.605	8.212	28.817	24.221	12.148	36.359

Table-3 Seasonal contents of Chlorophyll 'a', 'b', total Chlorophyll (mg/g) in leaves of *Eucalyptus globulus* growing at polluted and controlled sites

Seasons Sites	Winter			Summer			Rainy		
	Chl 'a'	Chl 'b'	TC	Chl 'a'	Chl 'b'	TC	Chl 'a'	Chl 'b'	TC
Polluted	15.018	9.322	24.34	18.322	11.623	29.945	22.413	14.613	37.016
Controlled	10.232	25.113	35.345	15.421	29.231	44.652	19.383	33.585	52.950

Chl 'a' - Chlorophyll a
Chl 'b' - Chlorophyll b
TC - Total Chlorophyll

Table- 4 Correlation of dust load with total chlorophyll content (r) in selected tree species

Name of Species	Polluted Site	Controlled Site
<i>Cassia fistula</i>	-0.91928	-0.99037
<i>Eucalyptus globulus</i>	-0.99998	-0.99933

IV. DISCUSSION

Cement industry is inherently characterized by particulate air pollution and essentially the dust. The dust is produced during blasting of raw materials, grinding of cement clinker and packaging and loading of finished cement (Gbadebo and Bankole, 2007). The dust produced during various processes are highly alkaline, have wide range of sizes and varied in chemistry. Leaves are sensitive and highly exposed parts of a plant, may act as persistent absorbers in a polluted environment (Maiti, 1993; Samal and Santra, 2002). They act as pollution receptors and reduce dust concentration of the air.

In the present study the variation in dust accumulation in different seasons is quite eminent and plant with short height showed more dust accumulation than taller plants. Generally the pollution load depends upon the emission levels from different sources, the locations and heights of emission sources, and micro-meteorological factors (Mohanraj, 2002). Higher dust accumulation in *Cassia fistula* may also be due to their slightly rough leaf surfaces with depressions in the middle of the leaves; small petioles that reduce movement of leaves in wind and shortness of the plants also must be taken into account. Lower dust accumulation in *Eucalyptus globulus* may be due to the height of the tree, the long petioles that help the leaves to flutter during wind, and the vertical position of the leaves which prevents dust retention. The influence of plant height and leaf characteristics on dust accumulation have also been observed by Vora and Bhatnagar (1986), Somashekar et al. (1999), Singh(2000), Garg et al. (2000), and Singh et al. (2002).

Maximum dust deposition was observed in winter followed by summer and lowest in rainy season in all the tree species. In winter, wet surface of leaves help in dust capturing, preventing particulate dispersion causing maximum dust deposition where as in rainy season, washing of leaves due to rain accounts for least dust accumulation. Chlorophyll measurement is an important tool to evaluate the effects of air pollutants on plants as it plays an important role in plant metabolism and any reduction in chlorophyll content corresponds directly to plant growth (Joshi and Swami, 2009).

Both the tree species exhibited maximum chlorophyll content during rainy season followed by summer and winter season. The variation in chlorophyll content of selected plants may be due to the dust particles. The present study showed significant variation of pigment (total chlorophyll, chlorophyll a and chlorophyll b), content from species to species and season to season in the plants exposed to polluted sites. It is evident from the present investigation that chlorophyll content showed variable responses to dust. Decrease in total chlorophyll

content in the exposed leaves compared to that of the control leaf may be attributed to the alkaline condition developed by solubilization of chemicals present in the dust particulates in cell sap which is responsible for chlorophyll degradation. The reduction in chlorophyll might be due to inhibition of enzymes essential for chlorophyll biosynthesis by the interference of dust particles (Vijaywargiya and Pandey, 1996). Similar results demonstrating that the total chlorophyll content of polluted leaves was lower than that of control leaves were also reported by Somashekar *et al.* (1999), Mandal and Mukherji (2000), Samal and Santra (2002), and Singh (2000). Katiyar and Dubey (2000) observed a similar type of response in some crop plants.

The reduction in chlorophyll content during winter season may be due to maximum dust accumulation on the leaf surface and its interference with incident light intensity, leading to a reduction in net photosynthesis. The highest chlorophyll content of leaf may be due to least dust accumulation during rainy season.

Correlation of dust load with Total Chlorophyll Content is shown in table-4. The Total Chlorophyll Content showed significant negative correlation with dust load. Prajapati and Tripathi (2008 a and 2008 b) also concluded that dust capturing and its deposition in different plant species not only depends upon the sources and amount of pollutants in the environment but also depends on morphological characters of plants like leaf size, texture, hair, length of petiole and weather condition and wind direction.

V. CONCLUSION

The research presented in this work revealed that the cement industry is one of the highly polluting industry that is mainly harmful for air environment. The deposition of cement dust on plant leaves varies with the morphology of leaves, with the height and canopy structure of trees, and with the location and height of emission sources. Smaller plants with short petioles and rough leaf surfaces accumulate more dust than larger plants with long petioles and smoother leaf surfaces. The cement dust had a significant effect on the photosynthetic pigments such as Chlorophyll 'a', Chlorophyll 'b' and total chlorophyll. The results showed that cement dust pollution significantly reduced the photosynthetic pigments.

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