



LEAF DUST ACCUMULATION AND ITS IMPACT ON CHLOROPHYLL CONTENT OF *AZADIRACHTA INDICA* AND *BAUHINIA VARIEGATA* DEVELOPING IN THE PROXIMITY OF JAYPEE CEMENT PLANT, REWA (M.P.), INDIA

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Abstract: Foliar surface of plant is continuously exposed to the surrounding atmosphere and is the main receptor of dust. Dust affects the photosynthesis, respiration, transpiration and allows the penetration of phytotoxic gaseous pollutants. The present exploration was undertaken to study the seasonal variation in dust deposition on leaves and its impact on chlorophyll content of two common tree species namely *Azadirachta indica* and *Bauhinia variegata*. This research was conducted during March 2019 to February 2020 on both these plant species in the region of JP cement plant. Authors found that cement dust had a significant effect on the photosynthetic pigments such as chlorophyll 'a', chlorophyll 'b' and total chlorophyll content. Maximum dust deposition occurred during winter followed by summer and rainy season in both plant species. The authors reported a significant negative correlation between dust load and chlorophyll content in all the three seasons. *Azadirachta indica* showed more dust deposition rates in comparison to *Bauhinia variegata*. Thus, plants can be used in the abatement of dust pollution as they act as natural filters.

Keywords: Air pollution, Cement dust, Chlorophyll, Seasonal variation.

INTRODUCTION

Air pollution is a big problem generated due to anthropogenic activities mainly arising from industrialization, unplanned urbanization, alarming increase in vehicle fleet, electronic wastes and population growth (Gupta and Mishra, 1994; Verma and Prakash, 2020). The cement industry plays a major role in creating the environmental imbalance and produces air pollution hazards. In cement manufacturing, grinding and mixing of raw materials is taken place followed by mild heating with water and CO₂ present in the limestone. After that, it is heated at a very high temperature to form clinker. The clinker is cooled and then ground with gypsum and other adhesive to form cement. In India, 40% of the total pollution problem is

caused by dust pollution (Khan *et al.*, 1989). Pollutants which are created and realized through automobiles and industries deteriorates the quality of air, they affect the photosynthetic process (Nirbhay, 2017).

The pollutants of the cement industry produce the adverse impact not only on air, but also water and land. Cement industry is one of the 17th most polluting industries listed by central Pollution Control Board, New Delhi. Since 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 and roads. Cement dust is consider to be one of the most hazardous dusts of industrial origin because it

does not only form crusts but also reacts with atmospheric moisture; thus it is chemically active (Boudaghpour and Jadidi, 2009).

Green plants have always played an important role to determine the status of the environment. Many green plants act as an environmental indicator (Joshi *et al.*, 1997). Kabir and Madugu (2010) found that dust pollution is an important factor near roads, quarries, cement works and other industrial areas. According to Shah *et al.* (2020), chronic exposure to cement dust induced novel damage in plant leaves, which affects the foliar surfaces of leaves. These undesirable effluents changed cellular morphology and modulated the biochemical constituent and pigment content of leaves, resulting in massive damage owing to the persistent presence of the pollutants. Chlorophyll measurement is an important tool to evaluate the effects of air pollutants on plants as it plays a major role in plant metabolism and any reduction in chlorophyll content directly affects the plant growth (Joshi and Swami, 2009).

Tajudeen and Joy (2011) highlighted the hazardous of prolonged exposure to cement dust and underscore the need for urgent action for the protection of animals and plants. Cement dust contains heavy metals like nickel, cobalt lead, chromium and pollutants hazardous to the biotic environment and disturbs the ecological balance, which is necessary for flourished flora, fauna and human survival (Baby *et al.*, 2008; Ashok, 2017; Ashok, 2018).

The Vindhya region of Madhya Pradesh (M.P.), India is well known for its thick deposits of lime stone and coal. This has facilitated the establishment of many mega cement plants in this region. At present 10 mega cement plants are under operation in Rewa, Satna, Katni belt and many are proposed to be established in near future. The effects of cement dust on *Azadirachta indica* and *Bauhinia variegata* are yet not properly explored. Therefore authors attempted to explore the impact of leaf dust deposition on chlorophyll content of these two tree species in the area of JP Cement Plant, Rewa (M.P.) and to evaluate the relationship between dust

deposition and chlorophyll content of leaves during March 2019 to February 2020.

MATERIALS AND METHODS

Study Site: JP Cement Plant campus of Rewa (M.P.) was selected for exploration. It is located near about 15 km from Rewa city and is one of the biggest cement factories in India.

Sample collection: Leaves of *Azadirachta indica* and *Bauhinia variegata* growing in the area of JP Cement Plant, Rewa and APS University, Rewa campus as control site, were plucked carefully and kept in separate polythene bags for the study.

Dust load accumulation: Ten leaves were taken from both tree species for the estimation of dust load and total leaf area. These leaf samples were washed in petridish containing 50 ml of distilled water with the help of brushes and forceps. The amount of dust was calculated by taking the initial and final weight of petridish in which the leaf samples were washed. Dust load was calculated by using this formula:

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

Where, W_1 = weight of petridish without dust,

W_2 = weight of petridish with dust,

A = Total area of leaf in cm^2

For the calculation of total leaf area, following method is used:

$$\text{Total leaf area} = L_1 + L_2 + L_3 + \dots + L_n \text{ cm}^2$$

The surface area of sampled leaves were calculated in cm^2 by putting all washed leaves on graph paper and counted the entire book covered by one leaf. After getting the total surface area of all leaves, average surface area can be calculated.

$$\text{Average leaf surface area (cm}^2\text{)} = \frac{L_1 + L_2 + L_3 + \dots + L_n}{N}$$

Extraction of Chlorophyll: Chlorophyll extraction was done as per method of Arnon (1949). One gram of finely cut fresh leaves was taken and ground with 20-40 ml of 80% acetone. It was then centrifuged at 5000-10000 rpm for 5

minutes. The supernatant was transferred and the procedure was repeated till the residue becomes colorless. The absorbance of solution was read at 645 nm and 663 nm against the solvent (acetone) blank.

Estimation of chlorophyll content: The estimation of concentration of chlorophyll 'a', chlorophyll 'b' and total chlorophyll were done by using equations:

$$\text{Chlorophyll 'a'} : 12.7(A_{663}) - 2.69(A_{645})$$

$$\text{Chlorophyll 'b'} : 22.9(A_{645}) - 4.68(A_{663})$$

$$\text{Total chlorophyll} : 20.2(A_{645}) + 8.02(A_{663})$$

RESULTS AND DISCUSSION

The result 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 that both the tree species showed higher dust deposition in winter followed by summer and lowest in rainy season. The dust accumulation was noticed higher in *Azadirachta indica* ($0.585 \pm 0.281 \text{ mg/cm}^2$) and lower in *Bauhinia variegata* ($0.331 \pm 0.176 \text{ mg/cm}^2$). Authors found that the dust fall on the leaves of tree species growing in polluted site was high as compared to those growing in the control site in all the seasons (table 1 and fig. 1 and 2).

Seasonal variation in the chlorophyll pigments *i.e.* chlorophyll 'a', chlorophyll 'b' and total chlorophyll in the leaves of *Azadirachta indica* and *Bauhinia variegata* are presented in table 2 and table 3. The result showed that both the tree

species exhibited maximum pigment contents during rainy season followed by summer and winter. Generally, in all plants chlorophyll 'a' is present in the higher quantity in comparison to chlorophyll 'b'.

The present study showed a clear cut change 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 the seasons. Higher concentration of chlorophyll pigments was found in *Bauhinia variegata* (20.321 mg/g) and lower in *Azadirachta indica* (6.721 mg/g) during 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. It shows significant negative correlations between dust load and pigment content *i.e.* -0.99007 at polluted site and -0.89944 at controlled site for *Azadirachta indica*. Similarly -0.78486 at polluted site and -0.55427 at controlled site for *Bauhinia variegata*. Almost similar finding was obtained by some researchers who concluded that pollution by the cement dust has caused adverse effects on the photosynthetic pigments, the pH of cell sap and soluble sugars (Abdel-Rahman and Ibrahim, 2012).

Foliar surface of plant is continuously exposed to the surrounding atmosphere and is therefore the main receptor of dust (Rai and Panda, 2014). Leaves act as pollution receptors and decrease the dust load of the air. A large number of trees and

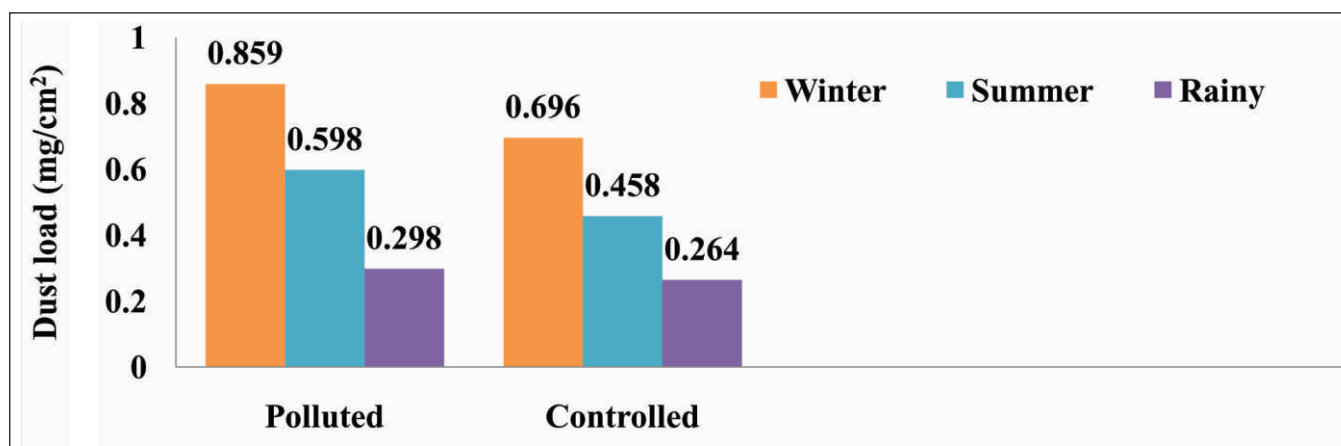


Fig.1: Seasonal variation of dust accumulation (mg/cm^2) in *Azadirachta indica*.

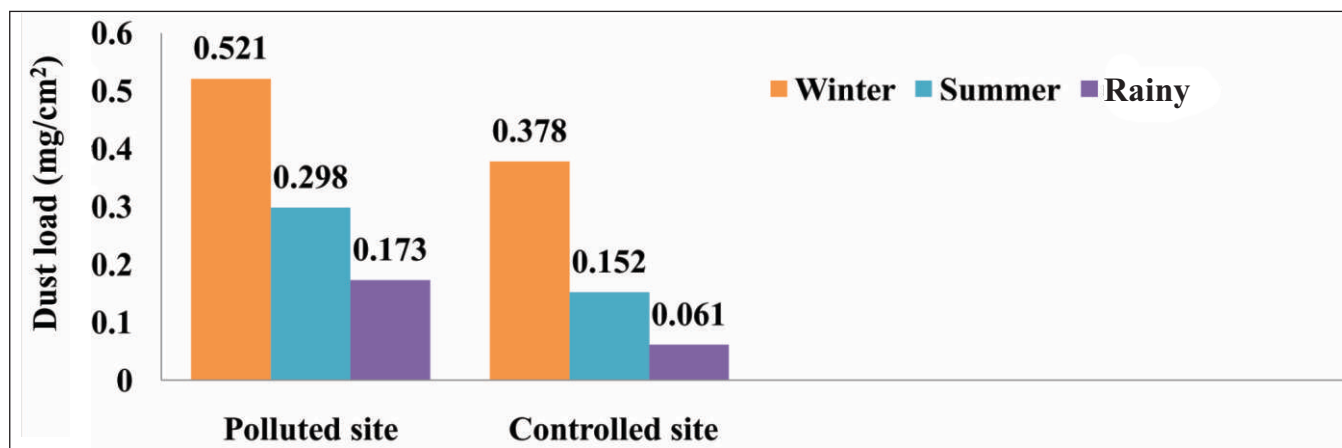


Fig. 2: Seasonal variation of dust accumulation (mg/cm²) in *Bauhinia variegata*.

Table 1: Average Dust Accumulation (mg/cm²) in two tree species under study.

Tree Species	Dust Deposited (mg/cm ² leaf area)	
	Polluted	Controlled
<i>Azadirachta indica</i>	0.585 ± 0.281	0.473 ± 0.216
<i>Bauhinia variegata</i>	0.331 ± 0.176	0.197 ± 0.163

Table 2: Seasonal variation of chlorophyll 'a', 'b' and total chlorophyll (TC) content (mg/g) in leaves of *Azadirachta indica*.

Seasons Sites	Winter			Summer			Rainy		
	Chl 'a'	Chl 'b'	TC	Chl 'a'	Chl 'b'	TC	Chl 'a'	Chl 'b'	TC
Polluted	2.110	1.002	3.112	3.063	1.281	4.344	4.887	1.835	6.721
Controlled	2.740	1.240	3.980	3.334	1.102	4.436	5.412	1.817	7.228

Table 3: Seasonal variation of chlorophyll 'a', 'b' and total chlorophyll (TC) content (mg/g) in leaves of *Bauhinia variegata*.

Seasons Sites	Winter			Summer			Rainy		
	Chl 'a'	Chl 'b'	TC	Chl 'a'	Chl 'b'	TC	Chl 'a'	Chl 'b'	TC
Polluted	7.814	3.114	10.928	10.411	5.001	15.412	12.001	8.320	20.321
Controlled	13.202	1.022	14.224	16.321	3.132	19.453	12.458	6.022	26.474

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

Name of Species	Polluted Site	Controlled Site
<i>Azadirachta indica</i>	-0.99007	-0.89944
<i>Bauhinia variegata</i>	-0.78486	-0.055427

shrubs have been identified and leaf traits can be used as dust filter to check the rising urban dust pollution (Lorenzini *et al.*, 2006).

The variation in dust deposition in different season is well known and plant with short height presented more dust load than taller plants. Higher dust accumulation on *Azadirachta indica* leaves may be due to their rough foliar surfaces with depression 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. This tree is well known for its medicinal properties (Arya, 2019). Lower dust accumulation on *Bauhinia variegata* may be due to medium height of the plants. 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) and Singh *et al.* (2002).

Maximum dust load was noticed in winter season (due to wet surface of leaves that help in dust capturing, preventing particulate dispersion) followed by summer and lowest in rainy season (due to washing of leaves). Dust deposition on leaf surfaces may also reduce the synthesis of chlorophyll 'a' due to a shading effect and photosynthesis (Singh *et al.*, 2002). The decrease of chlorophyll contents occurs in winter season (due to maximum dust accumulation on leaf surface and its interference with incident light intensity leading to reduction in net photosynthesis) while highest chlorophyll content occur in rainy season (due to least dust accumulation).

Dust accumulation 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, weather condition and wind direction (Prajapati and Tripathi, 2006). Thus, it can be concluded that cement industry is one of the highly pollution causing industries and exerts adverse effect on atmosphere, plants, animal as well as human beings.

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