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RESEARCH ARTICLE

LEAF DUST ACCUMULATION AND ITS IMPACT ON CHLOROPHYLL OF THREE TREE SPECIES GROWING IN THE J.P. CEMENT PLANT REGION OF NAUBASTA, REWA (M.P.).

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ABSTRACT

This study determined the dust deposition and its impact on foliar chlorophyll contents of three tree species (*Azadirachta indica, Bauhinia variegata and Bombax ceiba)* growing in the J.P. cement plant region of Naubasta, Rewa (M.P.). Results indicated higher dust load and lower chlorophyll content in the leaves of observed plants at polluted sites, as compared to control site. A negative correlation has been calculated between dust load and chlorophyll contents of leaves sampled from polluted sites. There was marked seasonal variation in the foliar dust accumulation and chlorophyll contents. Leaf samples collected during winter months showed higher accumulation of dust and lower chlorophyll contents as compared to summer and monsoon months leaf samples.

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INTRODUCTION

Plants play significant role in removal of particulate matters from ambient air of industrial as well as urban regions by intercepting and retaining them on their leaf surface. The foliage of plants acts as persistent absorber and filter of air. Leaves of the plants can effectively absorb air particulates (Freer –Smith et al. 1997, Prusty et al. 2006, Nowak et al. 2006, Jamil et al. 2009, Qiu et al. 2009) and reduce air pollution (Nowak et al 2006, Hofman et al. 2014, Lin et al. 2017). The leaf morphology and biochemical characteristics such as ascorbic acid, relative water and chlorophyll contents are influenced by accumulation of dust on plant leaves. There is variation in ability of each plant species to absorb and adsorb pollutants by their foliar surface and depends on several biochemical, physiological and morphological characteristics (Seyyednejad et al. 2011). The leaf tissues are directly injured by cement dusts with PH values of 9 or higher (Vardaka et al. 1995) or indirectly injured through alteration of soil pH (Hope et al. 1991, Auerback et al.1997). The present study was conducted to assess dust accumulation on leaves of three tree species growing in the J.P. cement plant region and to study the correlation between dust load and chlorophyll contents of leaves.

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MATERIALS AND METHODS

This study was conducted in the campus of J.P. cement plant of Naubasta, Rewa (M.P.) which is situated about 15 km away toward north –west direction from Rewa city. The study site is situated at latitude 24^0 -20' N and longitude 81^0 -20' E. Dust deposited fresh leaves of three tree species namely *Azadirachta indica*, Bauhinia variegate and *Bombax ceiba* growing in cement plant region where collected during winter, summer and monsoon months of 2017. Fifteen replicates of nearly equal size leaves from branches of almost similar height of each plant species growing in cement plant region as well as in A.P.S. university campus (as control) were collected and packed in pre-weighted polythene and brought to the laboratory. The dust adhering on the dorsal and ventral surface of leaves was carefully cleaned with the help of fine brush in the same polytehne. Again the weight of polythene was taken with the help of electronic balance in order to determine the amount of dust present on the leaf surface. After cleaning, the leaf area was calculated with the amount of graph paper. Each leaf sample out line was drawn on a graph paper and then the number of squares was counted in cm^2 to obtain the leaf area. The amount of dust deposited on leaf surface in mg/cm^2 was calculated by the following formula (Prajapati and Tripathi 2008).

$$W= (W_2 – W_{1)}/a$$

Where W is dust content (mg/cm$^{2)}$, $w_{1\ is}$ initial weight of polythene, W_2 is final weight of polythene with dust and 'a' is total area of leaf (cm^2).

Estimation of chlorophyll: Chlorophyll extraction was done as per method of Aronon (1994). 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 in to another tube and was then centrifuged at 5000-10000 rpm for 5 minutes. The supernatant of the sample was transferred and the absorbance was taken at 645 nm and 663 nm with the help of spectrophotometer. The absorbance at 645 nm and 663nm against the solvent (acetone) blank was also taken. The concentration of chlorophyll 'a', chlorophyll 'b' and total chlorophyll were calculated using the following equation:

Chlorophyll 'a': 12.7(A663) – 2.69 (A645).
Chlorophyll 'b' : 22.9(A645) – 4.68(A663).
Total chlorophyll : 20.2 (A 645)+ 8.02(A663).

RESULTS AND DISCUSSION

Foliar dust accumulssation varied seasonally on the leaves of three plant species at both polluted and control sites (Table-1). Winter leaf samples of three species accumulated higher dust followed by summer and monsoon leaf samples.

Thus, *Azadirachta indica* leaves accumulated 4 times more dust at polluted site than control site, while *Bauhinia variegata* accumulated 5 times more dust than control site. The plant species *Bombax ceiba* growing at polluted site accumulated 6 times more dust than that of control site. Dust deposition on leaf is influenced by micro-morphology (epidermal and cuticular features, presence /absence of grooves and trichomes, wax coating), orientation (horizontal or vertical), sessile or semi- sessile nature, size and thickness, and folded margins of leaves and height and canopy of plant species (Davison and Blackmore 1976, Garg et al. 2000, Pal et al. 2002, Prusty et al. 2005, Prajapati and Tripathi 2008, Keler et al. 2016, Sharma et al. 2017). Leaf micro-morphology such as groove area and trichomes have direct effect on particulate deposition (Chen et al. 2017). Higher dust accumulation on *Azadirachta indica* leaves may be due to rough foliar surface with depressions in the middle of the leaf and small petiole. Small petiole reduces movement of leaves leading to accumulation of dust. Comparatively lesser accumulation of dust on *Bombax ceiba* leaves may be attributed to smooth surface and thin lamina of leaf. The medium height of *Bauhinia variegata* might be responsible for least accumulation of dust on leaves. A negative correlation has been calculated between dust load and chlorophyll content of leaves of *Azadirachta indica* (r -0.990*), Bauhinia variegata* (r-0.784) and *Bombax ceiba* (r-0.999) growing at polluted sites i.e. higher the dust deposition; lower the leaf chlorophyll content of the plant species.

Table 1. Seasonal dust accumulation (mg/cm2) on the leaves of three tree species growing in J.P. cement plant region (polluted) and control site

Species	Polluted Site			Control Site		
	Winter	Summer	Raining	Winter	Summer	Raining
Azadirechta indica	0.854	0.548	0.290	o.196	0.153	0.069
Bauhinia variegata	0.521	0.298	0.173	0.098	0.052	0.041
Bombax ceiba	0.598	0.365	0.231	0.079	0.063	0.050

Table 2. Seasonal content of chlorophyll 'a','b' and total chlorophyll (mg/g) in leaves of three tree species growing at polluted and controlled sites

Species	Sites	Season								
		Winter			Summer			Monsoon		
		Chl-a	Chl-b	TC	Chl-a	Chl-b	TC	Chl-a	Chl-b	TC
Azadiracta indica	Polluted	2.110	1.002	3.112	3.063	1.102	4.165	4.887	1.815	6.702
	Controlled	2.740	1.240	3.980	3.334	1.281	4.615	5.412	1.837	7.249
Bauhinia variegata	Polluted	7.814	3.114	10.928	10.411	5.001	15.412	12.001	6.320	20.321
	Controlled	13.202	1.022	14.224	16.321	3.132	19.453	20.458	8.022	26.474
Bombax ceiba	Polluted	15.216	3.563	18.779	19.564	5.181	24.745	22.713	7.820	30.526
	Controlled	15.513	6.982	22.495	19.578	9.820	29.398	22.660	12.616	35.267

Chl 'a'-Chlorophyll 'a', Chl 'b'- Chlorophyll 'b' ,TC –Total Chlorophyll. Polluted – J.P. Cement Plant Region, Controlled – University Campus.

The higher dust accumulation in winter months may be due to cool and foggy condition and wet surface of leaves that help in dust capturing, preventing particulate dispersion as suggested by Rai and Panda (2014). Whereas in monsoon month, washing of leaves due to rains might have accounted lower dust accumulation. High wind speed may be the reason for comparatively lower dust deposition on leaves during summer months (Prajapati and Tripathi 2008). Average dust deposition (mg/cm^2) has been determined for tree species growing at polluted and control sites (Fig.1). *Azadirachta indica* leaves accumulated the higher amount of dust as 0.582 mg/cm^2 in J.P. cement plant region followed by *Bombax cieba* (0.398 mg/cm^2) and *Bauhinia variegata* (0.330mg/cm^2). The average foliar dust accumulation at control site was observed as 0.139 mg/cm^2, 0.064 mg/cm^2 and 0.063 mg/cm^2 for *Azadirachta indica*, *Bombax ceiba* and *Bauhinia variegata* respectively.

Leaf samples of plant species growing at polluted and control site were analysed for chlorophyll 'a', chlorophyll 'b' and total chlorophyll contents for three seasons (table-2). Results indicated marked seasonal variation in chlorophyll contents of tree species. Monsoon month's leaves showed higher content of chlorophyll fallowed by summer and winter month's samples at both the sites. The leaf samples of observed plants exhibited reduced contents of chlorophyll 'a', chlorophyll 'b' and total chlorophyll at polluted sites as compared to control ones. Several recent studies have demonstrated that dust accumulation causes degradation in photosynthetic pigments (Singh and Siddiqui 2003, Prajapati and Tripathi 2008, Rai and Panda 2014, Singh and Pal 2017, Singh et al. 2018, Walia et al. 2019). Prajapati and Tripathi 2008) have suggested that dust particles might be having various metals and polycyclic hydrocarbons, inhibiting the enzymes necessary for

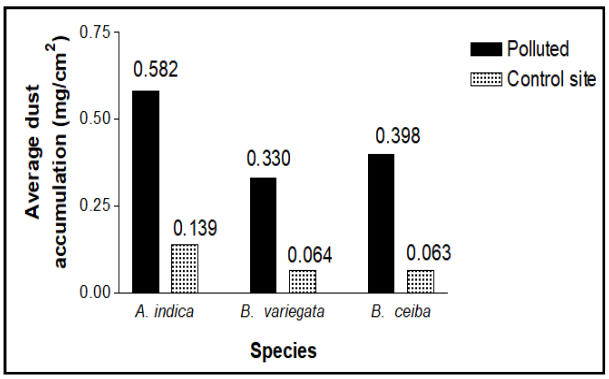

Fig. 1. Average dust accumulation (mg/cm2) on the leaves of tree species in polluted and control site

synthesizing chlorophyll. Gunamani et al. (1991) are of the opinion that alkaline conditions prevailing due to solubility of dust particulate in the cell sap are responsible for chlorophyll degradation.

Conclusion

This study concludes that plant species are reducing the particulate loads of ambient air in the J.P. cement plant region by intercepting and accumulating them on their foliar surface. This study also indicates that particulate matters of ambient air in the region are adversely affecting the plant species. The accumulated dust on foliar surface appeared to be responsible for degradation of chlorophyll, a photosynthetic pigment.

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