Dust Arresting Capacity and its Impact on Physiological Parameter of the Plants

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Abstract: ***Air borne dust particles represent a complex mixture of organic and inorganic substances of varying shape and size seems to be a very serious problem in respect to organism and plant health. Sources of dust pollution include agriculture related activities, power plants, cement factories, etc. Vegetation is considered as a sink and abatement measures for both particulates and gaseous pollutants. Dust arresting capability of plants depends on their range of characteristics which include outside geometry, phyllotaxy and leaf attributes (cuticle and pubescence of leaves), tallness and canopy of plants. Leaves characteristics like surface, epicuticular wax, cuticle, epidermis, size of stomata and stomatal density are the most important factors controlling the amount of captured dust. But dust capturing capacity of leaves make it more prone to various physiological losses.***

Various studies have reported a serious setback in plant physiology due to the effect of dust load. Dust particles are reported to be absorbed through the outer surface of the plants showing some common effects such as chlorophyll degradation, necrosis, and reduction in photosynthesis and decline in growth. Small size particles had greater shading effect than larger particle. Dust deposition may vary with season, different plant species and source of pollution. This study aims to investigate the dust load and its physical effects of dust accumulation on leaf physiology parameter, as a way to better understand the impact of dust on plant.

Keywords: Dust, Chlorophyll, Carotenoids, Stomata

1. INTRODUCTION

Atmospheric deposition is an important mechanism controlling the fate of toxic airborne pollutants and their transfer from the atmosphere to the natural surfaces. Vegetation cover is first available surface for most atmospheric pollutants as they are deposited on terrestrial ecosystems. Plants take up gaseous pollutants through their stomata and intercept particulate matter with their leaves. Plants as monitor of air pollution has long been reputable, as plants are the first interceptors of air pollutants.Dust particles can be absorbed into the tree, though most particles that are intercepted are retained on the leaf surface [7]. Dust interception capacity of leaves depends on their surface

geometry, phyllotaxy, leaf external characteristics (such as hairs, cuticle, etc.), and height and canopy of trees. Leaf orientation and the sessile or semisessile nature of leaves surface play significant roles in dust deposition as they determine the surface available for dust deposition [4, 11].

Dust deposited on the leaf surface gives a shading effect to leaves and block stomata as well as light penetration through dust particle. The amount of light absorbed by a leaf is a function of the photosynthetic pigment content; thus, chlorophyll content can directly determine photosynthetic potential and primary production [3].Various studies reveal dust deposition on the leaves surface reduce photosynthetic pigment. Through this study an attempt has been made to study the dust retaining capacity and different physiological impact of dust on Ficus *religosa* and Ficus *benghalensis*

2. MATERIALS AND METHODS

2.1 Study site

Bokaro Thermal Power Station is coal based power plants located at Bokaro district in Jharkhand, 44 km from Bokaro steel city and is extended from 23°47'07 latitude and 85°52'48´ longitude with a subtropical climate. This power plant is one of the coal based power plant of DVC and has an installed capacity of 630 MW having three units of 210 MW each. Residential colonies are situated in the surrounding of thermal power plants and covered with to native plants.

2.2 Methodology

This research study was conducted during summer and winter season in October, 2013 and January, 2014. Two common species Ficus *religosa* and Ficus *benghalensis* were selected for the sampling from the vicinity of Bokaro thermal power plant. The selection of these species was made because of their contrasting leaf characteristics. The plants were selected based on the commonness and their tolerance capacity for dust pollution reported by various authors during their research study. Sampling of leaves was done in triplicate manner for each species and three leaves from each.

The leaves were carefully removed from the branches and were put in polythene bags and brought back to the laboratory. The leaves were carefully taken out from the bags and dust present on the leaves was cleaned using a fine brush in 50 ml of distilled water. Dusts collected in the distilled water were filtered through whatman filter. Individual leaf area was calculated by tracing out the leaves on graph paper. Amount of dust per unit area was calculated using the equation $W = (W_d - W_b)/A$, where W is dust content (g/cm^2), W_d is weight of filter paper with dust, W_b is initial weight of blank filter paper and A is total area of the leaf (cm^2). Chlorophyll and carotenoids were

extracted in 80% acetone from leaves and the amount of chlorophyll *a, b,* and *total,* were quantified spectrophotometrically following [1].

3. RESULTS

3.1 Dust deposition

Based on the above methodology, the dust deposition on Ficus *religosa* and Ficus *benghalensis* was evaluated on seasonal basis (summer and winter) as shown in Table 1 and Fig. 1.

Table 1 Seasonal average of dust accumulation in different plants under study

	Dust deposited (g/cm^2 leaf area)	
Plant species	**winter**	**summer**
Ficus religosa	0.566 ± 0.144	0.073±0.008
Ficus benghalensis	0.307 ±0.267	0.069±0.020

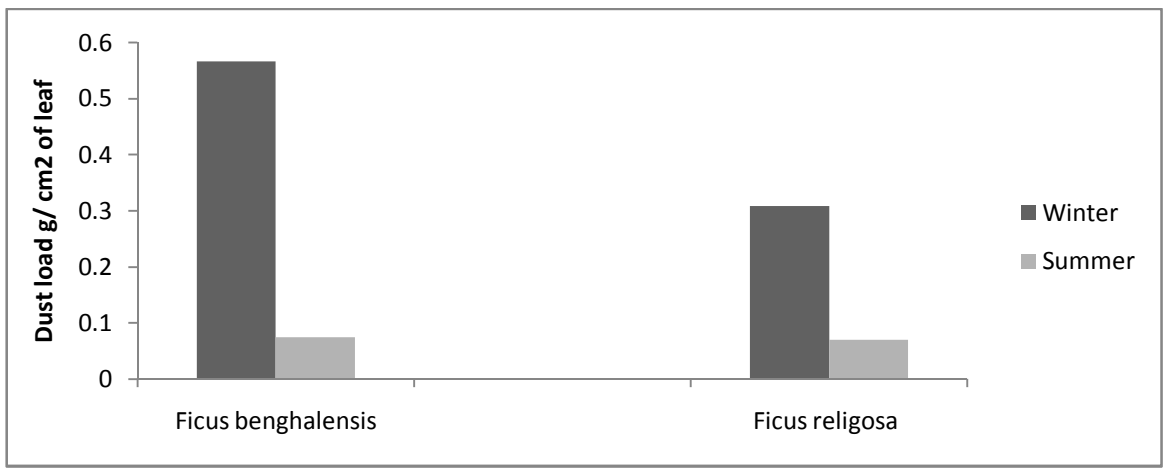

Fig. 1: Variation in dust load in different season

It was observed that all plants showed higher dust deposit in winter and lowest in summer season. The average seasonal dust accumulation in different plants under study is presented in Table1. It shows that F. *benghalensis* to have better dust retention capacity than F. *religosa* in both season winter and summer.

3.2 Pigment content

The seasonal variations in pigment concentration of F. religosa and F. benghalensis under study are presented in Fig 2. The results showed that the pigment contents (total chlorophyll; chlorophyll a;

chlorophyll b; and carotenoid) were maximum in summer season and minimum in winter season. In summer season F. *benghalensis*, chlorophyll a content is higher but other three pigment types were minimum than F.*religosa*, whether in winter season chlorophyll a content is maximum in F. *benghalensis* and rest others pigments content is minimum than in F. *religosa*.

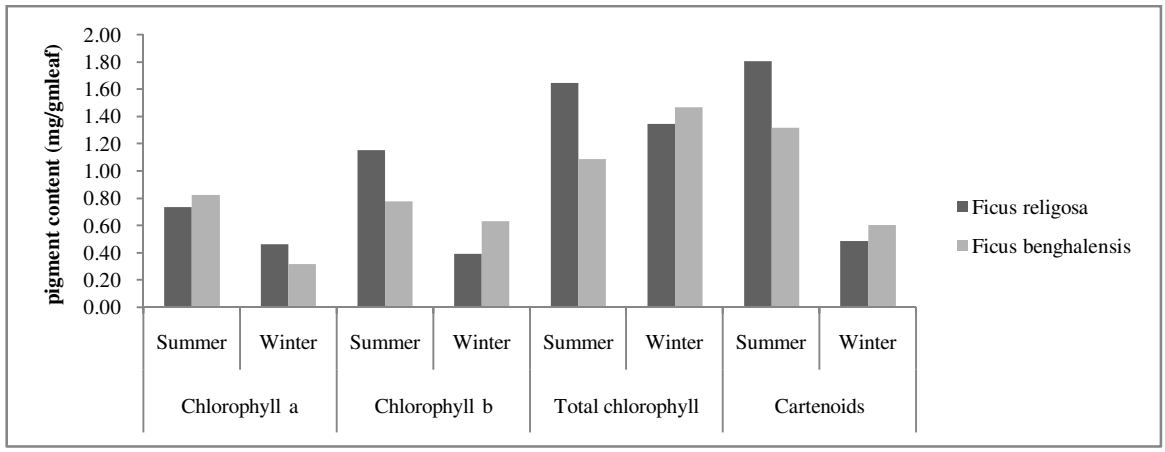

Fig. 2: Seasonal variation in pigment content of plant species

4. DISCUSSION

This work illustrates the significant variation in dust accumulation in two different species at same locations near Bokaro thermal power plant. Dust load was maximum during winter season on both species and minimum in summer. Different kinds of factors, such as leaf uniqueness, i.e., form and size, orientation, surface texture, occurrence/lack of leaf hairs, petioles length, etc., air current and its speed, climatic conditions and anthropogenic actions affect the dust interception and accumulation capacity of different plants. F. *benghalensis* having short petioles and thick hairy leaves showed the most dust accumulation capacity as compared with F. *religosa* which had long-leaves stalks. Air movement easily disturbs leaves having thin lamina, smooth surfaces, and long petioles. Consequently such leaves can hold lesser amounts of dust while thick leaves having rough surfaces or hairs on the surface and short petioles can hold large amount of dust and hence are better collectors of dust [8, 9]. In the present research study variation in pigment of leaf is prominently higher during summer than winter season this may be due to less dust accumulation during summer than winter season. Dust load puts shading effect on plants which reduce availability of light for photosynthesis and diffusion of air is affected by blocking stomatal openings [5, 6, 1]. Reduction in pigments can be due to the drop in pigment synthesis due to the shading effect. The study showed reduction in both chlorophyll and carotenoid content, indicating that the dust accumulation has an effect on the all the pigments present in leaves.

5. CONCLUSION

Dust arresting capacity of plants differs significantly due to differences in their leaf surface characteristics such as epicuticular wax, cuticle, epidermis, stomata and the trichomes. Leaf orientation, leaves surface play important roles in dust deposition as they determine the surface available for dust deposition. This study reveals that dust retaining capacity of F. *benghalensis* is maximum than F. *religosa* and dust deposited on the surface of leaves reduce photosynthetic pigment of leaves.

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