# *Impact of Air Pollution caused by Mining and Marble Dust on Foliar Sensitivity through Biochemical Changes*

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***Abstract*: The escalating anthropogenic activity, industrialization and urbanization have exaggerated the emission of various pollutants leading to air pollution globally. Jaipur is the one of the major city of India and a hub of budding small and large scale industries, including mining and marble based industries. The Air pollution caused by the dust generated during the marble crushing and mining can pose serious problems to overall physiology of plants by entering through leaves. Continuous exposure of trees to dust can lead to accumulation and integration of pollutants, thereby causing foliar injuries, stomata damage, premature senescence, chlorosis, yield reduction, change in photosynthesis and transpiration making them more sensitive. This sensitivity can be measured through various biochemical changes. In this study, the effects of marble dust on the pH, Relative Water Content (RWC) and Total chlorophyll contents (Chlorophyll A+ chlorophyll B) from leaves of commonly growing trees within the vicinity of mining and marble statue making polluted sites in comparison to the control site were investigated and the results reveal foliar morphological, physiological and biochemical changes inhibiting the photosynthetic activity due to reduction of chlorophyll and carotenoid contents of leaves. Around 10-20% reduction in total chlorophyll content was observed in comparison to nearby vegetation of similar plant species. Thus, responses of plants to pollutants may provide a simple method of bio monitoring air pollutants as well as providing the pollution abatement measures.**

***Keywords*: *Air Pollution, Marble dust, Mining dust, Total Chlorophyll***

## I. INTRODUCTION

The major outcome of Industrial revolution was air pollution which is being faced throughout the globe, especially in the developing countries. Sustainable mitigation of this potent threat is a major challenge for the mankind today. It deteriorates not only human, animal but plants and ecological conditions too. Pollutants have deleterious effect on stomata movements, foliar geometry, photosynthesis, membrane permeability and transportation of nutrients leading to stunted growth, poor yield and premature senescence in highly susceptible plants. Plants can be used to intercept dust particles which are of potential health hazards to human beings. Dust is one of the important factors affecting the plant vigour. The foliar dust interception efficiency and effect of dust deposition on total chlorophyll and ascorbic acid content was evaluated for some tree species like *Ficus religiosa, Ficus benghalensis, Mangifera indica, Dalbergia sissoo, Psidium guajava, and Dendrocalamus strictus* and maximum dust deposition was observed in the winter season and moreover the total Chlorophyll content decreased while ascorbic acid content increased following rise in dust deposition [1]. Dust emission occurs from many operations in the marble statue making industries viz., cutting, buffing and polishing. Particulate Matter produced during the marble crushing and cutting for statue making is usually of relatively large size. A large number of mining processes also yield a lot of particulate emission [2, 3]. Urbanization has raised the need for construction and therefore has led to manifold increase in mineral extraction by many countries [4, 5]. All these industrial processes have culminated into degradation in air quality standards leading to health hazards in most of the developing countries. Plants are often sensitive to deficiency and the excess doses of some heavy metal ions which act as essential micronutrients [6, 7]. Further, such toxic elements are considered as potent soil pollutants having acute and chronic toxic effect on plants grown in such soils. The chemical composition of the dust tends to be homogenous mixture of oxides of Calcium, Aluminum, Potassium, Silica and Sodium, which turns into a hard mass in presence of water [8]. In short, dust pollution affects environmental health of a region. Marble dust and stone crusher dust is detrimental to human health, fauna and flora of the surrounding areas. The dust with high particulate matter hampers not only the visibility but also causes minor injuries and biochemical changes in pH, RWC, Chlorophyll content, photosynthesis and transportation rate, etc. in the leaves [9]. Several studies have indicated that the plant growth is adversely affected by deposition of particulate matter on vegetation, [10, 11, 12, 13, and 14]. Thus, scrutinizing the impact of dust particles on plants is also very important as it directly affects the food chain. Taking into consideration all these factors the study was conducted to determine the impact of air pollution on plant leaves caused by mining and marble dust. The study sites selected were around Jaipur including Kookas, Chonp and Amity University Rajasthan. Hence, plants that were commonly available to all these sites were considered for the whole study.

## II. METHODOLOGY

### *A. Study sites for sample collection*

For this study, fresh leaves from selected plants were collected from the experimental sites near marble statue making (Site 1, Kookas), mining area (Site 2, Chonp) and Amity University Rajasthan (Site 3, Control) near Jaipur city during month of September 2016. The plants selected (Fig. 1)

for the study were *Azadirachta indica, Ficus religiosa, Ficus benghalensis* and *Eucalyptus grandis.*

Fig. 1. Study Plant samples collected from various sites

*B. Impact of Dust pollution on Foliar Biochemical Parameters*

Fresh leaves from the selected plants were used according to the standard prescribed methods. Aqueous extract was used for the study.

1. ***pH:*** 100mg of fresh leaves were thoroughly rinsed with distilled water thrice and then homogenized in 10ml deionised water. It was filtered and pH of the leaf extract was determined after calibrating pH meter with buffer solution pH 4 and pH 9.

2. **Total chlorophyll content:** The chlorophyll pigments in the leaves were estimated following the method of Arnon (1949) [16]. First of all, the leaves were washed thoroughly with distilled water. About 500mg of fresh leaves were blended and then extracted with 10ml of 80% acetone and kept for 15min. The liquid protein was decanted into another test tube and centrifuged at 2,500rpm for 3min. The supernatant was then collected and the absorbance was taken at 645nm and 663nm for chlorophyll a and b, using visible spectrophotometer (340- 990nm). The total Chlorophyll concentration of the leaves was calculated using the following formula and the results are expressed in mg/G fresh weight.

Chlorophyll a = [(12.7 X $OD_{663}$) - (2.69 X $OD_{645}$] X dilution factor

Chlorophyll b = [(22.9 X $OD_{645}$) - (4.68 X $OD_{663}$)] X dilution factor

Total chlorophyll = [(20.2 X $OD_{645}$) - (8.02 X $OD_{663}$] X dilution

3. **Relative Water Content (RWC):** Fresh weight was taken by weighing the leaves. To measure turgid weight, the leaf samples were then immersed in water over night blotted dry and then weighed again. The leaves were then dried overnight in a hot air oven at 70°C and reweighed to get the dry weight. RWC was determined and calculated by the method as described by Weatherly [15].

RWC= [(FW-DW)/ (TWDW)] x 100

Where: FW-Fresh Weight, DW-Dry weight and TW-Turgid weight

## III. RESULTS AND DISCUSSION

In Indian cities, airborne particulate matter seems to be a very serious problem [17]. Airborne particulate matter represents a complex mixture of organic and inorganic substances of varying size and may enter an organism or plant in a number of ways. The results of impact of air pollution caused by marble and mine dust on foliar biochemical components are enumerated in Table 1.

| S.No | Sample | pH | Chlorophyll content (mg/G) | RWC (in %) |
|---|---|---|---|---|
| **SITE 1** | | | | |
| 1. | *Azadirachta indica* | 7.93 | 0.672 | 94.88 |
| 2. | *Ficus religiosa* | 8.35 | 0.579 | 90.72 |
| 3. | *Ficus benghalensis* | 8.23 | 0.623 | 91.58 |
| 4. | *Eucalyptus* | 8.10 | 0.935 | 98.44 |
| **SITE 2** | | | | |
| 1. | *Azadirachta indica* | 7.36 | 0.602 | 87.12 |
| 2. | *Ficus religiosa* | 7.40 | 0.737 | 95.82 |
| 3. | *Ficus benghalensis* | 8.01 | 0.616 | 91.53 |
| 4. | *Eucalyptus* | 7.62 | 0.690 | 96.76 |
| **Control** | | | | |
| 1. | *Azadirachta indica* | 7.11 | 0.411 | 89.67 |
| 2. | *Ficus religiosa* | 7.16 | 0.482 | 95.94 |
| 3. | *Ficus benghalensis* | 7.26 | 0.352 | 86.65 |
| 4. | *Eucalyptus* | 7.62 | 0.280 | 98.38 |

Table1. Impact of Dust Pollution from Mining and Marble Dust on Foliar Biochemical Changes

*A. Impact of dust pollution on pH*

The photosynthetic efficiency has been reported to be strongly dependent on leaf pH [18]. The pH ranged between 6.0 and 8.8 lies in both intermediately tolerant plant species [19] and thus nearly all plant species in our study are intermediately tolerant to air pollutants.The pH was found to be high for the plant leaves of both the *Ficus* sps. at Marble site followed by mining site as compared to their controls (Fig.2). The pH of *Ficus religiosa* was 8.35 while that of *Ficus benghalensis* was found to be 8.23. The high pH

suggests the impact of marble dust and mining dust on the leaves of these plant species. Similar effect has been observed by Saini et al. [2].

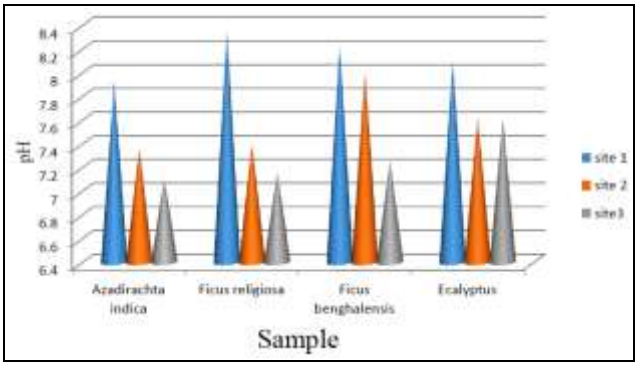


Fig.2. Impact of Dust Pollution on pH of Leaf samples

*B. Impact of dust pollution on Total chlorophyll content*

It's a fact that chlorophyll content of plants indicates its photosynthetic activity leading to the growth and development of plant biomass. The chlorophyll content is not same for all plants but depends on age of leaf, ecological conditions and also the pollution level [20]. Current study revealed that chlorophyll content in all the plants was higher (Fig. 3) for the plants at site 2 and site 1 (ranging from 0.579-0.935 mg/G) as compared to their control plants respectively (0.280- 0.482 mg/G) which shows that dust retaining capacity in *Eucalyptus grandis*, *Ficus benghalensis* and *Azadirachta indica* is more and this higher levels of total chlorophyll observed may be due to its tolerance nature to the pollutants [21, 22]. Similar results were reported by Saini et al. [2, 23 and 24]. Pigment content has been reported to decrease in the plants growing near the stone crushers in the mining site [21, 25] as compared to marble statue making sites. To retain the dust particle on plant surface depends on their phyllotaxy, surface and size of leaves [26], presence of appendages on leaf, and tree height [27].

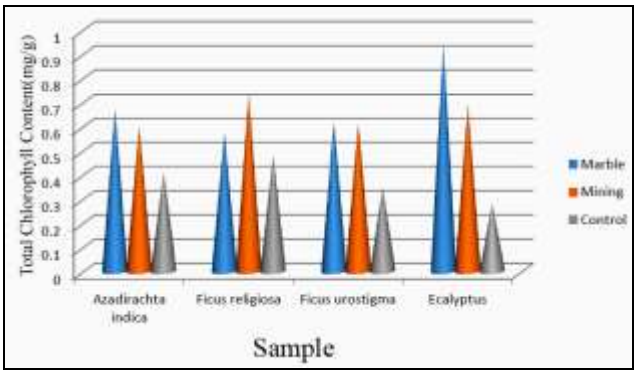


Fig.3. Impact of Dust Pollution on Total Chlorophyll content of Leaf samples

*C. Changes in Relative water content*

[1] Relative Water Content (RWC) refers to the water present in the leaves relative to its full turgidity. Relative water content is associated with protoplasmic permeability in cells cause loss of water and dissolved nutrients, resulting in early ageing and leaf senescence [28]. Present study showed higher relative water content (Fig.4) with respect to the control site in nearly all the study plants. The plants with high relative water content under polluted conditions may be tolerant to pollutants [11, 22].

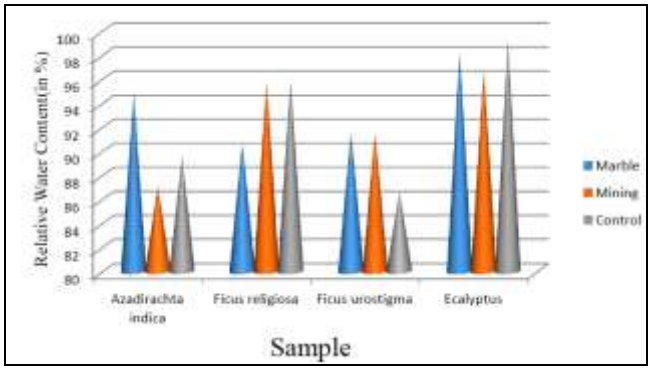


Fig.4. Impact of Dust Pollution on Relative water content of Leaf samples

Urban air usually comprises considerable amounts of particulate matter in form of dust [29]. Dust interception and retention depends upon geometry, orientation, age, surface texture and moisture retention capacity of the leaf [30, 31]. Dust emission occurs from various primary, secondary and tertiary processes and transportation during mining and also during marble statue making operations. It has been established that aerial parts of a plant especially leaves act as persistent absorbers in a polluted environment [32]. Exclusion of pollutants by phytoremediation from air is possible by absorption by the leaves, deposition of particulates and aerosols over leaf surfaces, etc. [33, 34 and 35]. Our study reveals that evaluation of apparent performance of plants against dust pollution might be very helpful in the selection of site specific tree species for raising green belts in the urban areas and nearby industries [36]. Mining dust may also intensify secondary stresses like drought, invasion by insects and pathogens, or allow penetration of toxic metal pollutants [37]. Mining and marble statue making dust can have a major impact on natural communities residing in its vicinity and may change the competitive balance between various species of respective trophic levels in a food chain i.e. from producers to grazers, higher animals and decomposers too. This might also disturb the concerned biogeochemical cycles of decomposition. Susceptible species are early pollution indicators and the tolerant plants can help in diminishing the pollution load [38, 39]. Thus, it is recommended to develop dust tolerant green belt in the dust prone areas.

## IV. CONCLUSION

Bio monitoring of dust pollution and understanding its impact on health of human, animals and plants is the need of the hour. Plants that are continuously exposed to pollutants leads to accumulation of pollutants into their own system thereby can alter the nature of leaf and can make them more sensitive while some plants have high tolerance to these pollutants due to its inbuilt metabolic machinery. The study

clearly reflects that the tolerance of plants towards air pollution may be site-specific. Susceptible species are early pollution indicators and the tolerant plants can help in diminishing the pollution load. Thus it is concluded that in the study area there is need to develop green belt for the betterment of environment and human being.

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