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# Influence of Marble Slurry Dust on Epidermal Characteristics of Selected Tree Species, in Reference to their Dust Holding Capacity

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**Abstract:** ***Green belts on the embankment of the dumpyard, at Kishangarh, have been developed for mitigating the air pollution caused by the slurry dust, by filtering, intercepting and absorbing the particles in a sustainable manner. The micro-morphological parameters of the phylloplane were undertaken, to evaluate the choice of tree species best suited for plantation. In the present study the dominant tree species of the green belt, viz. Callistemon lanceolata, Albizia lebbeck and Azadirachta indica indicated marked alternation in epidermal traits. Length, breadth and calculated area of stomata exhibited different percentages of inhibition whereas number of stomata, epidermal cells, and stomatal index showed stimulation.***

**Keywords:** Marble slurry dust, Callistemon lanceolata, Albizia lebbeck, Azadirachta indica, epidermal traits

## 1. Introduction

Air pollution directly affect plants via the exposed plant parts, particularly the leaves. The reaction of different species to the changes in the different microclimatic properties and most importantly to the pollution levels is strongly correlated with their functional and structural features. The exposure, over a period of time may lead to various alterations in the micro-morphological characteristics of the plant body. Leaves are the most sensitive part of a plant and are affected by air pollution. The degree of alterations particularly in the leaf micro-morphology depends to a large extent upon the dust holding capacity of the phylloplane.

In case of stress induced due to the suspended particulate matter, (in the present case, the slurry dust,)the texture, thickness and orientation of leaves and the canopy architecture of the tree species influence the dust holding capacity, which in turn regulates the adaptive alterations in the micro-morphology of the plant.

Green belts are effective tools of mitigation of anthropogenically induced air pollution. The embankment of the dump yard at Kishangarh, has been lined with many tree species. The vegetation here is exposed to fine marble dust suspended in the environment. This suspended particulate matter not only affects the plant physiology and anatomy, thereby retarding the growth but also causes micromorphological alterations in the plant.

The suitability of particular tree species better suited for the green belt may be correlated with structural adaptations under the stressful atmospheric conditions. In the present study, the micro-morphological parameters of the phylloplane were undertaken, to evaluate the choice of tree species best suited for plantation.

The parameters selected for this paper includes:

- Length, breadth and area of stomata
- Number of stomata, epidermal cells and stomatal index

**The Site of Study**

The Marble slurry dump yard is situated in the industrial area of Kishangarh Tehsil, of Ajmer district in Rajasthan. The area of the Tehsil falls between $26^0$ 15’ to $27^0$ 0’ North latitudes and $74^0$ 30’ to $75^0$ 15’ East longitudes. It is about 30 km from Ajmer (Rajasthan).

The marble slurry in Kishangarh is being dumped by the processing plants at the dumping yard. When this slurry dries up, it causes air pollution and related problems. Fine particles can cause more pollution than other forms of marble waste. They can easily disperse after losing moisture, in some atmospheric conditions, such as wind and rain. The white powder particles generally contain $CaCO_3$ and, therefore, can cause a visual contamination. The particle size of the suspension is less than 80 μm; subsequently it is consolidated as a result of the accumulation.

*Azadirachta indica, Callistimon lanceolata and Albizia lebbec* are the most dominant tree species in the green belt developed on the embankment of the marble slurry dump yard in the industrial area of the ‘Marble city’ Kishangarh.

**Review:**

Plants particularly the perennial tree species trap and absorb various pollutants, including the gaseous, particulate, aerosols and air-borne pollutants thus serving as significant sinks (Gajghate, 1999). Trees not only purify the surrounding environment but also mitigate the air pollution by intercepting, filtering and absorbing pollutants in a sustainable manner ( (Gareth, 1992); (Andy, 1991); (Ruth, 1994); (Sharma, 1997)).

The reaction of different species to the changes in the different microclimatic properties and most importantly to the pollution levels is strongly correlated with their functional and structural features. Leaves are the most sensitive part of a plant and are affected by air pollution. Foliage from trees near air pollution sources can even be 'coated' with particulates. Basically, exposed surface of the plants like leaves, play a role in absorbance of these dust particles ( (Samal, 2002)).

## 2. Methodology

Leaves of *Azadirachta indica* A. Juss., *Callistemon lanceolatus* (Sm) Sweet,and *Albizia lebbeck* (L.) Benth. were collected from the trees growing on the embankment of the marble slurry dump yard and the control samples of leaves were collected from the trees growing outside the Industrial Area, where they were not exposed to suspended slurry dust. The leaf samples collected were fixed in F.A.A.

Leaves of each species were washed with water and epidermal peels of mature leaves were taken out by the direct peel method. The peels were stained with 1% safranin and mounted in 5% glycerine on slides and examined under compound microscope using (15 x 40) magnification.

Number of stomata and epidermal cells were counted and stomatal index calculated by formula given by (Salisbury, 1927).
The length and breadth of stomata and their epidermal cells were measured with ocular micrometer under high power magnification (15 x 40 X). Five readings for each parameter per species were taken. The mean values were then calculated.

Leaf micro-morphology has often been used as a sensitive indicator of environmental pollution and the effect of environmental pollution on the epidermal features of the plant leaves have been well documented ((Bondada, 2006)). Quantitative analysis of stomata parameters showed that leaves from the polluted site had higher number of *stomata per unit area than those from control site while samples from control site had higher values for stomata size and pore size. (*(Ogbonna C. E., 2018)*;*(Ogbonna, 2017)*;* (Garg SS, 1999)*;* (Ulrichs, 2008)*).*

(Shrivastava, 2018) reported the increased number of epidermal cells and stomatal frequency and stomatal index on both dorsal and ventral surface at polluted sites as compared to control sites. The leaf samples collected from polluted sites exhibited decreased length and width of epidermal cell and guard cell as compare to control one.

Stomatal index has been proven to be an indicator of environmental stress ( (Gostin, 2009)). Decreased rate of photosynthesis and alteration of stomatal conductance are responsible for reduction of the stomatal index as well as dry matter content of leaf ((Khan. N.A., 2002))

*Air pollution is known to affect the stomatal index and it has been reported to decrease in some plants (*(Tiwari, 2012)*;* (Amulya, 2015) (Thara SB, 2015)*).*

## 3. Observations

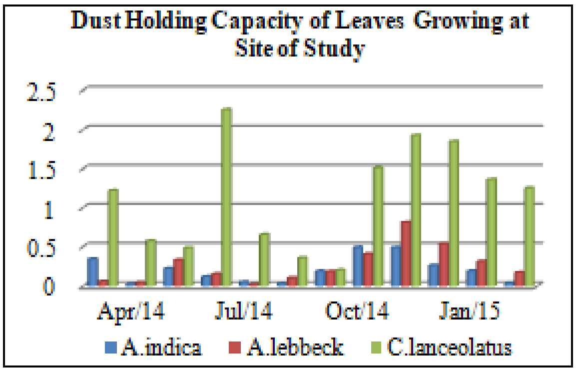



**Figure 1:** Dust Holding Capacity

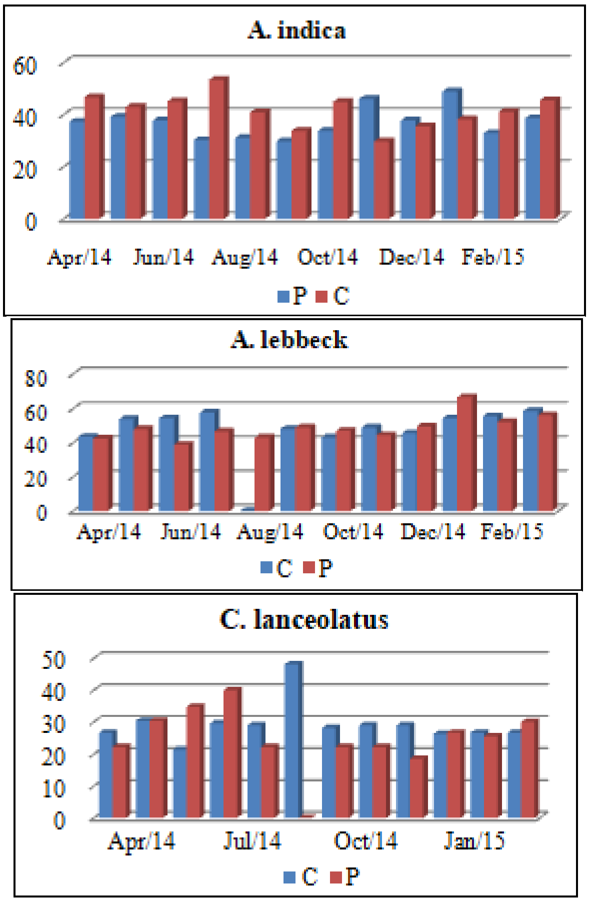
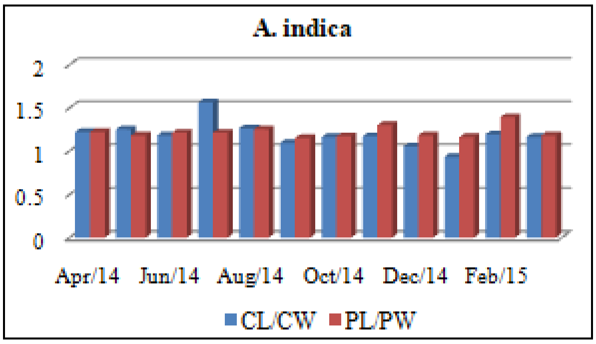



**Figure 2:** Density of Stomata (Lower Epidermis)



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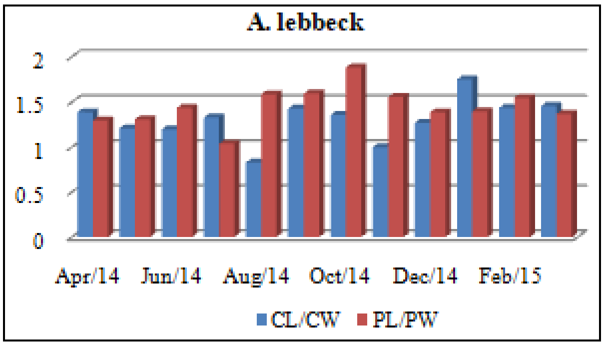


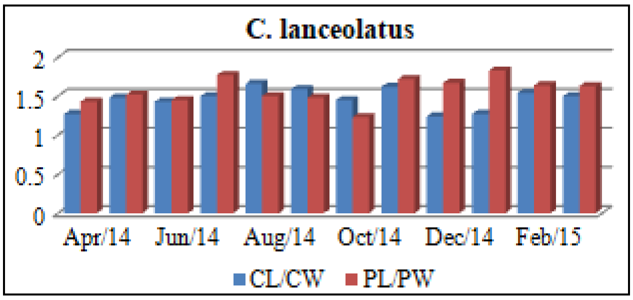
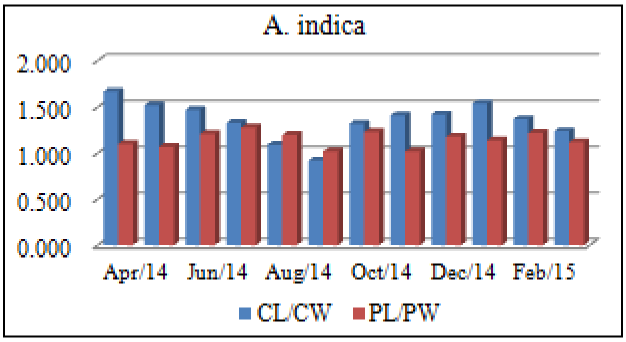
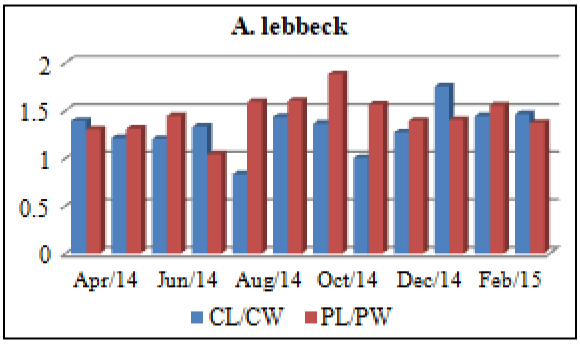




**Figure 3:** Length/Width Ratio of Stomata {Lower Epidermis}



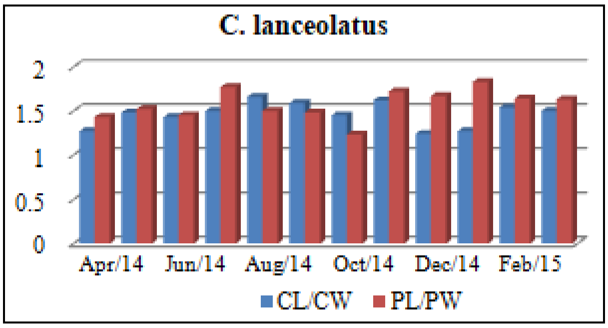
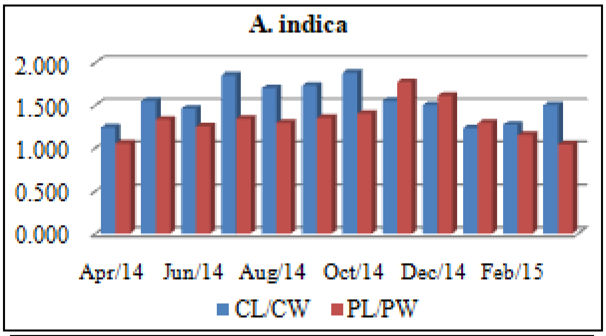
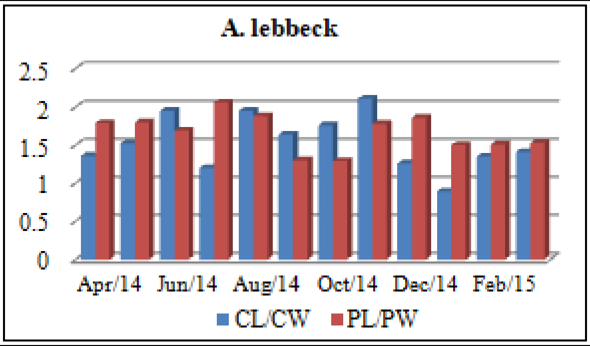




**Figure 4:** Length/Width Ratio of Stomata {Upper Epidermis}



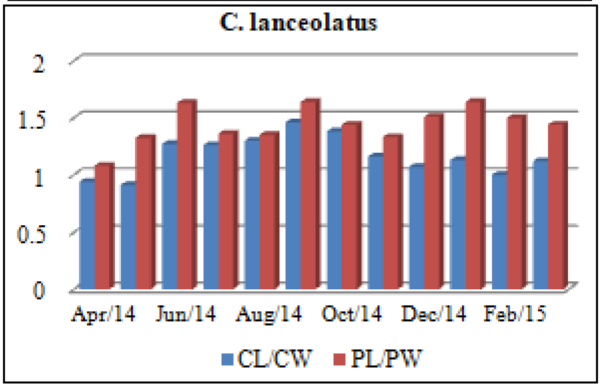
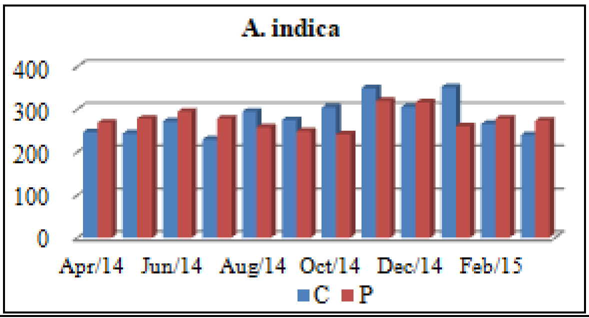
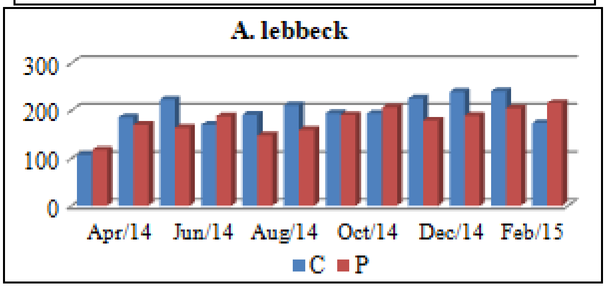




**Figure 5:** Length/Width Ratio of Epidermal Cells {On Lower Epidermis}



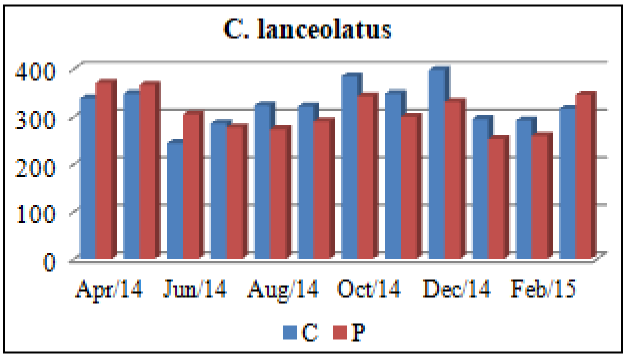



**Figure 6:** Density of Epidermal Cells {On Upper Epidermis}

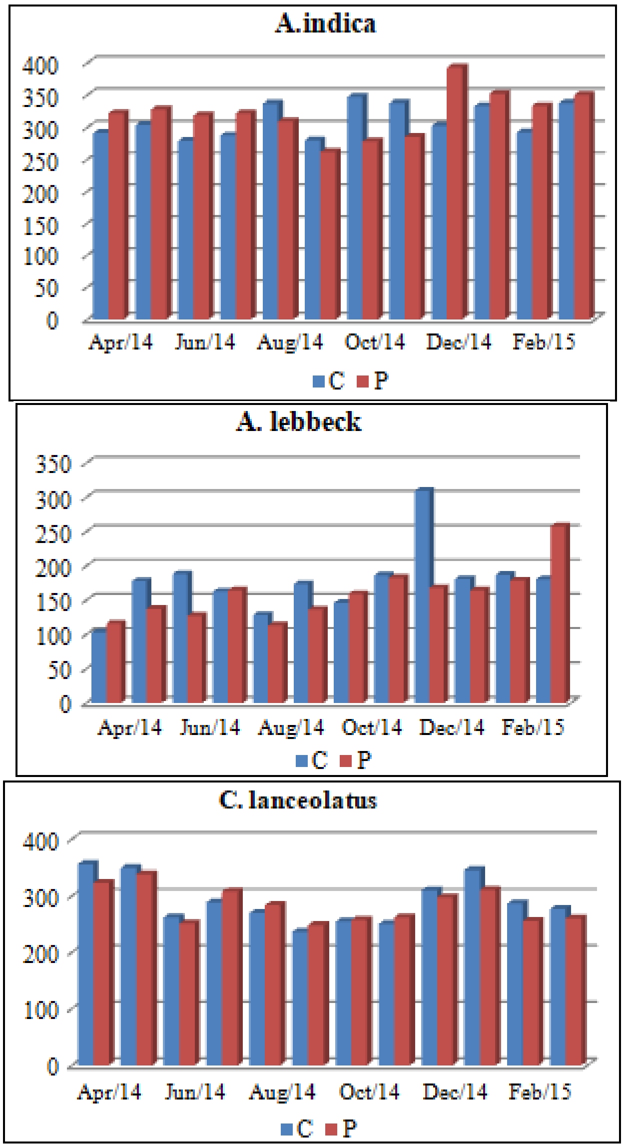



**Figure 7:** Density of Epidermal Cells {On Lower Epidermis}

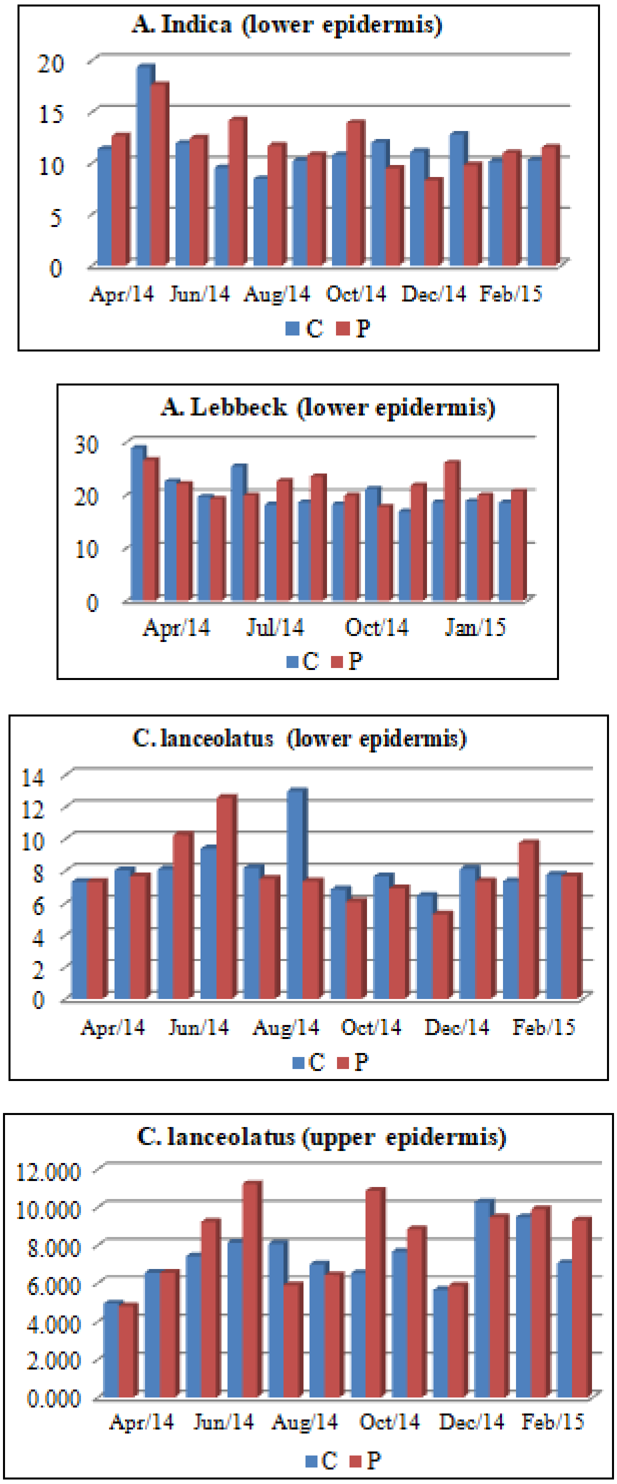



**Figure 8:** Stomatal Index

## 4. Discussion

In the present study maximum dust holding capacity was found to be that of *Callistemon lanceolata* plant followed by *Albizia lebbeck* and then *Azadirachta indica.* Seasonwise the maximum dust accumulated on the phylloplane of all the three species, during the winter months and the least during the rainy months.

Stomatal index recorded an increase in the lower epidermis of *Azadirachta indica* and *Albizia lebbeck* leaves from polluted sites as compared to that with those of unpolluted site during the months of May to October. The climatic conditions of the region during these months are generally either windy or when there are monsoon showers the marble slurry is washed off the surface of the leaves. However during winter months when the slurry deposition on the leaves in particular, increases, the value of stomatal index of these leaves exhibited a decrease.

In case of the rough, leathery leaves of *Callistemon lanceolata*, stomatal index in leaves from polluted site was more during the winter months, probably because the leaf anatomy of this tree species and its canopy architecture which reduces the accumulation of the slurry dust on the phyllo-plane. During the windy summer months the particulate matter remain trapped on the leaf surface and influences the characteristics of the leaf stomata. According to (Sharma GK, Leaf cuticular variations in Trifoliumrepens L. as indicators of environmental pollution. , 1973), the high pubescence would reduce the amount of solar radiation that hits the surface of the leaf. This alteration in leaf energy decreases its temperature and can alter the response to the accumulated particulate matter.

The light microscopic studies of the selected tree species indicated marked alteration in epidermal traits. Length, breadth and calculated area of stomata exhibited different percentages of inhibition whereas number of stomata, epidermal cells, and stomatal index showed stimulation in the area contaminated with the marble slurry dust.

The possible explanation for this result is, that probably the plants have had to allocate more resources to the production of more stomata to access more $CO_2$ from the already polluted atmosphere to carry out the desired rate of photosynthesis. The present results are supported by a series of previous studies reporting that the plants growing in polluted area exhibit varying percentages of reduction in the stoma area, while the number of stomata, epidermal cells, and the associated stoma indexes showed an increase ((Saadabi, Effects of Auto-exhaust Pollution on the Micro-Morphology and Leaf Epidermal Features of Ornamental Plants in Khartoum, Sudan, March 2011)). Furthermore, the data presented in this study are also supported by those of (Tiwari S. M., 2006)who recorded a decrease in the size of the stoma opening and an increase in the frequency of epidermal epidermal tissues and in response to environmental pollution. The results indicate that micro-morphology in leaves is an emergent property, the magnitude of which is environmentally constrained.

Increase in the number of stomata and epidermal cells with decrease in length and width of guard cells and epidermal cells was recorded in the samples of polluted area on both upper & lower surface of leaf. The decrease of the stomatal size may be an avoidance mechanism against the inhibitory effect of a pollutant on physiological activities such as photosynthesis (Verma, 2006).

On the basis of maximum dust removal efficiency and less affected morphological and micro morphological characteristics of plants (*Azadirachta indica*) can be used in the reduction of dust pollution by acting as natural filters and promoted for plantation in the industrial green belts, having greater dust removal efficiency.

The modification of the frequency and sizes of stomata as a response to the environmental stress is an important manner of controlling the absorption of pollutants by plants. Stomatal size was decreased significantly in all analyzed species, while stomatal index was increased to about a maximum of 20%

## 5. Conclusion

The light microscopic studies of the selected tree species indicated marked alteration in epidermal traits. Length, breadth and calculated area of stomata exhibited different percentages of inhibition whereas number of stomata, epidermal cells, and stomatal index showed stimulation in the area contaminated with the marble slurry dust.

On the basis of maximum dust removal efficiency in combination with less affected morphological and micro morphological characteristics, of the three tree species under consideration,*Azadirachta indica* can be used in the reduction of dust pollution by acting as natural filters and promoted for plantation in the slurry affected green belts.

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## Author Profile

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