Seasonal Assessment of Biochemical Characteristics and Suspended Particulate Matter (SPM) Retention Potential of Plant Species

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Introduction

The air quality of cities has deteriorated in recent years because of rapid urbanization, increased vehicular and industrial emissions (Anake et al., 2022; Peng et al., 2022). Dispersion of pollutants in the atmosphere and associated risk can be lowered by implementing plants as a green barrier that functions as pollutant sinks and natural filters (Abhijith et al., 2017; Eisenman et al., 2019). Plants mitigate pollutants via sedimentation, diffusion, and interception (Beckett et al., 2000). The leaf characteristics like surface roughness, size, and longevity impact the adherence of pollutants on the leaves. Activation of antioxidant machinery helps plant species combat the environmental stress such as air pollution. The capability of plants to reduce air pollution depends on their physio-biochemical parameters and antioxidative defense mechanisms (Kwak et al., 2020).The boundary layer plays a significant role as a barrier that pollutants must traverse before reaching the leaf surface (Jean-Pierre, 2019), as illustrated in Figure 1. The thickness of the boundary layer is influenced by factors such as the shape and size of leaves, the presence of trichomes on leaves, and the speed of the wind.

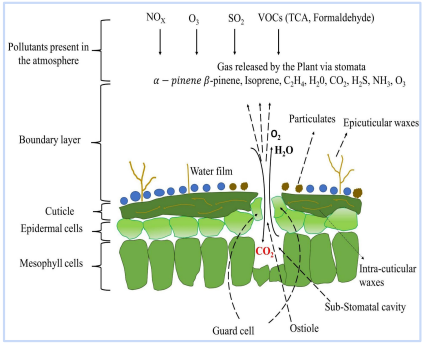

Figure 1: Interaction between air pollutants and leaf surface.

Methodology

- Six Plant species such as *Ficus benghalensis* L, *Ficus religiosa* L, *Polyalthia longifolia* (Sonn.) Thwaites, *Azadirachta indica* A. Juss, *Ficus benjamina* L have been selected from Okhla Phase-2 and Siri Fort in Delhi, India
- Biochemical parameters such as ascorbic acid, total chlorophyll content, relative water content, and pH were calculated (Tripathi and Nema, 2023).

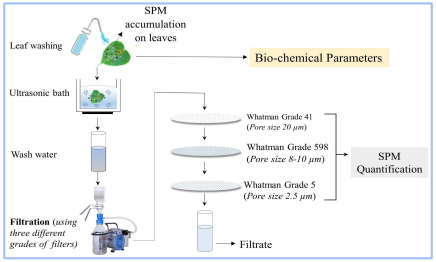

Figure 2 : Procedure followed for determining biochemical parameters and SPM from the leaf surfaces.

- Based on biochemical characteristics Air pollution tolerance Index (APTI) of plant species were measured.
- Moreover, Suspended Particulate Matter (SPM) retention potential of plant species have been determined (Figure 2).

Results

- Significant linear regression were observed between ascorbic acid ($R^2 > 0.60$) and chlorophyll content ($R^2 > 0.70$) with the APTI in both seasons, as illustrated in Figure 3.
- During the pre-monsoon, there was a notable 8.98% increase in APTI compared to the post-monsoon. Among the plant species, *F. benjamina* displayed the highest APTI value of 10.26 in the pre-monsoon, as shown in Figure 4.

- The seasonal variation in the accumulation of SPM on the leaves of plant species was measured (Figure 6). It has been observed that at Okhla Phase-2 and Siri Fort large SPM (> 20 μm) ranged between 59.14 to 340.78 μg/cm^2, and 100.27 to 589.39 μg/cm^2, respectively. Coarse SPM (8-10 μm) ranged from 10.84 to 103.16 μg/cm^2, and 7.78 to 63.08 μg/cm2, respectively. Fine SPM (< 2.5 μm) ranged between 3.86 to 67.03 μg/cm^2, and 3.15 to 34.07 μg/cm^2, respectively.

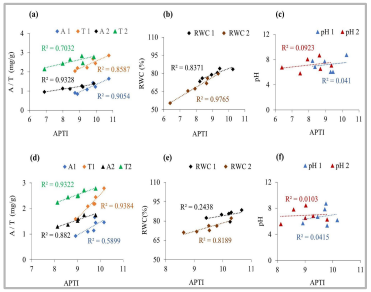

Figure 3: Linear relation of ascorbic acid (A), total chlorophyll (T), relative water content (RWC), and pH with APTI at Siri Fort (a,b, & c) and Okhla Phase-2 (d, e, & f). 1 and 2 denotes the pre- and post-monsoon, respectively.

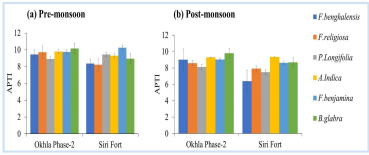

Figure 4: APTI at Okhla Phase-2 and Siri Fort during Pre- and Post-monsoon.

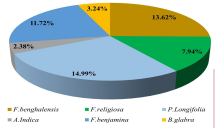

Figure 5 : Variation in APTI values from pre- to post-monsoon season.

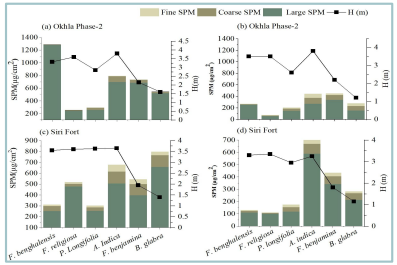

Figure 6: Seasonal variation in the SPM accumulation on the selected plant species in the pre- monsoon (a & c) and post-monsoon (b & d).

Conclusion

- The research findings indicated that the process of choosing appropriate plant species for urban green belts necessitates the consideration of various factors.
- These factors include biochemical parameters such as ascorbic acid, chlorophyll, relative water content, and pH, as well as the APTI, leaf morphology, and SPM retention potential.
- Also, seasonal variation in APTI was observed in this study, signifying the impact of air pollution on biochemical traits.
- Among the species studied, *F. benghalensis* emerged as the most tolerant species with the highest potential for capturing SPM.

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