

# **STUDIES ON AIR POLLUTION INDUCED STRESS DUE TO SPM & METAL CONCENTRATION IN PLANT SPECIES AND GREENBELT DESIGN FOR URBAN AREAS**

## **ABSTRACT**

Air pollution emerged as a major environmental concern due to various anthropogenic sources such as vehicles, road dust, and industrial activities, contributing to the agglutination of airborne Suspended Particulate Matter (SPM) on leaves of plants, especially in densely populated cities like Delhi, India. However, plant species can effectively capture airborne suspended pollutants. Understanding the role of plant species in mitigating air pollution necessitates the examination of biochemical Parameters (ascorbic acid, chlorophyll content, relative water content, and pH), morphological characteristics, pollutant capturing capacity, elemental accumulation, seasonal and species-specific variations to assess the tolerance levels of plant species. Therefore, this study aimed to investigate seasonal variations (pre- and post-monsoon) in pollution- mitigating potential, biochemical parameters, and tolerance indices (Air Pollution Tolerance Index (APTI) and Anticipated Performance Index (API)) of selected plant species (*Ficus benghalensis* L, *Ficus religiosa* L, and *Polyalthia longifolia* (Sonn.) Thwaites, *Azadirachta indica* A. Juss, *Ficus benjamina* L, and *Bougainvillea glabra*) and their capacity to capture SPM across Delhi, India. Moreover, the present study examined the levels and distribution of twenty-six elements, including heavy metals (Cd, Pb, Cr, Cu, Zn, Co, Ni, Fe, Mn, Ag, Mo, V, Ga, and Bi), light metals (B, As, Te, and Se), and metalloids (Al, Li, Sr, K, Mg, Na, Ca, and Ba) on leaves and within leaf tissues in six categorized (commercial, traffic-prone, residential, educational, greenbelt and industrial areas) regions in Delhi. In addition, this study also suggested a methodology to assist the plant selection procedure for urban greenbelt development by grouping plant species into three categories (i.e., large, medium, and small). The selection criteria have been decided (i.e., regional geographical tolerance, urban environment tolerance, growth characteristics, maintenance, economic value, pest and disease

resilience, medicinal property, and aesthetic appearance) based on published research articles, reports, and relevant books. Further, the hierarchical cluster and Analytical Hierarchy Process (AHP) technique was used to evaluate the criteria and allocate weights. In addition, the urban greenbelt planning model has been formulated to optimize the environmental and economic objectives. Statistical analyses were employed for data analysis, including one-way ANOVA, two-way ANOVA, Pearson's test, Principal Component Analysis (PCA), Hierarchical Cluster Analysis (HCA), and Structural Equation Modelling (SEM).

In this study, *F. religiosa* exhibited the highest APTI value of 11.94, while *P. longifolia* displayed the lowest APTI value of 8.00 during the pre-monsoon. *F. religiosa* demonstrated a significant Pearson's correlation ( $P < 0.05$ ) between chlorophyll content and SPM deposition during the pre-monsoon. Further, *F. benghalensis* L showed the maximum SPM adherence on leaf surfaces, with a deposition of  $1305.46 \mu\text{g}/\text{cm}^2$ , whereas *F. religiosa* exhibited the lowest SPM deposition of  $56.62 \mu\text{g}/\text{cm}^2$ . In the pre-monsoon plant species exhibited the highest metal accumulation (~21%) at the Anand Vihar (commercial) in Delhi, with the maximum average concentrations of Cr (118.25 mg/kg), Cu (204.38 mg/kg), Zn (293.27 mg/kg), and Fe (2721.17 mg/kg). *F. benghalensis* exhibited the maximum 213.73 Metal Accumulation Index (MAI) at the Anand Vihar in the pre-monsoon. Ni and Cr indicated the highest correlation ( $P < 0.05$ ,  $r = 0.82$ ) in the PCA test. HCA test revealed similarity (~87.7%) at ITO (traffic-prone) and Okhla Phase-2 (industrial) in *F. religiosa* regarding metal concentration patterns. However, a 16.11% drop was observed in the accumulation of all elements from the pre-monsoon to the post-monsoon. Additionally, this study explored species-specific metal accumulation, revealing potential implications of metal-tolerant plants for urban greenbelts. The findings of present study can be effective in selecting plant species for improving greenbelts in polluted cities.

**Keywords:** Air Pollution, Biochemical Parameters, Suspended Particulate Matter, Metal Accumulation, Air Pollution Tolerance Index, Urban Greenbelts.