Suspended Particulate Matter

Title	**The in situ pilot-scale phytoremediation of airborne VOCs and particulate matter with an active green wall**
Author Name	T. Pettit, P. J. Irga & F. R. Torpy
Journal Name	Air Quality, Atmosphere & Health
Year	2019
Volume and Issue	12, 1
Pages	33-44
Abstracts	Atmospheric pollutant phytoremediation technologies, such as potted plants and green walls, have been thoroughly tested in lab-scale experiments for their potential to remove air pollutants. The functional value of these technologies, however, is yet to be adequately assessed in situ, in 'high value' environments, where pollutant removal will provide the greatest occupant health benefits. Air pollution in countries such as China is a significant public health issue, and efficient air pollution control technologies are needed. This work used pilot-scale trials to test the capacity of potted plants, a passive green wall and an active green wall (AGW) to remove particulate matter (PM) and total volatile organic compounds (TVOCs) from a room in a suburban residential house in Sydney, Australia, followed by an assessment of the AGW's potential to remove these pollutants from a classroom in Beijing. In the residential room, compared to potted plants and the passive green wall, the AGW maintained TVOCs at significantly lower concentrations throughout the experimental period (average TVOC concentration 72.5% lower than the control), with a similar trend observed for PM. In the classroom, the AGW reduced the average TVOC concentration by ~ 28% over a 20-min testing period compared to levels with no green wall and a filtered HVAC system in operation. The average ambient PM concentration in the classroom with the HVAC system operating was 101.18 μg/m^3, which was reduced by 42.6% by the AGW. With further empirical validation, AGWs may be implemented to efficiently clean indoor air through functional reductions in PM and TVOC concentrations.
Keywords	Active green wall; Botanical biofilter; Living wall; Indoor air quality; Potted plant & Green infrastructure.

Title	**Potential of Thirteen Urban Greening Plants to Capture Particulate Matter on Leaf Surfaces across Three Levels of Ambient Atmospheric Pollution**
Author Name	Yanmei Li, Shaojun Wang & Qibo Chen
Journal Name	Int. J. Environ. Res. Public Health
Year	2019
Volume and Issue	16, 3
Pages	--
Abstracts	The potential of urban greening plants to capture particulate matter (PM) from the ambient atmosphere is contingent on interactions between the level of pollution and leaf surfaces. For this study, thirteen plant species were investigated to quantify their capacity of PM accumulation under three atmospheric environments, that is, industrial, traffic and university campus (control), in Kunming City (Southwest China). The sampled sites represented different pollution levels (that is, high pollution, slight pollution and clean air, respectively). The plant species differed in their accumulation of PM by six- to eight-fold across the three sites. Magnolia grandiflora was the most efficient evergreen tree species, whereas Platanus acerifolia had the highest capture of PM among deciduous trees. The accumulation capacity of the same species varied with the degree of pollution. For example, Osmanthus fragrans, Loropetalum chinense and Cinnamomum japonicum were highly efficient for the capture of PM in the traffic and university campus areas; however, they exhibited medium accumulation in the industrial area. Prunus majestica demonstrated an intermediate accumulation capacity in the industrial area, but was low in the traffic and university campus areas. The capturing capacity of the same genus was also different among the different levels of pollution. For example, C. japonicum had a 2.9–4.2-times higher PM accumulation than did C. camphora across the three sites. There were significant differences in leaf surface area, stomata density/length, guard cell area, and trichome density/length among these species. The species-specific efficacy of PM capture was primarily contributed to by leaf size and surface roughness, stomata density, and trichome length. In particular, hairy-leaf leaves with medium stomatal density exhibited higher PM capture. Therefore, leaf micromorphology, leaf size and longevity appeared to be significant predictive factors for the accumulation of PM, which may aid in the selection of greening plant species for the remediation of pollutants in urban areas.
Keywords	air particulate matter; functional zone; micromorphological traits; trees and shrubs

Title	**Removal of particulate matter and trace elements from ambient air by urban greenery in the winter season**
Author Name	Arkadiusz Przybysz, Gayane Nersisyan & Stanislaw Waldemar Gawroński
Journal Name	Environmental Science and Pollution Research
Year	2018
Volume and Issue	26, 1
Pages	473–482
Abstracts	Particulate matter (PM) is one of the most harmful inhaled pollutants. When PM is emitted into the atmosphere, the only possible method for cleaning ambient air is through vegetation acting as biological filters for pollutants. However, in winter periods when the concentration of PM is usually the highest, the efficiency of plants is very low. The aim of this work was therefore to examine the accumulation of PM and selected trace elements (TE) by three species, evergreen coniferous Taxus baccata L. and Pinus nigra Arn., and deciduous Carpinus betulus L. during the winter season. The highest amounts of PM accumulated on the foliage of P. nigra, while TE on the leaves of C. betulus. Most of the PM accumulated on plant foliage belonged to the large fraction size (10–100 μm) and was deposited on the surface of foliage (SPM). The concentration of four TE (Ni, Pb, Cd, and Sb) was higher in PM accumulated on foliage, while in the case of three other TE (Zn, Cr and Mg), their concentration was higher in plant tissue. The TE were recorded in all PM size fractions and were rather equally distributed between surface PM (SPM) and in-wax PM (WPM). These findings have implications for urban plantings in countries with short vegetative season, where tolerant conifer species and deciduous species which keep foliage through winter should be included in urban forest plantings due to their efficiency in the removal of pollutants from the air.
Keywords	Air quality; Evergreen trees and shrubs; Heavy metals; In-wax PM; Phytoremediation; PM size fractions; Surface PM

Title	Effect of Particulate Matter (PM) On Climate, Plants, Human Health and Ecosystem
Author Name	Dr. Subhadra Rajpoot & Kabom Lego
Journal Name	International Journal of Scientific Research
Year	2018
Volume and Issue	7, 5
Pages	--
Abstracts	The work reported in this paper is part of a much larger research project on airborne particulate matter. These particulates have now become a matter of serious concern in the global environment, since not only can they have substantial negative effects on human health but they can also influence precipitation levels, the earth's climate and the ecosystem. Furthermore, the deposition of these particles on vegetated surfaces can adversely affect plant and animal life. The size, chemical composition, and origin of these particulates vary greatly. The effects of these particles have been comprehensively studied and reviewed in this paper with their associated environmental impact.
Keywords	Particulate matter; effect on human health; effect on climate; effect on ecosystem; deposition

Title	Suspended particulate matter deposition and its impact on urban trees

Author Name	Indra Jeet Chaudhary & Dheeraj Rathore
Journal Name	Atmospheric Pollution Research
Year	2018
Volume and Issue	9, 6
Pages	1072-1082
Abstracts	Fine particulate matter of industrial and traffic emissions can cause serious health hazard to urban population. However, roadside trees can be particularly effective at capturing air suspended pollutants in urban areas. This study aimed to determine the dust removal efficiency of commonly present road side trees and to identify the air pollution tolerant tree species for their suitability as sustainable green-filtration unit of urban areas. The study was conducted at tropical wet-dry climate city Gandhinagar of India and found that the maximum level of dust was deposited in winter season followed by summer and minimum in monsoon season. However, dust deposition negatively influence the leaf dry weight, photosynthesis pigments, membrane permeability, stomatal index and develop oxidative stress as measured in term of ascorbic acid in all the experimental trees. Study concluded that the Ficus religiosa is superior air pollution tolerant plant species with moderate dust removal capacity while Dalbergia sissoo is moderately air pollution tolerant species with highest dust removal capacity. Therefore, Ficus religiosa and Dalbergia sissoo could be preferred over other species to develop sustainable green-filtration space.
Keywords	Suspended particulate matter; Sustainable green filtration; Air pollution tolerance index; Membrane permeability; Stomatal index.

Title	**Impact of particulate matter on basmati rice varieties grown in Indo-Gangetic Plains of India: Growth, biochemical, physiological and yield attributes**
Author Name	U.Mina, T.K. Chandrashekara, S. Naresh Kumar, M.C. Meena, S. Yadav, S. Tiwari, Deepak Singh, Pranav Kumar & Ram Kumar
Journal Name	Atmospheric Environment
Year	2018
Volume and Issue	188
Pages	174-184
Abstracts	The study presents the first experimental evidence of the effects of atmospheric particulate matter (PM) deposition on two basmati (scented) rice varieties [Pusa Basmati-1509 (PB-1509) and Pusa Sugandh-5 (PS-5)] grown in Indo-Gangetic Plains (IGP) of India. Atmospheric PM load at the experimental site during rice crop growth period (August–November) was in the range of 162–660 μgm−3. The rice varieties growth, biochemical, physiological and yield attributes were monitored under three levels of PM deposition namely - low levels of PM deposition (LPM), ambient levels of PM deposition (APM) and elevated levels of PM deposition (EPM). PM deposition and PM flux on the canopy of rice varieties were 400–574 μgcm−2 and 24–58 μgcm−2day−1, respectively. PM deposition was 4.5% higher on the PS-5 than PB-1509 and among growth stages; it was the highest during the reproductive growth stage. Significant reduction in chlorophyll, leaf water and carotenoid content were observed in both varieties under EPM compared to APM. The air pollution tolerance index (APTI) also declined significantly. PM deposition enhanced leaf temperature (1–6%) of rice varieties under EPM compared to APM. The reduction in photosynthesis, stomatal conductance and transpiration of rice varieties under EPM were in the range of 9–52%; 6–40% and 8–46%, respectively compared to APM. PM deposition effects on plant height, the number of tillers and recoverable root biomass were found non-significant. PS-5 and PB-1509 exhibited 4–7% enhancement and 7.5–14% reduction in grain yield under LPM and EPM compared to APM, respectively. The results of the study indicate that increasing atmospheric PM pollution in IGP may adversely affect productivity and economic gains from scented basmati varieties of rice.
Keywords	Indo-Gangetic plains; Particulate matter; Air pollution tolerance index; Pusa Basmati; Pusa Sugandhl; Yield.

Title	**Particulate matter pollution capture by leaves of seventeen living wall species with special reference to rail-traffic at a metropolitan station**
Author Name	Udeshika Weerakkody, John W.Dover, Paul Mitchell & Kevin Reiling
Journal Name	Urban Forestry & Urban Greening
Year	2017
Volume and Issue	27
Pages	173-186
Abstracts	Atmospheric Particulate Matter (PM) constitutes a considerable fraction of urban air pollution, and urban greening is a potential method of mitigating this pollution. The value of living wall systems has received scant attention in this respect. This study examined the inter-species variation of particulate capture by leaves of seventeen plant species present in a living wall at New Street railway station, Birmingham, UK. The densities of different size fractions of particulate pollutants (PM1, PM2.5 and PM10) on 20 leaves per species were quantified using Environmental Scanning Electron Microscope (ESEM) and ImageJ image-analysis software. The overall ability of plant leaves to remove PM from air was quantified using PM density and LAI (Leaf Area Index); any inter-species variations were identified using one-way Anova followed by Tukey's pairwise comparison. This study demonstrates a considerable potential for living wall plants to remove particulate pollutants from the atmosphere. PM capture levels on leaves of different plant species were significantly different for all particle size fractions ($P < 0.001$). Smaller-leaved Buxus sempervirens L., Hebe albicans Cockayne, Thymus vulgaris L. and Hebe x youngii Metcalf showed significantly higher capture levels for all PM size fractions. PM densities on adaxial surfaces of the leaves were significantly higher compared to abaxial surfaces in the majority of the species studied (t-test, $P < 0.05$). According to EDX (Energy Dispersive X-ray) analysis, a wide spectrum of elements were captured by the leaves of the living wall plants, which were mainly typical railway exhaust particles and soil dust. Smaller leaves, and hairy and waxy leaf surfaces, appear to be leaf traits facilitating removal of PM from the air, and hence a collection of species which share these characters would probably optimize the benefit of living wall systems as atmospheric PM filters.
Keywords	Outdoor air pollution; Urban green infrastructure; Green walls; Railway pollution