INFLUENCE OF PARTICULATE MATTER ACCUMULATION ON INTERIOR FOLIAGE PLANT IN JAUNPUR (U.P.) INDIA

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The characteristics of indoor air can be altered by the presence of interior plants. During his physiology plant alter the composition of CO_2 and O_2 in air which affects air composition in surrounding area. Particulate matter accumulation on horizontal surface was measured gravimetrically at 10 days intervals in two interior spaces. Species and plants were added or removed random. The location of particulate matter deposition was unaffected by the presence or absence of plants (deposition of PM in experiment dishes near door, centre or corner). Relative humidity was higher when plants were present.

KEYWORDS : Particulate matter, Interior Plants, Particles, Dust, Indoor air pollution.

INTRODUCTION

Plants play an important role in mitigating urban pollution. Leaves and other parts of plants may act as persistent absorbers of particulate matter (Liu *et al.*, 2013). Studies have shown that the PM retention capacity of leaves depends on their surface geometry, hairs, cuticles and epidermal features, length of petioles, phyllotaxy, the height and canopy structure of trees, plant age, leaf surface wettability and local meteorological conditions. A study in Guangzhou, China, found that urban vegetation could retain 8012.9 tons of dust per year (Liu *et al.*, 2013). Yang *et al.* (2005) reported that trees reduced by 772 tons PM_{10} from the air in Beijing over a year. Speak *et al.* (2012) concluded that green roof vegetation could remove 0.21 metric tons of PM_{10} a year, which equates to 2.3% (± 0.1%) of the PM_{10} emitted in a UK city. However, most previous studies about the particulate retention capability of plants focused mainly on dust or PM_{10} (Liu *et al.*, 2012, 2013), and only a few studies focused on the $PM_{2.5}$ capturing ability of plants leaves. Atmospheric particulate matter (PM) has received wide attention due to its adverse impacts on human health and the environment (Polichetti *et al.*, 2009; Perrone *et al.*, 2010).

PM is complex mixture of suspended solid and liquid particles with different physical and chemical properties, originating from natural and anthropogenic sources. According to the aerodynamic diameter, particles can be classified as PM_{10} (< 10 μm diameter) and PM2.5 (< 2.5 μm). The chemical composition of PM_{10} varies greatly and strongly depends on combustion sources and atmospheric conditions (Lighty *et al.*, 2000; Solomon and Sioutas, 2008; Amodio *et al.*, 2012). PM_{10} consists of major components representing the main part of

the total mass of particles, and trace components usually represent less than 1% of total particles mass (Amodio *et al*., 2010).

Although plants can reduce particulate matter in atmosphere, some plant performance studies have shown the plant growth is influenced by atmospheric pollution, and the level of influence on growth depends on plant species, pollutant type and concentration, as well as a number of environmental factors (Wuytack *et al*., 2011; Chaturvedi *et al*., 2013). Particles deposited on leaf surfaces can reduce the illumination reaching the photosynthetic apparatus and block stomata. In both cases, photosynthesis and growth would be reduced (Naidoo and Chirkoot, 2004).

In order to assess the effect of different size particles accumulation on leaf surfaces on leaf traits, this study measured the accumulation of three sizes of PM on leaf surfaces and seven parameters of leaf traits among plants species that are commonly cultivated as urban vegetation in central India. For each tree, mature and healthy leaves were collected from east, south, west and north facing aspects in open habitats at a height of 0.1 to 2.5 m above ground level according to the plant height (Liu *et al*., 2012). To obtain sufficient material for measuring the $PM_{0.2}$ and to avoid filter blockage by particles during filtration, the leaf area per species ranged between 300 and 400 cm^2, and a larger leaf area was required in the control site (Dzierzanowski *et al*., 2011). All the samples of the two sites were collected on the same day, and were placed in polyethylene bags, labeled and stored in the laboratory with a constant relative humidity and temperature until analysis. During transport to the laboratory, the samples were stored in an icebox.

PM accumulation by site and plants

The results showed the differences in PM (PM_{11}, $PM_{2.5}$, $PM_{0.2}$) accumulation at the 2 sites and among 10 species verifying our first hypothesis. PM accumulation data showed greater PM accumulation on the leaf surfaces in WISC, probably due to the higher air pollution due to coal combustion and huge traffic volume.

The PM retention differences of various plant species in the same place were also significant ($p < 0.01$). In WISC, *R. sisii* showed the highest total PM retention. Our results also showed an obvious difference among the three PM fractions retained on leaf surfaces. PM_{11} accounted for about 84.6% of the total particulate matter, and $PM_{2.5}$ and $PM_{0.2}$ accounted for only about 13.0% and 2.4%, respectively.

In our research, a model experiment was conducted to demonstrate and evaluate the environmental impact of the chemical components in PM_{10} on plants via root uptake. Among vegetables, tomato (*Solanum lycopersicum* L.) was chosen because it is one of the world's most important crops.

Research has shown that atmospheric dust over wooded areas can be 75% lower than over relatively non-vegetated, populated areas (Rotschke, 1937). Vegetation acts as a natural filter, causing particles to be deposited on the vegetative surface through sedimentation, impaction, or precipitation. Trees in urban areas have been shown to collect dust on their leaf surfaces and trichomes, and even on fungal mycelium growing on them (Smith and Staskawicz, 1977).

It is possible that interior plants will function through mechanisms similar to those of plants outdoors and contribute to the reduction of airborne particles in interior environments. It has also been speculated that the plants themselves or their growing medium may be sources of particulate matter and may contribute to an increase in particulate matter in interior spaces (Owen *et al*., 1992). The purpose of these studies was to begin to address the impact of interior plants on particulate matter in interior spaces.

METHODS

Foliage plants of various species and sizes were added to or removed from a 27-station instructional computer laboratory at Washington State University during fall semester 1993. The treatment period was seven days long, and the treatment condition (plants present or plants absent) was assigned randomly. Common low-light tolerant species of interior plants. These planters operate on a vacuum principle and supply water from the bottom. Water is distributed throughout most of the growing mix by capillary action, but the soil surface remains dry and appears dusty.

RESULTS AND DISCUSSION

In the Bed room, where about 2% of the room was filled with plants, particulate matter accumulation in the presence of plants was lower than in their absence. Because computer hard drives can be destroyed by excessive dust, the possibility that interior plants might actually contribute to increased particulate matter was a special concern. It was also a concern due to the dry and dusty growth medium surface typical for plants in self-watering containers. These results indicated that plants were not contributing to increased particulate matter, and were actually reducing it.

The second experiment supported the results of the experiment in the Bed room. In the office space, particulate matter accumulation was also significantly lower when plants were placed in the room than when they were absent (Fig. 1). These two experiments indicated that plants can contribute to reduced particulate matter in interior spaces, mirroring what has been shown for:

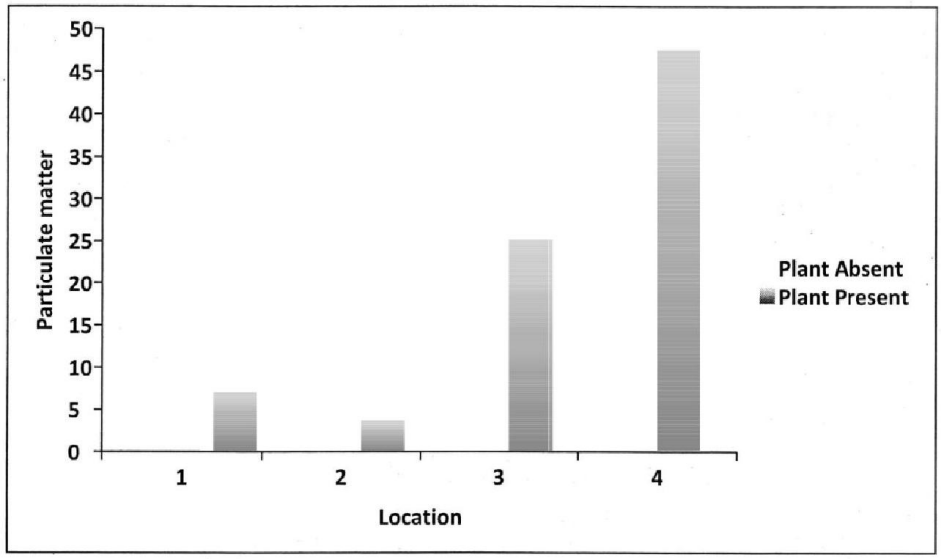

Fig. 1. Particulate matter accumulation, temperature and relative humidity means and standards errors in presence and absence of interior plants

In each experiment, there was a significant location effect (P = 0.0001). In the computer lab test site, for example, dishes at locations near the door to the lab consistently accumulated

more particulate matter, while those in the corners of the room accumulated less particulate matter than dishes at other locations, whether plants were present or not (Fig. 2, similar locations have been grouped to summarize the data). Locations in areas of the room with higher levels of human activity accumulated more particulate matter than locations in less frequently used areas of the room.

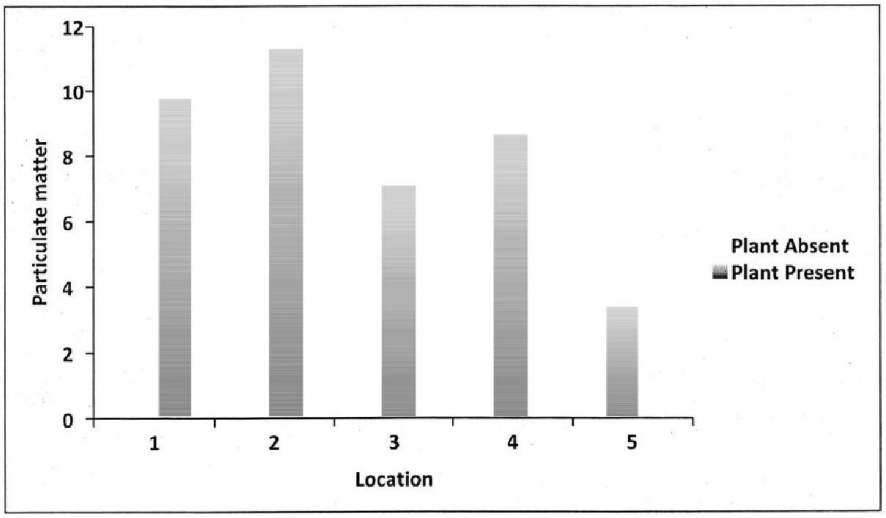

Fig. 2. Particulate matter accumulation means in the presence and absence of interior plants at various location in drawing room

The addition of plants to the office space did not affect average room temperature, but did change relative humidity (Fig. 1). Relatively humidity was marginally, but significantly, higher when plants were present than when they were not. These results are consistent with earlier reports that plants do contribute to increased relative humidity, but the increase is generally relatively small (Lohr, 1992a, b).

This experiment demonstrates that accumulation of particulate matter on horizontal surface in drawing room can be reduced by 12-16% by adding foliage plants. While few workers reported that airborne particles and plants had close relationship to occur on the seal present in interior spaces. Our study reveal that drawing is populated are nearby a day particularly as it may rebate to potential human health effects. It also throws light on documentation of a positive impact of interior plants on particulate matter deposition which serve to stimulate others to pursue this important relationship between plant and interior air quality.

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