Effect of Urban Air Pollution on Pollen Characteristics of *Peltophorum inerme* Naves in Mysore City

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Abstract

The present study examines the pollen characteristics of *Peltophorum inerme Naves* as a bio-indicator of vehicular air pollution in Mysore city. The effect of air pollutants on the pollen germination and pollen viability of the tree species growing at the traffic intersection-Fountain circle, Mysore city was primarily focused in the study. Scanning Electron Micrographs (SEM) showed significant changes in pollen grains of polluted area. Considerable reduction was observed in the viability of pollen, delay in the onset of germination and pollen tube length as compared to the pollen samples from the control area-Mahadevapura situated 20kms away from the city. The present study has explored the possibility of using pollen grains as bio-monitor of urban air pollution.

KEYWORDS: SEM, biomonitoring, pollen germination, pollen tube and ambient air quality.

Introduction

Biomonitoring consists of the use of responses of individual plants or plant associations at several biological organization levels in order to detect or predict the changes in the environment and to follow their evolution as a function of time. Some plant species are sensitive to single pollutant or to a mixture of pollutants.

Avenue trees act as scavengers by absorbing air pollutants in the urban environment. The plant organs show specific changes due to air pollutants in the form of visible injuries. Study of effect on micromorphological features, physiological changes (Kulshreshta et al., 1994; Saadabi et al., 2011; Tiwari and Tiwari 2006) and effect on reproductive organs (Rejanejad 2008; Chehregani et al., 2004; Malayeri et al., 2011) have been carried out. Plants reproductive organs are very sensitive to the air pollutants. The male reproductive organs being the important organs on plants changes in their structure, germination and viability. The present study was undertaken to evaluate the effects of vehicular pollution on pollen characters of *P. inerme* Naves in Mysore city. *P. inerme* is a common avenue tree with attractive yellow raceme inflorescence. They can be stored in adequate quantity and in viable condition for a long time. They are relatively more sensitive as compared to leaves and other plant organs. Biomonitoring with pollen can be easily accomplished with simple equipments. Hence, the present work was undertaken to assess the impact of pollutants on morphological changes in the pollen

grains of tree species in the historical city of Mysore. Pollen has a great advantage in biomonitoring the atmospheric pollution.

The present investigation aims at studying the effect of air pollutants on pollen germination and pollen tube growth of a roadside tree species *P. inerme Naves* growing at Fountain circle - one of the busiest traffic intersections in the city of Mysore, Karnataka, India. The tree growing at Mahadevapura, 20kms away from the city with negligible traffic served as the control. The city of Mysore has witnessed a phenomenal increase in traffic population from 6333 in 1970 to more than 4, 38,003 as on 31st March 2011 (Harish, 2012). Naturally, increased emission from the vehicles adversely affects the roadside vegetation.

Materials and Methods

Pollen samples from the tree species were collected during the flowering season both at control-Mahadevapura forest area and polluted area - Fountain circle of Mysore city which is a commercial area with more number of vehicles. Fluorochromatic Reaction (FCR) Test was done to assess the viability of pollen of the tree species following the method of Heslop-Harrison (1970). A drop of sucrose - Fluorescein diacetae (FDA) solution was taken on a micro slide. Sufficient amount of pollen grains were suspended in the drop and mixed thoroughly to ensure uniform distribution of pollen. The micro slide was incubated in a humidity chamber (>90 % RH) for 5-10 minutes. At the end of the incubation period, cover glass was placed over the slide and the preparation was observed under fluorescent microscope with suitable filters. The pollen grains that fluoresce brightly were considered viable. Photomicrographs were taken with fluorescent microscope.

Pollen was cultured using Brewbaker & Kwack's medium (1963). To culture the pollen, hanging drop culture method was followed (Shivanna and Rangaswamy, 1992). The responses of cultured pollen grains were assessed as percent pollen germination and average pollen tube length. Pollen grains from ten arbitrarily selected microscope fields were scored for germination. The slides were observed under microscope at every one - hour interval to record the result.

SEM studies were carried out to understand the ultra structural changes on the pollen grain. The samples were collected from both polluted and control areas and stored in glacial acetic acid. The pollen sample was acetolysed (Erdtmann, 1960) in the freshly prepared acetolysis mixture and proceeded for the SEM studies following the method of Falc (1980). The selected pollen grains from polluted and control area were photographed. Ambient air quality monitoring data at Fountain circle, Mysore was obtained from the Karnataka State Pollution Control Board, (KSPCB) Mysore. Monitoring was done for major pollutants namely SPM, SO_2 and NOx using High Volume Air Sampler.

Percent pollen germination = number of pollen grains germinated / total number of pollen grains in the field × 100

The length of the pollen tubes in ten microscopic fields was measured with an ocular micrometer.

Mean pollen tube length (μm) = Total length of all pollen tubes (in units of ocular micrometer) / Total number of pollen tubes measured from all fields.

Results

The tree species selected for the study showed considerable changes in the i*n vitro* germination studies, pollen viability test and SEM studies. For *in vitro* germination studies pollen samples of the tree species from control area-Mahadevapura and polluted area-Fountain circle were collected and used for testing the pollen viability, percent pollen germination and pollen tube length.

Basically the FDA test was used to examine the pollen viability. The viability results of pollen from control and polluted areas are shown in the Table 1. Pollen that fluoresce brightly when observed under fluorescent microscope was considered viable (Figure 1). The study reveals that the pollen from polluted area showed decrease in the pollen viability in the tree species studied. The result of percent germination of the tree species from control and polluted area is presented in figure 2a.

The mean length of pollen tube in the tree species of polluted and control area is shown in figure.2b. There was a significant reduction in the length of pollen tube in pollen of polluted area as compared to control area pollen in the tree species.

The pollen grains of *P. inerme* were circular in nature with ornamented thick exine. The pollen grain shows visible three colpes and a single pore. The exine wall was found to be highly articulated and in polluted samples exine wall is found to be slightly disturbed (Figure. 3).

Air quality monitoring data for pollutants SPM, SO_2 and NO_X for Mysore city is presented in the Table 2. The data was obtained from KSPCB Mysore, for the months of April, May and June for a period of 2 years. The data showed that SPM, SO_2 and NO_X concentrations were within the permissible limits prescribed by the Central Pollution Control Board, New Delhi.

Conclusion

The direct effect of pollutants on pollen ovules, zygotes and seeds are considered to be the most serious impact of air contamination on plants, resulting in alteration of gene flow and selection and in a change of genetic structure of plant population (Gregorius 1989, Giannini and Magnani, 1994). Of the reproductive structures mentioned, pollen was reported to be sensitive to air pollutants in concentrations lower than required for foliar injury (Cox, 1984). Pollen from trees affected by air pollution has a decreased viability and germination capacity (Bellani et al., 1988). Thus pollens may be used as a sensitive indicator of pollution (Wolters and Martens, 1987).

The present investigation precisely emphasizes the possibility of using pollen as bioindicator of air pollution in the urban environment. Numerous studies have assessed the impact of air pollutants on pollen but only limited investigations are carried out on the use of pollen to evaluate atmospheric pollution. Pollens are very sensitive to air pollutants and

have been used for air pollution monitoring (Varshney and Varshney, 1981). Fedotov et al., (1983) have also observed SO_2 induced reduction in pollen viability, size and shape of pine pollen grains.

Pollen used as bioindicator does not indicate levels of pollutants, but it measures their biological impact. It provides information on the potential adverse effects of pollutants on living organisms. This direct assessment of risk by bioindicator methods is of greater importance compared to the physico-chemical methods. Plant bioindication methods are not a substitute to physico-chemical methods for air pollution studies. However, they constitute complementary methods as they provide essential information on biological impact.

In SEM microphotographs, the exine wall was observed to be highly articulated and in polluted samples exine wall was found to be slightly disturbed. Increased phenolic content in the anther epidermal cells of *Lagerstroemia indica* was noticed by Rezanejad (2008) and pollen grains from polluted areas were irregular, shrunken and smaller when compared to the control area. The enhanced accumulation of phenolic materials was one of the most common reactions of plants to stresses.

Similarly, the pollen grains collected from polluted areas as well as the ones exposed to gaseous pollutants showed collapse and thinner exine. Airborne particle materials adhere to the pollen surface, causing the collapse and degradation of the exine surface, shrinkage and abnormality of pollen (Rejanejad 2007). SEM studies by Wolters and Martens (1987) revealed that O_3 caused degradation of epicuticular wax.

Pollen germination and pollen tube growth are crucial phases in reproductive development. The impairment of these processes may result in the failure of fertilization and as a consequence, seed set and crop yield could also be reduced. Air pollutants interact with the pollen and bring about changes in the pollen germination, pollen tube length and pollen viability which adversely affects the growth of pollen and ultimately leads to the failure in reproduction. The results of present investigation are in conformity with the observations of earlier researchers. The effects of air pollutants are very much complex and require comprehensive scientific investigations. Thus the methods using pollen for biomonitoring of air pollution could be successful one as they are cheap, simple and fast supplement for physicochemical methods. Pollen grains, as bioindicators provide particularly authentic and systematic data on the potential adverse effects of pollutants on living organisms.

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Figure captions

Fig.1. Fluorochromatic reaction test showing viable and non-viable pollen grains under fluorescent microscope. The viable pollen grain fluorescing brightly is indicated with arrow.

Fig. 2. a & b. Effect of pollutants on the percent pollen germination and mean pollen tube length of the tree species growing at control and polluted areas respectively.

Fig.3. Scanning Electron Micrographs of *P. inerme.* a & b. Pollen grains circular in nature with ornamented thick exine showing visible three colpes and a single pore from control area. 1000x and 2000x; c & d. Pollen samples from polluted area showing slightly disturbed exine wall.1000x and 2000x respectively.

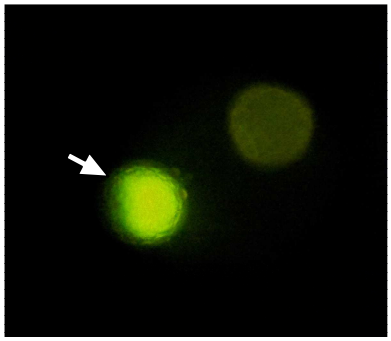
Table 1: Effect of vehicular pollution on percent pollen viability of tree species.

Tree species	Control (%)	Polluted (%)
Peltophorum inerme Naves	82	68

Table 2: Ambient air quality monitoring data for different pollutants of Mysore City.

Pollutants	April	May	June
SPM (µg/m^3)	105.5	103.85	89.45
SO_2 (µg/m^3)	11.05	12.2	12.0
NOx (µg/m^3)	23.75	25.7	25.1

Fig.1. Fluorochromatic reaction test showing viable and non-viable pollen grains under fluorescent microscope. The viable pollen grain fluorescing brightly is indicated with arrow.



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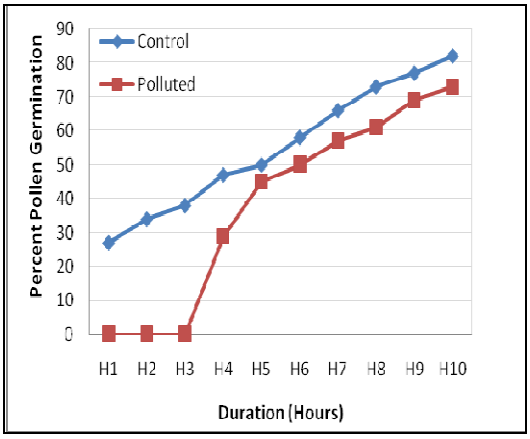
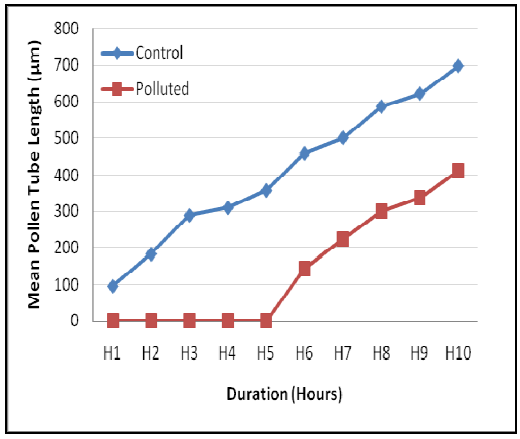


(a)



(b)

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