EFFECT OF AUTO-EXHAUST POLLUTION AT BYCULLA MUMBAI, INDIA ON THE PALYNOLOGY OF *Peltophorum ferrugenum* BENTH.

Iyer M. P.*¹ and Bholay A.D.²

1. Department of Environmental Science, Shri Jagdishprasad Jhabarmal Tibrewala University, Jhunjhunu, Rajasthan (INDIA)
2. Department of Microbiology, K.R.T. Arts, B.H. Commerce & A.M. Science College College, Nashik, Maharashtra (INDIA)

Received October 10, 2014  
Accepted January 20, 2015

ABSTRACT

Among the many factors that contribute to air pollution, automotive exhaust is posing a serious problem of increasing dimensions. Biomonitoring of the environment is now recognized to play a vital role in the assessment of environmental impact analysis. Biomonitoring can be employed to detect and evaluate the toxic substances in the environment. In recent years palynology has attracted the attention of many workers of different disciplines on account of its application in numerous fields. Pollen development and pollen viability and pollen tube growth are among the sensitive indicators of adverse factors in botanical environment. This led to the idea that the inhibited development and growth potential of pollen in response to various toxic atmospheric contaminants can be exploited as a good index of air purity. The present research work was conducted to understand the severity of automobile pollution at Byculla (Mumbai) and provides few affordable suggestions to reduce auto exhaust pollution. The study was carried on *Peltoforrum ferrugenum* through various parameters of pollen grains.

**Key Words**: Auto exhaust pollution, Sensitive and tolerant varieties of plants, Biomonitors, Environmental impact, Pollen viability

INTRODUCTION

Environmental science is a new name for an activity in which our species has been engaged throughout life time-learning how to live on this planet without damaging it or threatening our own existence in the process. Human utilization of the natural resources to some extent bears resemblance to a sort of planetary cancer. Successful medical treatment must be based upon the right diagnosis. It is vital to gain more insight into the structure and functioning of ecological systems in order to safeguard the environment. Solving the highly complex problems and interrelated issues of population, pollution resources requires a knowledge of scientific fields including chemistry, biology, physics, geology, climatology, forestry, agriculture, economics, as well as engineering and medicine. Thus, environmental science emerges as an inter and multidisciplinary course of action. The deadly 275 tons of lead is released from the vehicles every year. The ambient air in the city contains 1.2ug/m³ of lead. It is interesting to note that in some areas of Mumbai children have very high levels of lead in their blood. At Byculla, it is 14.6ug/m. SO₂ and oxides of Nitrogen corrode and damage lungs. In Byculla almost 25% to 30% of the children suffer from emphysema and asthma. Several doctors in Byculla pointed out that each year they receive larger number of cases of chronic bronchitis and cardiovascular illness.

The present study provides flood gates of information about the drastic effects of auto-exhaust pollution on the vegetation and provides suggestions to control the vehicular pollution. Since plants are far more sensitive than animals the plants are used as indicators of vehicular pollution. Attempts have been made to develop some plant strains which can be specially used for indicating particular pollutants at a particular

*Author for correspondence
region. On the basis of their responses to vehicular pollutants plants have been classified into sensitive and tolerant ones.

Maximum attention was given to collect the plants closer to the traffic pathway at Byculla. Comparatively less polluted area (Vasai village) was selected as a control. The collection of flowers was done on the same day at fixed times from both polluted and control sites. For each data mean and standard deviation was calculated. For finding out the significance of each observation Student’s t-test was done.

**MATERIAL AND METHODS**

The present work deals with the evaluation of toxicity of auto-exhaust pollution at Byculla (Mumbai) through the pollen physiology of *Peltophorum ferrugineum* Benth. Palynology is the branch of botany which deals with the study of pollen grains. Pollen is a fine to coarse powder containing the microga metophytes of seed plants, which produce the male gametes (sperm cells). Pollen grains have a hard coat that protects the sperm cells during the process of their movement between the stamens to the pistil of flowering plants or from the male cone to the female cone of coniferous plants. When pollen lands on a compatible pistil of flowering plants, it germinates and produces a pollen tube that transfers the sperm to the ovule of a receptive ovary. The individual pollen grains are small enough to require magnification to see detail under the compound microscope (Fig. 1 and Fig. 2).

**Fig. 1**: Pollen grains seen under compound microscope

**Fig. 2**: Pollen grains showing pollen tube growth

Under pollen physiology the following parameters were examined.

- **Pollen production** – Pollen grains of ten flowers per species were counted.
- **Pollen viability** – Pollen viability was tested by 2,3,5 – triphenyl tetrazolium chloride ten random fields all over the slide were counted, making a total of 500 pollen grains. Pollen viability was also determined by germination potential of the pollen grains.

- **Pollen size** – Length and breadth of pollen grains were measured by the micrometry and the mean of 25 observations was expressed in µm.
- **Rate of germination and tube growth** – To find out the germination potential of pollen grains, flower buds of various sizes marking the various stages of development and the open flowers were plucked at the same time. Series of successive flowers marked were:
F-Flowers at stage of dehiscence of anthers
F-24 Flower buds which require 24 hr to open.
F-48 Flower buds which require 48 hrs to open.
F-72 Flower buds which require 72 hrs to open.
Germination of pollen grains was studies by
standing drop technique in Brewbaker and
Kwack’s culture medium. The experiment
was conducted in Winter to maintain the
suitable relative humidity. The experiments
were run in triplicates and the average results
were recorded. The rate of pollen germination
and tube growth were determined by fixing the
cultures at one hour intervals which was
continued for ten hours.
Rate of decrease in pollen germination and
tube growth – It deals with the ability of the
pollen grains to remain viable after the
dehiscence of the anthers in the detached
successive flowers under natural conditions.
The rate of decrease in pollen germination and
tube growth were also studied periodically
during storage by fixing the cultures at two
hours intervals. Such cultures were continued
for ten hours.
For each parameter number of observations
was made and the average and standard
development were calculated. Each data was
statistically analyzed applying the t-test of
significance. The difference from the control
readings was also calculated to find out the
relative inhibitory and stimulatory effects on
the various parameters.

*P<0.1%, **P<0.05% and ***P<0.01%.
C, control; P, polluted; values given are mean ± S.D. of 10 flowers, values are significant at

RESULTS AND DISCUSSION
Air pollution due to vehicular emission mostly
arises from cars, buses, minibuses, wagons,
rickshaws, motorcycles and trucks could
threate[n the health of human beings, trees,
crops and animals. Air pollution at Byculla
the city of Mumbai is rising to an alarming state
rapidly since the last few decades due to heavy
automobile activities. Rapid increase in
automobile activities and traffic congestion
contributes most of air pollution problems,
resulting in damage to the plants growth. The
following observations show that the plant’s
pollen grains growing adjacent to roadsides of
the city exhibited considerable damage in
response to automobile exhaust emission.

Table 1: Effect of auto-exhaust pollution at Byculla on the pollen production / flower,
pollen size and pollen viability of *Peltophorum ferrugineum* Benth.

<table>
<thead>
<tr>
<th>Parameters</th>
<th><em>Peltophorum ferrugineum</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
</tr>
<tr>
<td>Pollen production / flower</td>
<td>032913.21 ± 056.50</td>
</tr>
<tr>
<td>Pollen size</td>
<td>51.25 ± 5.61 X44.12+7.08</td>
</tr>
<tr>
<td>The pollen viability (By T.T.C)</td>
<td>83.34 ±0.51</td>
</tr>
<tr>
<td>The pollen viability (By germination)</td>
<td>83.47 ±0.38</td>
</tr>
</tbody>
</table>

Table 4 and Fig. 6)

654
Table 2: Effect of auto-exhaust pollution at Byculla on the rate of decrease in pollen germination of successive flowers of *Peltophorum ferrugineum*

<table>
<thead>
<tr>
<th>Time in Hrs.</th>
<th>Successive flowers</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>P</td>
<td>C</td>
</tr>
<tr>
<td>00</td>
<td>96.85 ± 0.63</td>
<td>66.82 ± 0.66</td>
<td>NG</td>
</tr>
<tr>
<td>02</td>
<td>83.14 ± 0.72</td>
<td>63.70 ± 0.33</td>
<td>NG</td>
</tr>
<tr>
<td>04</td>
<td>80.36 ± 0.44</td>
<td>60.20 ± 0.57</td>
<td>NG</td>
</tr>
<tr>
<td>06</td>
<td>72.46 ± 0.31</td>
<td>54.86 ± 0.45</td>
<td>NG</td>
</tr>
<tr>
<td>08</td>
<td>69.84 ± 1.06</td>
<td>48.41 ± 0.28</td>
<td>NG</td>
</tr>
<tr>
<td>10</td>
<td>62.20 ± 1.14</td>
<td>44.72 ± 0.64</td>
<td>NG</td>
</tr>
</tbody>
</table>

C, control; P, polluted; NG, Non-germinated; Values given are mean ± S. D. of 500

Table 3: Effect of auto-exhaust pollution at Byculla on the rate of pollen tube length (µm) of successive flowers of *Peltophorum ferrugineum*

<table>
<thead>
<tr>
<th>Time in Hrs.</th>
<th>Successive flowers</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>F-24</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>P</td>
<td>C</td>
</tr>
<tr>
<td>01</td>
<td>178.16 ± 114.32</td>
<td>NG</td>
<td>NG</td>
</tr>
<tr>
<td>02</td>
<td>286.80 ± 082.46</td>
<td>NG</td>
<td>NG</td>
</tr>
<tr>
<td>03</td>
<td>340.36 ± 126.31</td>
<td>NG</td>
<td>NG</td>
</tr>
<tr>
<td>04</td>
<td>445.21 ± 180.43</td>
<td>NG</td>
<td>NG</td>
</tr>
<tr>
<td>05</td>
<td>620.43 ± 216.38</td>
<td>NG</td>
<td>NG</td>
</tr>
<tr>
<td>06</td>
<td>684.28 ± 186.57</td>
<td>341.35 ± 165.40</td>
<td>NG</td>
</tr>
<tr>
<td>07</td>
<td>695.42 ± 221.48</td>
<td>356.11 ± 216.35</td>
<td>NG</td>
</tr>
<tr>
<td>08</td>
<td>716.80 ± 175.43</td>
<td>622.86 ± 120.75</td>
<td>NG</td>
</tr>
<tr>
<td>09</td>
<td>780.00 ± 083.71</td>
<td>654.35 ± 096.31</td>
<td>NG</td>
</tr>
<tr>
<td>10</td>
<td>820.65 ± 135.26</td>
<td>689.74 ± 130.12</td>
<td>NG</td>
</tr>
</tbody>
</table>

C, control; P, polluted; NG, Non-germinated; Values given are mean ± S. D. of 500

Table 4: Effect of auto exhaust pollution at byculla on the rate of decrease in pollen tube length (µm) of successive flowers of *Peltophorum ferrugineum*

<table>
<thead>
<tr>
<th>Time in Hrs.</th>
<th>Successive flowers</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>F-24</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>P</td>
<td>C</td>
</tr>
<tr>
<td>00</td>
<td>841.32 ± 130.84</td>
<td>751.62 ± 134.11</td>
<td>NG</td>
</tr>
<tr>
<td>02</td>
<td>756.83 ± 145.32</td>
<td>662.18 ± 083.16</td>
<td>NG</td>
</tr>
<tr>
<td>04</td>
<td>682.75 ± 216.43</td>
<td>581.20 ± 056.25</td>
<td>NG</td>
</tr>
<tr>
<td>06</td>
<td>568.82 ± 185.14</td>
<td>526.62 ± 141.73</td>
<td>NG</td>
</tr>
<tr>
<td>08</td>
<td>545.32 ± 078.31</td>
<td>475.85 ± 125.46</td>
<td>NG</td>
</tr>
<tr>
<td>10</td>
<td>316.65 ± 081.54</td>
<td>278.22 ± 216.64</td>
<td>NG</td>
</tr>
</tbody>
</table>

C, control; P, polluted; NG, Non-germinated; Values given are mean ± S. D. of 500.
Fig. 1: Effect of auto-exhaust pollution at Byculla on the pollen production/flower of Peltophorum ferrugenum Benth

Fig. 2: Effect of auto-exhaust pollution at Byculla on the pollen size of flower of Peltophorum ferrugenum Benth

Fig. 3: Effect of auto-exhaust Pollution at Byculla on the pollen viability of flower of Peltophorum ferrugenum Benth
Fig. 4: Effect of auto-exhaust pollution at Byculla on the rate of decrease in pollen germination of successive flowers of *Peltophorum ferrugineum*.

Fig. 5: Effect of auto-exhaust pollution at Byculla on the rate of pollen tube length (µm) of successive flowers of *Peltophorum ferrugineum*.

Fig. 6: Effect of auto-exhaust pollution at Byculla on the rate of decrease in pollen tube length (µm) of successive flowers of *Peltophorum ferrugineum*.
Some workers are of the opinion that $H^+$, HSO$_3^-$, SO$_3^{2-}$ and SO$_4^{2-}$ ions, which are produced by specific air pollutant dissolution in water in cytoplasm, are preferentially incorporated into thylakoid membranes and pollen fertility$^5$ and induce swelling or disintegration of the membranes$^6$. Only the infinitesimal number of pollen produced by the anther are of fertile value and the rest are dispersed, distributed and deposited in various areas of scientific investigations of application to human progress and developments. The toxicity of the air is deleterious to the delicate pollen grains which in turn affect fertilization biology. The pollen has been used as an index for environment pollution by many workers. As a result of long lasting or regularly recurring impacts of automobiles, vegetation shows retarded growth and plants will have fewer leaves with smaller size and decreased rate of plant metabolism. According to$^7$ there was a considerable reduction in the growth of plants from the polluted area. He observed reduction in stem growth, leaf, flower and fruit sizes and quality in Commelina bengalensis$^8$ observed decreased growth of lettuce sheet as well as root due to industrial pollution. Cassia siamea showed reduction in leaf area (mm$^2$), length of leaf and trichome frequency in plants from polluted area when compared with plants from reference site$^9$. All these observations give support to find out the deleterious effects of automobile exhaust in the roadside plants. 

Table 1 reveals that the species studied showed inhibition in its pollen production, pollen viability and pollen size. Thus it can be used as an indicator of auto-exhaust pollution. Inhibition in the pollen fertility by automobile pollution$^{10}$. 

Pollen germination plays a supreme role in reproductive biology and genetics improvement of plants$^{11}$. Low pollen germination and inhibition length of pollen tubes as affected by automobile pollution may considerably affect the yield.

The automobile pollution at Byculla causes the prolongation of the resting period of pollen grain of F – series by 2, 3 or 5 hours in the species studied. This proves that these pollen grains are sensitive to auto-exhaust pollution. Peltophorum ferrugineum was affected due to the prolongation of the resting period of F-series to 5 hrs (Table 4). Peltophorum ferrugineum showed potentiality of pollen germination in F – series only. F – 24 series of flowers in Peltophorum ferrugineum showed no germination at all. However$^{12}$, reported pollen germination in Citrullus colocynthis as early as in the microspore tetrad stage. The rate of pollen germination showed inverse proportion to the storage period. The rate of decrease in pollen germination in the species studied was stimulated by the ambient air at Byculla. Auto-exhaust pollution at Byculla inhibited the pollen tube length of Peltophorum ferrugium. Growth of pollen tube also was found inversely proportionate to the storage time (Table 4). Inhibition in pollen tube length by automobile pollution was supported by others too. Damaging effects of air pollutants on plants have long been recognized and are therefore used as indicators$^{13-17}$. To control the air pollution problems attention must be given to check the emission at point source and vehicular emissions as per the prescribed limits and implement air pollution control regulations rigorously. There could be a lot of technological approaches to be adopted for motor vehicle emission control in each part of the automobile engine. Some of the control methods at the four deferent sources of automobiles are dealt herewith$^{18-22}$. Formaldehyde gas is also created from the combustion of organic material and can be produced secondarily in air from photochemical reactions involving virtually all classes of hydrocarbon pollutants which effects the pollen production and pollen germination potential$^{23}$. The effect of auto exhaust is also supported$^{24}$ on the feature of pollen grain. According to a research$^{25}$ pollen grains of timothy grass are good indicators of pollutants. Catalytic converter is a stainless steel container mounted somewhere along the exhaust pipe of the engine and inside the container is a porous ceramic structure through which the exhaust gas flows$^{26}$. To minimize the gaseous pollutants at the exhaust pipes, additional fresh air is injected by an air pump which sends air through an air bypass valve mounted on the side of the exhaust manifold. Utilization of
catalytic converters is the most recent measure which offers a potential for reducing pollution at the tail pipe without a drastic effect on the combustion process inside the engine. The catalysts consist of metal oxide impregnated on inert porous ceramic support materials. Any suitable catalyst can be selected and installed in the exhaust system between the engine and mufflers. This catalyst usually converts the pollutants into harmless products. It has been reported that catalysts combining platinum and rhodium was found the best to reduce the exhaust pipe pollution. It has been found that substitution of Liquefied Petroleum Gas (LPG) and Compressed Natural Gas (CNG) as fuels reduce moisture of the exhaust pollutants, and mixing of hydrogen in gasoline appears to be the most promising engine fuel. The Indian auto industry is working with the authorities to facilitate for introduction of the alternate fuels. India has also set up a task force for preparing the hydrogen road map. LPG has been introduced as an auto fuel and the oil industry has drawn up plans setting up auto LPG dispensing stations in major cities. Pedestrian precincts have a salutary effect on the traffic situation. It increases the safety of the pedestrians. Planting of certain fast growing trees, which are resistant to and can withstand the increasing air pollution will be significantly useful for the air pollution control.

**CONCLUSION**

The present research work concludes that as per the tolerant levels, the plants can be classified as resistant verities and tolerant ones. The automobile pollution at Byculla causes the prolongation of the resting period of pollen grain of F – series by 2, 3 or 5 hours in the species studied. This proves that these pollen grains are sensitive to auto-exhaust pollution. *Peltophorum ferrugineum* was shown affected more due to the prolongation of the resting period of F-series to 5 hrs. *Peltophorum ferrugineum* showed potentiality of pollen germination in F-series only. *Peltophorum ferrugineum* showed no germination at all in F-24 series. Auto-exhaust pollution at Byculla inhibited the pollen tube length also. Growth of pollen tube also was found inversely proportionate to the storage time. As a concluding note it should be mentioned that the current trend of environmental degradation, if allowed to go unchecked, would reach a stage of upsetting and disrupting the life supporting capabilities and processes of earth before the turn of this century. It must be remembered that there have always been and will always be solutions to the problems we face. Environmental problems are among the hardest for human societies to solve because individuals seldom have to pay directly for their contribution to these problems. Individuals act in ways that promote their own short-term welfare, which often conflicts directly with the long-term environmental interests of the present and future generations. This tragedy of the comments is the main factor that limits the effectiveness of social solutions to environmental problems.

**REFERENCES**