ORIGINAL RESEARCH PAPER

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Effect of Auto Exhaust on the Plants growing along the Median Strips in the Western Suburbs of Mumbai

KEY WORDS: Auto exhaust, Air pollution, Median Strips ,Heavy metals

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ABSTRACT

Median strips are made to ensure that traffic moves in an organized way and are also used for beautification of the city. Ornamental plants planted along the median strips add aesthetic value to any city in addition to helping in reducing air pollution.In the present study an attempt was made to find out the effect of autoexhaust on the plants growing along the median strips in the western suburbs of Mumbai.It was observed that out of the five plants studied, Bougainvillea spectabilis plant was found to be most resistant compared to the other plants Hence these plants can be planted safely along the median strips. Lantana camara plant was found to be the most sensitive plant as maximum Dfc was observed in most of the parameters studied.

Introduction

A median strip is the dividing area, either paved or landscaped, between opposing lanes of traffic on highways and city roads.

Air pollution from vehicle exhaust and industry is a worsening problem for India.

Heavy metals such as Cd and Pb are non-essential elements for plants. If

plentiful amounts are accumulated in the plants, heavy metals will adversely affect the absorption and transport of essential elements, disturb the metabolism, and have an impact on growth and reproduction.

Materials and Methods

For the present study five plants most commonly found growing along the median strips were selected-

1. ***Bougainvillea spectabilis Willd.***
2. ***Catharanthus roseus (L.) G.Don.***
3. ***Lantana camara Linn.***
4. ***Pedilanthus tithymaloides, Poit.***
5. ***Ervatamia coronaria, Stapf.(Tabernaemontana)***

Following three polluted sites were selected for the purpose of the investigation. Aarey garden was selected as control site.

1. ***S.V Road Malad***
2. ***Link Road Goregaon***
3. ***Western Express Highway Kandivali***
4. ***Aarey garden (Control Site)***

Parameters studied

Morphological Characters:

1. Length of Leaf
2. Breadth of Leaf
3. Length of the fixed Internode (3rd Internode)

Dust load

Chemical Analysis

1. Chlorophyll content
2. Heavy metal content

Observations

Maximum effect of auto exhaust on the length and breadth of the lamina was observed in *Lantana camara.* This is indicated through its %Dfc that is highest among all the selected plants . The second highest %Dfc values were observed in *Pedilanthus tithymaloides.* The least mean value of length and breadth of leaf was shown by *Bougainvillea spectabilis.* The effect of auto exhaust on this parameter is seen to be highest on western Express Highway Kandivali as all the plant studied show maximum %Dfc at this site.
In the present study the effect of auto exhaust on the dust load on leaf was also studied. The observations show that the maximum load is deposited on the leaves of Lantana camara followed by *Bougainvillea spectabilis and Pedilanthus tithymaloides* respectively. The least effect of auto exhaust on the dust load was observed on *Catharanthus roseus* with the least value of %Dfc observed in this plant. All the studied plants show highest %Dfc on Western Express Highway Kandivali site.

The present study also revealed that the effect of auto exhaust on the Chlorophyll content is maximum on *Lantana camara* followed by *Pedilanthus tithymaloides* and the least effect is seen on *roseus Catharanthus* followed by *Ervatamia coronaria*. This parameter is highly affected at Western Express Highway Kandivali as shown by %Dfc by all the selected plants .

As far as heavy metals are concerned *Lantana camara* shows maximum level of most of the heavy metal accumulated in it at Express Highway Kandivali site. As shown in Table 3.2 it has accumulated 18.534 ppm Copper /100 ml , 0.678 Lead/ 100 ml and 0.07 ppm Cadmium/ 100 ml. The plant that shows the least accumulation of the three Heavy Metals is *Ervatamia coronaria* as it shows least values for Lead, Copper and Cadmium most of the plants. The concentration of Cadmium is not detected in most of the plants at Aarey site.

Table 1.1 Effect of Auto-Exhaust on Length and Breadth of Leaf of *Bougainvillea spectabilis, Willd.*

Site	Length (in cms) Mean ± SD	%Dfc Diff from Control	Breadth (in cms) Mean ± SD	% Dfc
S.V Road Malad	3.47±0.153	16%	2.93±0.153	5%
Link Road Goregaon	3.5±0.1	15%	3.03±0.115	1.3%
W.E Highway Kandivali	3.4±0.26	18%	2.90±0.153	6%
Control site	4.13±0.058	0.00	3.07±0.58	0.00

Table 1.2 Effect of Auto-Exhaust on Length and Breadth of Leaf of *Catharanthus roseus (L) G.Don.*

Site	Length (in cms) Mean ± SD	% Dfc Diff from Control	Breadth (in cms) Mean ± SD	% Dfc
S.V Road Malad	5.87±0.058	9%	3.4±0.1	6%
Link Road Goregaon	4.93±0.252	24%	3.3±0.1	9%
W.E Highway Kandivali	4.50 ± 0.055	30%	2.95±0.1	19%
Control site	6.47±0.058	0	3.63±0.58	0.00

Table 2.1Effect of Auto-exhaust on Chlorophyll Content of Leaf of *Bougainvillea Spectabilis, Willd*

Site	Chlorophyll Content A (mg/gm) Mean ± SD	% Dfc	Chlorophyll Content B (mg/gm) Mean ± SD	% Dfc	Chlorophyll Content Total (mg/gm) Mean ± SD	% Dfc

S.V. Road Malad	0.077±0.001	52%	0.094±0.001	25%	0.17±0.002	42%
Link Road Goregaon	0.080±0.001	50%	0.116±0.002	13%	0.193±0.001	35%
W.E Highway Kandivali	0.072±0.002	55%	0.090±0.01	33%	0.161±0.001	45%
Control site	0.1617±0.001	-	0.1338±0.01	-	0.2949±0.001	-

Table 2.2 Effect of Auto-exhaust on Chlorophyll Content of Leaf of *Catharanthus roseus (L) G. DON.*

Site	Chlorophyll Content A (mg/gm) Mean ± SD	% Dfc	Chlorophyll Content B (mg/gm) Mean ± SD	% Dfc	Chlorophyll Content Total (mg/gm) Mean ± SD	% Dfc
S.V. Road Malad	0.088±0.001	54%	0.077±0.001	49%	0.165±0.001	39%
Link Road Goregaon	0.11±0.01	42%	0.132±0.001	13%	0.208±0.001	23 %
W.E Highway Kandivali	0.078±0.001	59%	0.072±0.001	52%	0.157±0.001	42%
Control site	0.191±0.01	-	0.151±0.001	-	0.27±0.001	-

Table 3.1 Effect of Auto-exhaust on Heavy Metal Content in Leaf of *Bougainvillea Spectabilis, Willd.*

Site	Copper (mg/gm)	Lead (mg/gm)	Cadmium (mg/gm)
S.V Road Malad	0.0033	0.0003	ND
Link Road Goregaon	0.0039	0.0002	0.00002
W.E Highway Kandivali	0.0060	0.0006	0.00008
Control Site	0.0008	0.0001	ND

Table 3.2 Effect of Auto-exhaust on Heavy Metal Content in Leaf of *Catharanthus roseus, Reichb.Consp.*

Site	Copper (mg/gm)	Lead (mg/gm)	Cadmium (mg/gm)
S.V Road Malad	0.0007	0.00005	0.00004
Link Road Goregaon	0.0146	0.00009	0.00007
W.E Highway Kandivali	0.0156	0.00009	0.00007
Control Site	0.001	0.00003	ND

Table 3.3 Effect of Auto-exhaust on Heavy Metal Content in *Leaf of Lantana camara, Linn.*

Site	Copper (mg/gm)	Lead (mg/gm)	Cadmium (mg/gm)
S.V Road Malad	0.016	0.00009	0.00006
Link Road Goregaon	0.012	0.0005	0.00006
W.E Highway Kandivali	0.018	0.0007	0.00007
Control Site	0.0002	0.00002	ND

Discussion

Over the years, there has been a continuous increase in human population, road transportation, vehicular traffic and industries which has resulted in further increase in the concentration of gaseous and particulate pollutants (Joshi et al., 2009).

The present investigation revealed the effect of auto exhaust on length and breadth of the lamina through its remarkably smaller size in the polluted sites. The stunted growth of the stem is shown by the reduction in the size of internode on the selected sites exposed to high pollution.

- Dust may affect photosynthesis, respiration, transpiration and allow the penetration of phytotoxic gaseous pollutants. Visible injury symptoms may occur and generally there is decreased productivity. Effects of particulate matter on vegetation may be associated with the reduction in light required for photosynthesis and an increase in leaf temperature due to changed surface optical properties (Santosh Kumar Prajapati). This deposition is seen to be many folds in plants grown in the urban areas as compared to rural area because of the use of automobiles. At the urban site leaf were heavily loaded by dust particles. The present research brings forth the results that the dust load received by the lamina of *Lantana camara* plants on polluted site is many hundred times than the control site. This is probably due to the trichomes on the leaf surface. According to Prajapati and Tripathi (2006) in their study of dust interception and its accumulation in different plant species, not only depends upon the sources and amount of pollutants in the environment, but also depends on morphological characters of plants like leaf size, texture, hair, length of petiole and weather condition and wind direction. Dust deposition, was observed very high in polluted areas, which was due to more pollutants.

One of the parameter in the present research was to compare the chlorophyll content in all the selected plants. Chlorophyll is found in the chloroplasts of green plants and is called photoreceptor. Chlorophyll itself is actually not a single molecule but a family of related molecules, designated as chlorophyll a, b, c, and d. Chlorophyll a and b are the major constituents of the photos ynthetic apparatus Chlorophyll is also one of the most sensitive biomolecules quite prone to degradation by light, heavy metal pollution, acid rain, air pollution and chemical exposure . Any change in the chemistry of any of the macromolecules of this system leads to the destruction of chlorophyll molecules and ultimate loss of photosynthetic activity (Annapurna Singh, Nandita Singh and M. Yunus)

- It was observed in the present study that there is considerable reduction in pigment (chlorophyll a, chlorophyll b) observed at sites receiving higher pollution load. The same results were found out by the zonal officer of Central Pollution Control Board, Kolkata, in the study of effect of particulate pollution on the tissue system in tropical plants (Sukumaran, 2012) Avnish Chauhan in his research on photosynthetic pigment changes in some selected plants induced by Automobile exhaust in Dehradoon, Uttrakhand (2010) cited the reduction in chlorophyll a and chlorophyll b in polluted sites as compared to the control site. This study puts the light on the serious damages that can be done on plant through auto exhaust as all the plants grown on polluted sites show great reduction in their chlorophyll content as compared to control plants. The reduction in chl-a and chl-b as compared to control plants can be taken as the indicator of slight or moderate air pollution (Moyer D Thomas).

The major component of auto-exhaust is Sulfur dioxide. Exhaust gases are first known to attack leaf palisade parenchyma resulting in necrotic spots with reduced chlorophyll content(Kans Kammerbaver Michele Dani Sanchez, Tuiskondick 1999).Spruce trees grown next to a highway border showed a decrease in photosynthetic activity (Keller, 1985);(Kammerbauer et al., 1987a). Exhaust gases from gasoline combustion also impaired the photosynthetic apparatus under laboratory conditions.(Banerjee et al 1983) detected a close connection between distance of plants from the road and decrease in soluble protein and chlorophyll-a contents.

Heavy metals possess a great threat faced by mankind nowadays. Copper, in particular, poses serious problems due to its widespread industrial and agricultural use. Unlike other heavy metals, such as cadmium, lead, and mercury, copper is not readily bioaccumulated and thus its toxicity to man and other mammals is relatively low. On the contrary, plants in general are very sensitive to Cu toxicity, displaying metabolic disturbances and growth inhibition of Cu contents in the tissues only slightly higher than the normal levels. The reduced mobility of Cu in soil and sediments, due to its strong binding to organic and inorganic colloids, constitutes, in a way, a barrier to Cu toxicity in land plants. Excess Cu inhibits a large number of enzymes and interferes with several aspects of plant biochemistry, including photosynthesis, pigment synthesis, and membrane integrity. Perhaps its most important

effect is associated with the blocking of photosynthetic electron transport, leading to the production of radicals which start per oxidative chain reactions in plants. (J.C. Fernandes and F.S. Henriques). Similar outcomes are observed in the present investigation where *Lantana camara* accumulated the maximum amount of Copper and thus shows the stunted growth. On the other hand the two plants *Ervatamia coronaria* and *Catharanthus roseus* avoided the accumulation of copper and their growth is not much hampered.

High concentrations of a number of heavy metals have been reported to inhibit the growth and decrease in the productivity of crops . Among them, cadmium (Cd) is well known as a highly toxic environmental element due to its great toxicity and high mobility from soil to plants and further down the food chain. It can be incorporated and accumulated by all organisms in large amounts and disturb physiological metabolisms in plants like transpiration, photosynthesis, respiration, and nitrogen assimilation (Chugh et al., 1999; Zhou et al., 2006; Wang et al., 2008). Additionally, Cd is a divalent heavy metal cation (Cd2+) which is readily taken up and causes phytotoxicity

Lead may exist in the atmosphere as dusts, fumes, mists, and vapors, and in soil as a mineral. Soils along roadsides are rich in lead because vehicles burn leaded gasoline, which contributes to environmental lead pollution.(Sengar RS, Gautam M, Sengar RS, Garg SK, Sengar K, Chaudhary.)The effects of Lead on plants, especially at high concentrations, are harmful.

Conclusions

- *Bougainvillea spectabilis* plant is found to be most resistant compared to the other plants as minimum Dfc was observed in most of the parameters studied. Hence these plants can be planted along the median strips. The plant is tolerant to air pollution hence even if they accumulate harmful elements in them they grow well. Such plants should be selected for the beautification of the cities as they require little maintenance. They are economical in terms of money, maintenance and human efforts.

- *Lantana camara* plant is found to be the most sensitive plant as maximum Dfc was observed in most of the parameters studied. Maximum Heavy Metals content was also found in Lantana camara plants.

- Auto exhaust affects the plants most at Eastern Express Highway Kandivali since maximum Dfc was observed in almost all parameters in the studied plants indicating it to be the most polluted as compared to the other selected sites. Maximum heavy metals accumulation was also observed in plants at this site hence this site must be the most polluted as compared to the other sites.

- Since in spite of maximum pollution at the selected polluted site, *Catharanthus roseus* plant is found growing well in most of the parameter with least Dfc in most of the parameter studied it can be considered that this plant also is very resistant to auto exhaust hence can be selected to grow along the median strips.

Recommendations

- Based on the observations, investigation and conclusions of the present study, the following recommendations can be made:

- Plants that have leaves with rough surface or trichomes on the surface should be avoided from growing on the median strips as they tend to collect more of the air particulate matters on their leaf surface that in turn can affect their metabolic activities and lead to the death of the plant. This will prove to be dearer to the government as these plants may need continuous replacements by some other plants as in case of *Lantana camara.*

- Plants with smooth leaves avoid heavy loading of the air particulate matters thus their metabolic activities like respiration and photosynthesis are not hampered . these plants prove to be better options to be grown on median strips as is the case of *Catharanthus roseus and Tabernaemontana.*

- Some plants are tolerant to air pollution. Even if they accumulate harmful elements in them they grow well like *Bougainvillea spectabillis.* such plants should be selected for the beautification of the cities as they require little maintenance. These plants can prove to be economic in terms of money. Maintenance and human efforts.

- In order of preference the plants that recommended for growing along the

median strips are Baugainvillia spectabilis, Catharanthus roseus, Ervatamia coronaria, Pedilanthus tithymaloides, Lantana camara.

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