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Research Article

Studies on Epidermal Appendages of Commonly Growing Plant in Polluted and Non-Polluted Areas of Aurangabad City

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Abstract

In today scenario vehicular pollution has become one of the major and complex challenges of environment problems in big cities of India. The present study was made to explore the comparative status of vehicular emission on the epidermal appendages and chlorophyll contents on leaves of road side species, *Cocculus hirsutus* (L.), *Lantana camera* (L.), *Hyptis suaveolens (*L.) *Gliricidia sepium* (Jacq.) at Aurangabad city. Considerable reduction in stomatal index, trichome frequency and leaf length and width were observed at sites receiving higher vehicular emission. A significant observed correlation was found between polluted and non polluted areas of the city which exhibited plants species growing in polluted area were adversely affected with pollution load.

INTRODUCTION:

Ambient air can no longer be taken for granted. Today the air in the big cities of India is severely polluted and this pollution has a huge impact on the population. Vehicles in metro cities contribute greatly to air pollution. Vehicle emissions have a very detrimental effect on the environment, human health and the ecosystem. The vehicular emission contains suspension of particulate matter (SPM), volatile organic compound (VOC), oxides of nitrogen (NOX), oxides of sulfur (SOX) and hydrocarbons. These pollutants adversely affect on the roadside plants. Plants are constantly exposed to this polluted air that is absorbed by the leaves of plants. (Rajesh Kumar *et al.*, 2015).

Pollutant can cause leaf damage, stomatal damage, premature aging, decreased photosynthetic activity, decreased membrane permeability, and diminished growth and yield in sensitive vegetable species (Tiwari *et al*., 2006). Plants provide a large home area for the intervention, absorption and accumulation of air pollutants to reduce air pollution in different forms for different species (Liu and Ding, 2008). The use of plants as monitors for air pollution has long been established as plants are early adopters of air pollution. They act as absorbers of many air borne particles in the atmosphere (Joshi and Swami, 2009). Vegetation is an effective indicator of the overall effect of atmospheric pollution and the observed effect is a more reliable average time result obtained from the direct determination of the pollutant in the air over a shorter period. However, a large number of trees and shrubs have been identified and used as dust filters to control the increase in urban dust pollution levels (Rai *et al*., 2013).

In recent the Aurangabad city has a very rapid increase in vehicular traffic and during certain time it appears to be unmanageable. Hence, the air pollution due to exhaust pollutants is also on the rise in this peaceful and historical city. In order to study the level of air pollution mainly due to the vehicles and its impacts on plant histo-morphologics the present work has been taken up.

MATERIAL AND METHOD

Study area:

The area under investigation, Aurangabad is centrally situated city of Marathwada region of Maharashtra state lies between 19.88^0 N latitudes and 75.32^{0}E longitudes at an elevation of 568 m (1,864 ft.) above the mean sea level. Area of Aurangabad city is 139 km^2 (54 sq. m.) It is represented by surrounding hills on all directions and different kind of phytogeographical habitats and floristic biodiversity. Aurangabad city became a significant and long term point source of pollutants causing air pollution. The entire area under the study has been divided into four sites in order to assess the status of air pollution on the epidermal appendages of leaves and physiological parameters of plant along with morphological changes. A detailed description of the selected sites is described below (Figure-1)

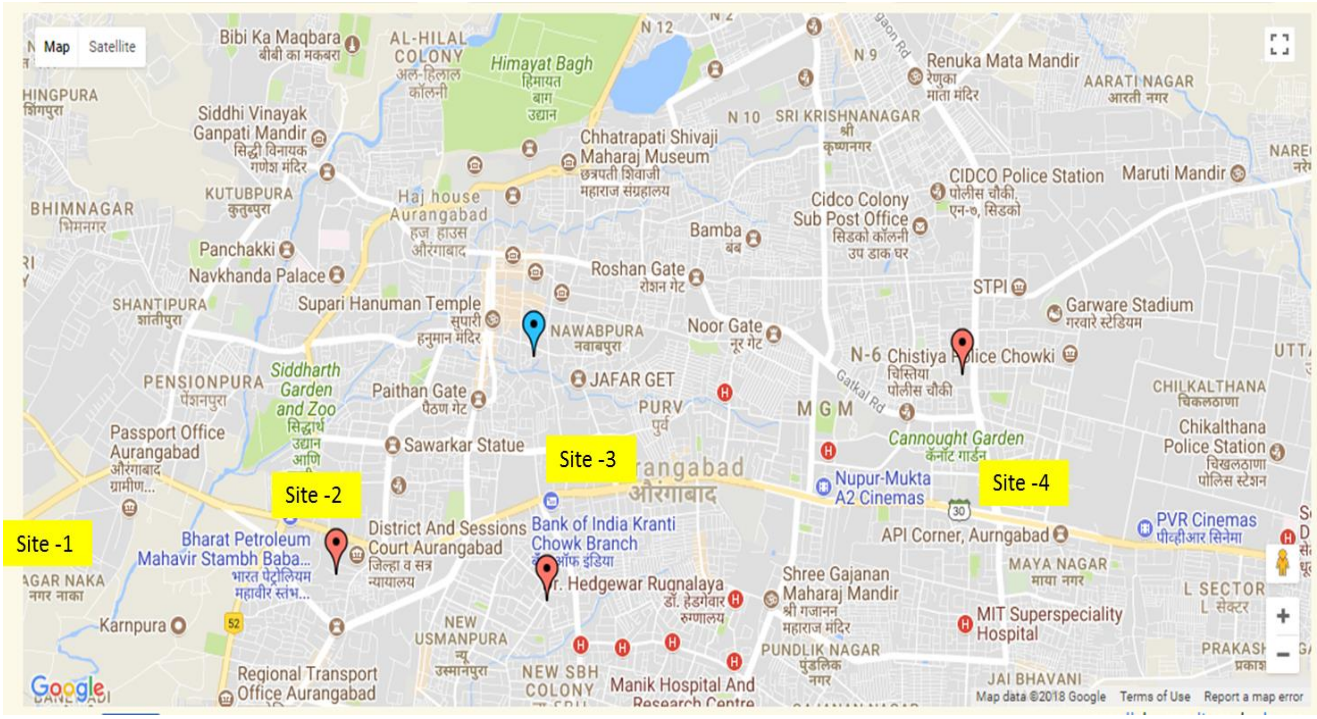

Fig. 1: Map photograph: Location of sampling site in Aurangabad city

Site-1: Nagar Naka road is an area with high traffic.
Site-2: Baba petrol Pump - Station road is an commercial area and densely populated.
Site-3: Kranti Chowk - heavy load of traffic with high vehicular emission.
Site-4: Cidko – Jalna road an industrial area.

For comparative study, first through survey, it reveals that above four different has a high emission of pollutants due to heavy and small vehicles and industries. These places were selected for sample collection as polluted sites and non-polluted area were selected as the campus of Government Institute of Science, Aurangabad,

Plant Sample Collection,

From both i.e. polluted and non polluted sites, 4 plants species namely *Cocculus hirsutus* (L.), *Lantana camera* (L.), *Hyptis suaveolens* (L.) and *Gliricidia sepium* (jacq.) were selected. Leaf samples were collected randomly from both the sampling sites during study period December (2017) to February (2018) at interval of 15 days. The samples from mature leaves of each plant were plucked through random selection in early hours of morning about 20 to 30 leaves were taken from each individual and brought in polythene bags, kept in refrigerator to the laboratory.

Micromorphological studies,

The leaves fixed or temporarily stored in 4% formalin (formaldehyde) solution immediately after collection from both polluted and non polluted areas. The epidermal peel for comparative micromorphological measurements were obtained as following the method of Ahmed and Yunus (1974).

The collected leaves fresh as well as fixed washed through with water and peeled off by freehand carefully with the help of forceps and needle and in another method by heating in HCL (4%) for few minutes. Some square of section was taken on slide and stained with 1% safranine and mounted temporarily. The slides were examined under the microscope and data were collected from five microscopic fields selected at random. The diameter if the field were calculated by using stage and ocular micrometre. Micromorphological characteristics such as the number of stomata and number of epidermal cells counted in each field. Stomatal index and Trichome frequency were determined by taking mean value of five fields and data were analysed statistically.

Stomatal index:

The stomatal index is the percentage in which the number of stomata forms to the total number of the epidermal cells. Each stomata being counted as one cell. Stomatal index calculated by using following equation, (Salisbury, 1927)

$$SI = \frac{S}{E+S} \text{ X } 100$$

Where, SI-Stomatal Index; S-Number of stomata per unit area; E-Number of epidermal cells per unit area.

Trichome frequency:

The trichome frequency was determined as a number of occurrences per microscopic field of view at 100x magnification of light compound microscope. The numbers of trichome cells were counted visually.

Measuring of leaf size.

Quantitative characters of the leaves i.e. leaf length and width were recorded periodically at 15 days interval of three months viz. December January and February. All the measurements were based on three replicates. Leaf lengths (cm), width (cm) were determined by using graph paper method. For compound leaves, single leaflets were treated as analogous to simple leaves.

Table 1: Effect of air pollution on epidermal appendages of leaf, SI- Stomatal Index; TF-Trichome frequency.

RESULTS AND DISCUSSION

Observations on stomatal index, trichome frequency and length and width of plant leaves growing at non polluted and polluted sites of Aurangabad city are presented in table 1 and the average effect of vehicular emission during three months on the epidermal appendages and leaf area in plant samples from non polluted and polluted areas is presented in table 2.

Results indicated marked alteration in various parameters, with decrease number of stomata per unit area of leaves at polluted sites, as compared to non/less polluted site. The average decrease in stomatal index was observed in the range of 19.03 to 26.95 % in all species collected from polluted site. (Table no.2)

Leaf samples collected from polluted sites also showed significant reduction in trichome frequency on both the surfaces than those of non polluted samples. The average reduction in the trichome frequency on adaxial and abaxial surface respectively was 0.698 to 4.157 and 1.043 to 6.154 in all species collected from polluted site. (Table no.2). Length and width of the leaves were determined, for all the species (*Cocculus hirsutus* (L.), *Lantana camera* (L.), *Hyptis suaveolens (*L.) *Gliricidia sepium* (Jacq.)), the leaves which were collected from a polluted area from the four different sites in the city showed significant reduction in length and width of leaf (table no.2).

The leaf length was measured and the average results of three months i.e. December, January and February revealed that there was reduction in leaf length in polluted plants when compared to non-polluted plants. In the selected plants *Cocculus hirsutus L* (Polluted) showed the highest reduction in leaf length (2.08 cm) in comparison of Non-polluted plants, followed by *Giricidia sepium (Jac)* (2.03 cm), *Hyptis suaveolens L.* (1.38 cm), *Lantana camara L* (1.25 cm) (Table 2). Leaf Width among the selected polluted and non-polluted road side plants there were reduction in the width of leaf in the polluted plants. In polluted plants *Giricidia sepium (Jac)* (1.28 cm) showed the highest reduction in leaf width followed by *Hyptis suaveolens* L., *Cocculus hirsutus* L and *Lantana camara* L.(Table 2)

Table 1: Effect of air pollution on epidermal appendages of leaf, SI- Stomatal Index; TF- Trichome frequency and Leaf Size

Name of plant	Sr.No.	Non Polluted						Polluted				
		Dates	SI	TF		Leaf size (cm)		SI	TF		Leaf size (cm)	
				Upper	Lower	length	width		Upper	Lower	length	width
Cocculus hirsutus L	1	15-12-2017	30.74%	1.3259	2.8148	3.8	1.8	20.20%	0.9188	2.303	1.5	1.2
	2	30-12-2017	30.00%	1.2794	2.8847	3.6	1.7	19.33%	0.8142	2.302	1.7	0.9
	3	15-01-2018	29.07%	1.8494	2.3844	3.9	1.9	19.06%	0.8842	2.3146	1.3	1.1
	4	30-01-2018	30.71%	1.2562	2.8613	3.5	1.6	18.72%	1.0031	1.0024	1.4	1.2
	5	15-02-2018	30.00%	1.2794	2.8613	3.3	1.8	18.55%	0.9188	1.8028	1.8	0.9
	6	30/02/2018	30.00%	1.2562	2.8613	3.3	1.5	18.32%	1.0003	1.0025	1.2	1.1
Lantana camara L.												
	1	15-12-2017	33.86%	1.8494	2.1938	3.8	2.6	28.84%	1.5828	1.7912	2.4	1.5
	2	30-12-2017	32.00%	1.8726	2.4778	3.6	2.4	28.80%	1.5818	1.7619	2.6	1.4
	3	15-01-2018	33.13%	1.8494	2.3844	3.9	2.3	26.13%	1.5935	1.7912	2.4	1.8
	4	30-01-2018	30.29%	1.8728	2.3844	3.8	2.5	26.66%	1.5586	1.7698	2.5	1.6
	5	15-02-2018	30.29%	1.8728	2.3733	3.7	2.8	26.13%	1.5928	1.7098	2.8	1.8
	6	30/02/2018	30.25%	1.7828	2.2841	3.9	2.4	25.11%	1.5468	1.7096	2.5	1.8
Hyptis suaveolens L.												
	1	15-12-2017	36.76%	7.675	8.8423	6.8	4.2	29.35%	4.7693	6.286	5.3	3.9
	2	30-12-2017	31.85%	7.9046	8.9586	6.7	4.4	29.09%	4.5363	6.5165	5.2	3.5
	3	15-01-2018	34.98%	7.9092	8.4313	6.4	4.5	25.16%	4.4715	6.1601	5.3	3.8
	4	30-01-2018	36.09%	7.5625	8.1442	6.6	4.6	24.42%	3.6057	6.3303	5.2	3.6
	5	15-02-2018	36.00%	7.2716	7.9112	6.8	4.5	24.49%	3.9547	6.2233	5.2	3.5
	6	30/02/2018	35.01%	6.9788	7.6788	6.5	4.2	24.00%	3.6143	5.3913	5.3	3.4
Giricidia sepium (Jac)												
	1	15-12-2017	27.33%	0.8025	1.2445	4.2	2.1	24.58%	0.6746	1.0584	2.1	1.4
	2	30-12-2017	26.57%	0.7444	2.2213	3.9	2.2	24.39%	0.6978	0.9537	1.8	1.5
	3	15-01-2018	26.24%	0.8491	1.1515	3.8	2.1	25.10%	0.7446	1.0584	1.9	1.7
	4	30-01-2018	25.69%	0.8417	1.1515	4.3	2.3	23.10%	0.7095	1.0584	1.8	1.5
	5	15-02-2018	25.69%	0.8491	1.1502	3.9	2.4	23.01%	0.7059	1.0458	2.1	1.3
	6	30/02/2018	25.00%	0.8417	1.1512	3.8	2	22.00%	0.6467	1.0332	2	1.8

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Table 2: Average of all three months - Effect of vehicular emission epidermal appendages of leaf, SI- Stomatal Index; TF- Trichome frequency.

Name of the plant	Non Polluted					Polluted				
	SI	TF		Leaf size (cm)		SI	TF		Leaf size (cm)	
		Upper	Lower	length	width		Upper	Lower	length	width
Cocculus hirsutus L	30.09	1.374	2.777	3.56	1.71	19.03	0.922	1.787	1.48	1.06
Lantana camara L	31.64	1.849	2.349	3.78	2.05	26.95	1.576	1.755	2.53	1.65
Hyptis suaveolens L.	35.12	7.552	8.327	6.63	4.4	26.09	4.157	6.154	5.25	3.61
Giricidia sepium (Jac)	26.09	0.821	1.345	3.98	2.18	23.71	0.698	1.034	1.95	1.53

Other workers in the previous year have also showed significant reduction in different leaf variables in the polluted environment in comparison with clean atmosphere. Pathak H. and Pancholi K. (2014) in their study on *Mangifera indica, Azadirachta indica, Polyalthia longifolia* and *Cassia siamea* at two sampling sites (reference and polluted) changes in leaf area, epidermal cells, number of stomata, trichome frequency and L/B ratio in the polluted air. Reduction in various parameters shows that plants species growing in polluted area were adversely affected by air pollution in the vicinity of heavy dust and vehicular emission.

Decrease in stomata could be regarded as an adaptive feature developed by plants in order to cope up with the effect of the gaseous pollutant which enters the leaf, injuries the tissue and causes death Marie *et al*. (2008); Prakash *et al*. (2008). Higher stomata and trichome density and smaller epidermal cells and trichome size as compared to those of leaves collected from unpolluted area in *Psidium guajava* (Yunus and Ahmad, 1980).

Studies of the modifications of foliar surface traits in response to air pollution were conducted on *Ipomoea fistulosa* collected from polluted environment of Churk and Renukoot showed increased stomatal, trichomes and epidermal cell density; relatively bigger stomata, larger trichomes and small epidermal cells which on comparison with healthy populations collected from Lucknow environments. Studies on the effect of air pollution on some tree species namely *Mangifera indica, Azadirachta indica* and *Cassia siamea* at two sampling sites from Indore city. On the basis of their observation they showed that *cassia siamea* shows maximum reduction in stomatal index, leaf area (mm2) in polluted site as compared with reference site. (Pathak *et al.,* 2014).

This study illustrates that epidermal appendages of leaf, including stomata and epidermal cells, in plant species growing along road sides are considerably modified due to the stress of automobile exhaust emission with high traffic density in Aurangabad city. These changes could be considered as indicator of environmental stress.

Conclusion

The present study brings out the effects of air pollution especially the vehicular pollution on road site plants. The pollutants from vehicular exhaust not only affect the morphology of plants but also alter the physiology and biochemistry. In polluted leaf stomatal frequency significantly decreases, reduction in above parameters of plant species studied at polluted sites clearly indicates the deleterious effect of air pollution on plant health. Therefore, the present study on various macro- and micro-morphological features of four species clearly suggests that the areas studied in Aurangabad city is very much affected by air (vehicular) pollutants. Thus, this study provides useful insights for selecting tolerant and sensitive species for future planning and Greenbelt development in urban areas.

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