PHYTOMONITORING OF ATMOSPHERIC POLLUTION IN ROAD SIDE PERENNIAL TREES OF INDORE CITY (M.P.) INDIA

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ABSTRACT
The present study was conducted to explore the effects of air pollution on roadside plants due to vehicular emission at Indore city .The study was conducted in Industrial area pologround which is more polluted and less polluted area college campus. It is known fact that 60 % of air pollution in metro city is caused by automobiles only. The effect of these pollutants is observed on plants which are considers for investigation of effect of auto exhaust pollutants on road side vegetation. The two plant species selected which are dominated on road side Bouganvillia spectabili and Delbergia sisoo selected for study. The parameters like chlorophyll a, chlorophyll b, pH, Electrical conductivity and optical properties of leaf wash from sample collected from less polluted and more polluted area of road side of Indore city. Depletion of chlorophyll, change in pH recorded from polluted area.

KEY WORDS—*Vehicular pollution, chlorophyll, Bouganvillia spectabili, Delbergia sisoo.*

I. INTRODUCTION

Vehicular pollution is one of the burning and serious environmental problems in big cities of India. As the society develops it lead to more air pollution which is a global problem. Some natural and human activities introduce gases and particulate which contaminate air as a result of which causes air pollution. Pollutants have been increases in air pollution due to rapid industrialization, increasing heavy traffic load, rapid economic development and higher level of energy consumption by population.

In metro cities vehicles are major contributors of air pollution. The vehicular emissions have a very harmful effect on the environment, human health and ecology. These vehicles emits suspended particulate matter (spm), volatile organic compound (voc), oxides of nitrogen (NOx), oxides of sulfurs (SOx) and hydrocarbons. These pollutants adversely affect roadside growing plants [1] ecological imbalance, health hazards which cause different diseases. Plants are continuously exposed to this polluted air which absorb by plant leaf. The plants act as sink for pollutants. Leaf is an exposed part of plants and easily available in all seasons, so it can be used to indicate air pollution [2]. Road side growing plants are more affected by air pollutants because of heavy traffic load. In polluted area plants shows several changes in morphology, physiology anatomy, and biochemistry of leaves. [3]

Photosynthesis process affected by air pollution and gets inactivated because pollutants had accumulated on surface of leaf and then absorbed on the surface of leaf. Therefore the plants can be called as bio indicators of air pollution. [4] Leaves are sensitive parts of plant to because of abundance of stomata on surface, from which pollutants penetrate into the sensitive tissues of leaves[**5]** During summer, excessive chlorophyll produces while in winter chlorophyll production become slow and then stops[**6]** Chlorophyll absorbs light energy and transfers it to the photosynthetic apparatus chloroplast. Plants in urban areas play an essential role to cleanse the pollution in human

environment. The study describes the choice of eco–friendly plant species and their right placement in the urban environment to overcome the pollution problems. Trees are known as the largest and the most efficient carbon and pollution sinks.**[7]** According to **[8]** air pollution which actually covers lots of different types of problems. They are, health problem, acid rain, domestic and industrial smoke, smog, greenhouse effect, particulates, radionuclides and ozone layer depletion.

II. STUDY AREA

Indore is an important densely populated metro city and the commercial capital of Madhya Pradesh with a Population of over 3,276,697 lakh and Density 839 per Sq. Km. (Reported in the year 2011). Indore is located in the western region of Madhya Pradesh on the southern edge of the Malwa plateau. It has an average elevation of 553.00 meter above mean sea level. It is located on an elevated plain, with the Vindhyas range to the south.

III. SAMPLING

In our investigation, study of two dominated plant species *Bouganvillia spectabili* and *Delbergia sisoo* were selected and sample randomly collected 10 replicates of leaves which continuously exposed to more polluted area (Pologround industrial area) and the another sample of leaves were collected from less polluted area Govt. Maharani Laxmi Bai Girls P. G. College campus , Fort Indore. It is a covered area and noted as less polluted area.

IV. MATERIAL AND METHOD

The selected parameters study in laboratory are pH of leaf wash and cell sap by digital pH Meter (MK-VI Systronic), electrical conductivity by digital conductivity meter (304 Systronic) and estimation of chlorophyll a , chlorophyll b and total chlorophyll by UV visisble spectrophotometer . The extraction of fresh leaf samples was estimated by the Arnon method[9].One gram fresh sample leaf was macerated with 80% chilled acetone and a pinch of magnesium carbonate in a pestle and mortar. The extract was centrifuged at 2500 rpm for 10 minutes. The absorbance was measured at 645, 663 Metzer UV-visible spectrophotometer for chlorophyll. The absorption spectra of leaf wash sample was taken of quantity 50 ml. leaf wash and for optical density measure by preparing five solutions of different concentration and by the help of UV spectrophotometer we got λ_{max} value.

V. RESULTS AND DISCUSSION

The study of two dominated road side plant showed impact of vehicular Pollution. The result recorded in the data table No. 01 and 02 showed that the different physiological changes observed specially the photosynthetic pigment chlorophyll which is Present in the leaves. The leaves of more polluted site recorded reduction in chlorophyll content in the leaves of *Bouganvillia spectabilis* and *Delbergiasisoo* plant due to probably emission of SO_2 and NO_2 and other gases in the air .These gases deposited on the leaves so changes occur in pH of leaf wash and pH of cell sap of leaves . These parameters compare with the two plant species.

Table No. 1 Concentration of Chlorophyll pigment (mg/gram) in Leaves of Bouganvillia spectsbilis.

S.N.	Parameters	Less polluted L P	More polluted M P	Percentage reduction %
1.	Chlorophyll a	3.26	2.98	30.06
2.	Chlorophyll b	2.93	1.80	38.56
3.	Total Chlorophyll	6.02	4.61	23.42
4.	pH leaf wash	6.45	6.12	5.39
5.	pH cell sap	5.22	5.10	2.35
6.	Electrical conductivity Of leaf wash micromohs	096	025	35.20

Table No. 2. Concentration of Chlorophyll pigment (Mg/gram) in Leaves of *Delbergia sisoo.*

S.N.	Parameters	Less polluted L P	More polluted M P	Percentage reduction %
1.	Chlorophyll a	2.12	1.62	23.58
2.	Chlorophyll b	1.10	0.58	47.27
3.	Total Chlorophyll	2.98	2.14	28.18
4.	pH leaf wash	6.65	6.22	6.91
5.	pH cell sap	5.6	5.4	3.70
6.	Electrical conductivity Of leaf wash micromohs	034	087	64.15

The more polluted site (Pologround) is industrial area of west Indore and Ujjain Road which crosses from Industrial area , heavy vehicles and traffic load affect the road side plants . The dominated species *Bouganvillia spectabilis.* It is shrub and ornamental plant . The concentration of chlorophyll pigment in leaves of *Bouganvillia spectabilis* is given in fig 1. The concentration of chlorophyll 'a' pigment recorded in leaves of less polluted site is 3.26 mg/g and recorded in more polluted site is 2.98 mg/g , so % reduction occur 30.06.while the concentration of chlorophyll 'b' pigment recorded in leaves of less polluted site is 2.93 mg/g and in more polluted site is 1.80 mg/g, so % reduction occur 38.56 .while in total chlorophyll concentration similar trend recorded high value in less polluted area and low concentration in more polluted area. (Table No. 1). The experimental data indicates that the depletion in chlorophyll concentration is due to vehicle pollution. The parameter, pH of leaf wash, pH of cell sap and electrical conductivity of leaf wash showed that air pollutant content like SO_2 and NO_2 and suspended particle matter affect the physiology of plants. The data indicate that in less polluted site pH of leaf wash towards neutral while in more polluted site the pH of leaf wash towards acidic ,similarly pH of cell sap trend towards acidic in more polluted site than less polluted site.

Another road side dominated plant tree *Delbergia sisoo.* (Shisham) wood yielding plant. The concentration of chlorophyll pigment in leaves of *Delbergia sisoo* is given in fig 1. The concentration of Chlorophyll 'a' 2.12 mg/g in less polluted site and 1.62 mg/g in more polluted site .The % reduction 23.58%. The % reduction in chlorophyll ' b' show high % of reduction in comparison of Chlorophyll 'a'. Chlorophyll ' b' show high % reduction 47.27. In total chlorophyll the % reduction low 28.18 % than chlorophyll ' b'. The pH of leaf extract 6.22 and 6.65, pH of Cell sap 5.4 and 5.6 at more and less polluted site respectively and Electrical conductivity recorded 87 micromohs and 034 micromohs. The experimental data is given in the table 2.

The plants act as monitors of air pollution has long been established as plants are the initial, acceptors of air pollution. They act as scavengers for many airs borne Particulates in the atmosphere[10] **.**The chlorophyll concentration in the leaves of plants Indicate productivity of plant ,but due to the impact of vehicular pollution Chlorophyll pigment damaged .The chlorophyll pigment of the leaves which present in highly organized state , under stress condition pigment undergo different photochemical change like oxidation, reduction, pheophytinisation and reversible bleaching process[11]. The chlorophyll concentration decreases [12] similarly reduction in chlorophyll concentration due to pollutant gases specially SO_2 reported by different workers[13] When any change in chlorophyll concentration or composition may results changes in physiological, biochemical and morphological change in leaves of plants. Thus, plant having high chlorophyll content in natural conditions are generally tolerance to air pollution in plants while decreases in foliar chlorophyll amount in leaves might be due to depletion of chlorophyll in leaves. In the present study, it is observed that the plants from polluted site revealed that the % reduction in chlorophyll pigment 'a' in the following order

Bouganvillia spectabilis.> Delbergia sisoo.

Maximum% reduction in *Bouganvillia spectabilis* and minimum in *Delbergia sisoo.* While in % reduction in chlorophyll pigment 'b'

Delbergia sisoo.>Bouganvillia spectabilis

Maximum% reduction in *Delbergia sisoo.* and minimum in *Bouganvillia spectabilis* While in% reduction in total chlorophyll pigment ' b'

Delbergia sisoo. > Bouganvillia spectabilis

Maximum% reduction in *Delbergia sisoo* andminimum in *Bouganvillia spectabilis.*

The parameters like pH of leaf wash of sample leaves and cell sap of sample leaves are given in table 1 and table 2. The data clearly indicate that pH of more polluted site are more acidic than less polluted sample leaves . The effect of vehicular pollution on the pH of leaf wash and on the cell sap of leaves supported by number of workers [14, 15] The toxic gases , dust, smoke SO_2, NO_2 and SPM change the pH of cell sap and leaf extract which deposited on leaf surface In more polluted area. 5.6 pH recorded in *Delbergia sisoo* and 6.22 *Bouganvillia spectabilis.*

Delbergia sisoo.>Bouganvillia spectabilis

It is stated that the pH 6.5 shows nutrient availability high to the plants and toxicity low[16]. The nature of air pollutant indicate the

presence of SO_2, NO_2 and SPM contain the sulphate and chloride salts. They are deposited on the leaf surface and turn in to acidic nature. The condensation of SO_2 and convert in sulphates , sulphonates , dithionates and their derivatives are responsible for acidic nature[17] .

The leaf is the important part of plant so leaf optical properties are governed by surface and internal structure properties as well as by concentration and distribution of biochemical component in the leaves. Thus remote analysis of reflected light can be used to assess both the structure and physiological status of a plant .The smoke ,dust deposit on surface of leaf may change the optical properties . For optical measurement , absorption spectra were taken for different leaf wash sample with the help of spectrophotometer . The variation of absorption with wavelengths is given in the fig 1 and fig 2. From the absorption spectra λ_{max} of less polluted leaf wash is 410 and λ_{max} of more polluted leaf wash is 370.The optical density of *Bouganvillia spectabilis* leaf wash having different concentration is given in table 3. and the optical density of *Delbergia sisoo* leaf wash having different concentration is given in table 4.

Table No. 3 Absorbance of Leaf Wash of leaves of *Bouganvillia spectsbilis.*

S.No.	Concentration of leaf wash of leaf (CS:DW)	Absorbance(OD) of less polluted sample	Absorbance(OD) of more polluted sample	Percentage reduction %
1	1 : 4	0.058	0.041	29.31
2	2 : 3	0.094	0.052	44.18
3	3 : 2	0.142	0.079	44.36
4	4 : 1	0.180	0.094	47.77
5	5 : 0	0.224	0.116	48.21

Table No. 4 Absorbance of Leaf Wash of leaves of *Delbergia sisoo*

S.No.	Concentration of leaf washof leaf (CS:DW)	Absorbance(OD) of less polluted sample	Absorbance(OD) of more polluted sample	Percentage reduction %
1	1 : 4	0.056	0.051	8.12
2	2 : 3	0.059	0.054	8.47
3	3 : 2	0.068	0.060	10.34
4	4 : 1	0.077	0.068	11.68
5	5 : 0	0.176	0.099	43.75

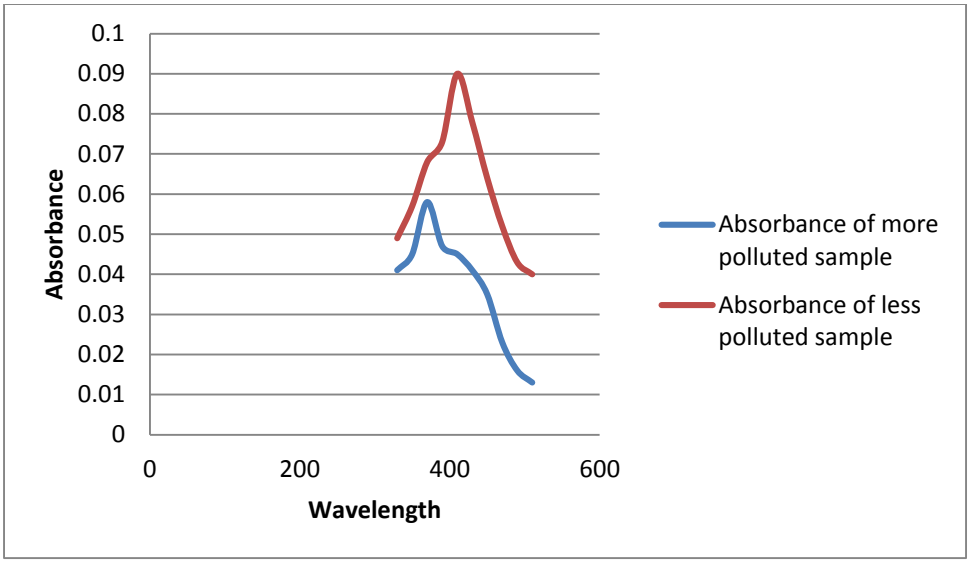

Fig 1 Absorption spectra of *Bouganvillia spectebilis*

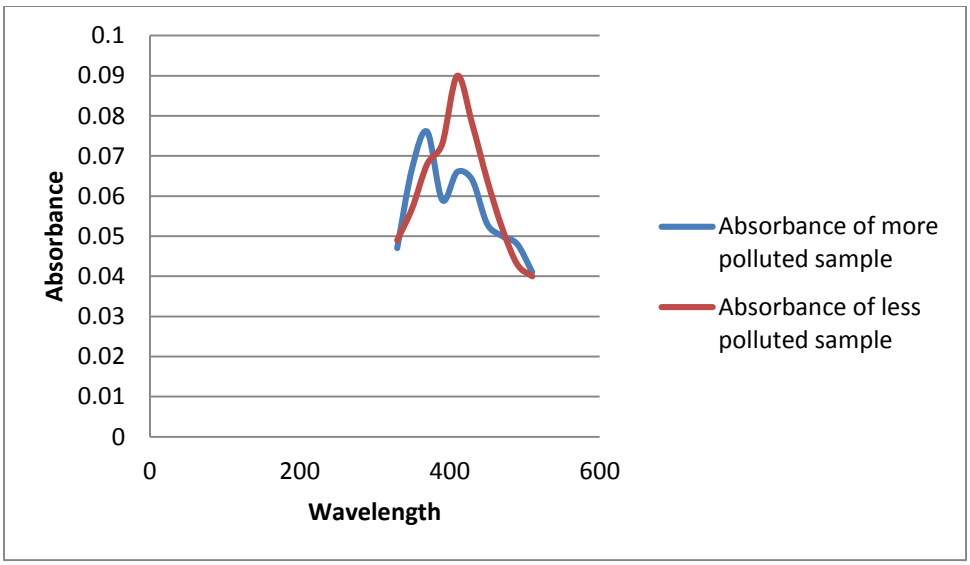

Fig 2 Absorption spectra of *Delbergia sisoo*

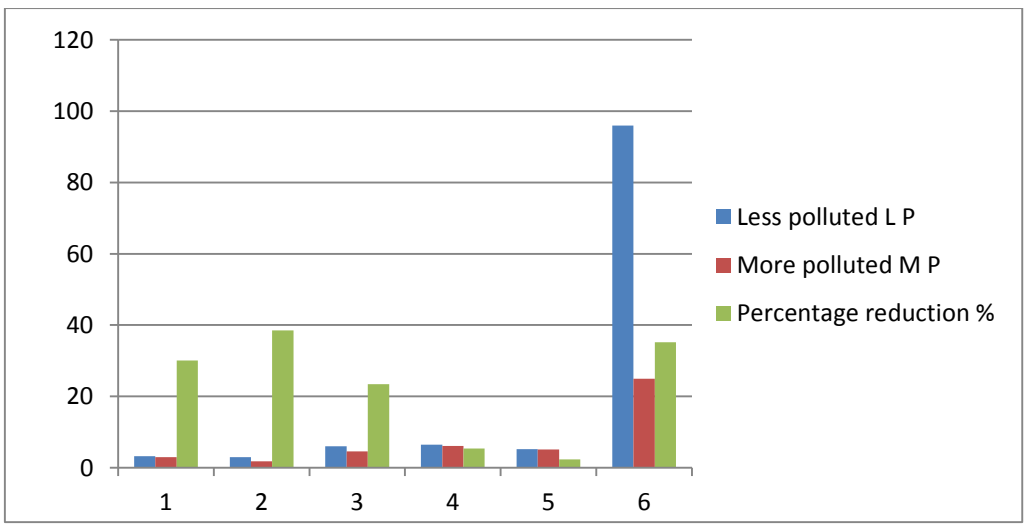

Fig 3 Concentration of Chlorophyll pigment (mg/gram) in Leaves of *Bouganvillia spectsbilis.*

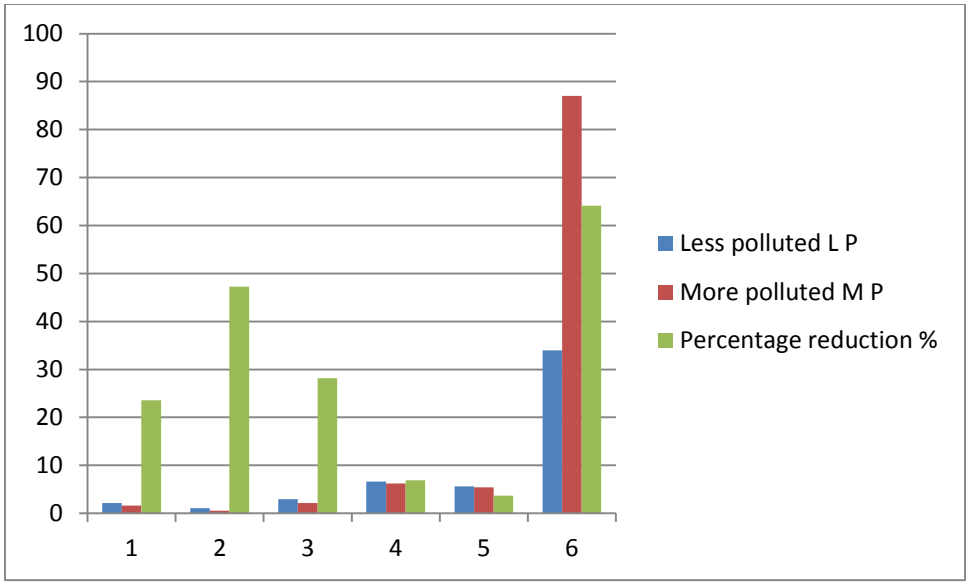

Fig 4 Concentration of Chlorophyll pigment (Mg/gram) in Leaves of *Delbergia sisoo.*

The optical densities of less polluted leaf wash and more polluted leaf wash of different concentration have significant difference. The effect of absorbance can be used to explain structure and physiological status of plant.[18,19]. The reduced absorbance in more polluted sample is due to high dust load and atmospheric pollution on the leaves.

There are documentations on the trees which perform well in controlling air pollution and that trees having a high score in air pollution tolerance index (APTI) will also be good for CO2 sequestration and as such absorb carbon dioxide from the atmosphere and hence can be used in green belt developments in industries which are major contributors for greenhouse gas emissions [20, 21,22]. *Mangifera indica* is highly recommended for planting in terms of mitigating air pollution both as an urban tree or an avenue tree besides it is also one among the fast growing trees and also stores high amount of organic carbon in its tissues so it should be given high priority for planting [23].

VI. CONCLUSION

From the results, it can be concluded that air pollutants affect the vegetation near the point sources .The morphology, physiology of road side plants changes and the chlorophyll concentration also change due to their oxidizing potential. Suspended Particulate Matter (SPM) is there as on is being the growing number of automobiles and poorly and congested road with heavy traffic. This problem can be overcome by adapting advance eco-friendly transport systems, uses age biofuels and widening of roads. Proper environmental awareness and personal protective devices may be useful in avoiding health problems.

VII. FUTURE PLAN

Thus, it is necessary to evaluate the status of urban air pollution continuously and to assess its impact on human health and plants. So that proper imitative measures can be implemented. The plant species for air pollution control the important characteristics could be considered. Plant species should be evergreen, large leaved, rough bark, indigenous, ecologically compatible, low water requirement, minimum care, high absorption of pollutants, resistant pollutants, agro-climatic suitability, height and spread, Canopy architecture, Growth rate and habit (straight undivided trunk), Aesthetic effect (foliage, conspicuous and attractive flower color), Pollution tolerance and dust scavenging capacity.

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