Int. J. Chem. Sci.: 10(4), 2012, 1917-1924
ISSN 0972-768X
www.sadgurupublications.com

TREE AS BIO-INDICATOR OF AUTOMOBILE POLLUTION IN SURAT CITY: A CASE STUDY

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ABSTRACT

With the fast growth in industrial projects along with vehicular growth in Surat city the level of pollution is also increasing. The study examined the air pollution tolerance indices (APTI) of plant species Gulmohar Plant (*Delonix Regia*) around residential area, commercial area, developing area and industrial area of Surat city. Air Pollution Tolerance Index (APTI) is used by landscapers to select plant species tolerant to air pollution. Experimental data suggested that combining a variety of physiological parameters could give more reliable results. The results of control site (CS) were compared to that of experimental site (ES). Throughout the study period, some species exhibited APTI variation related to changes in air, temperature and water status of the plant. The results highlighted the need for APTI measurements to be conducted at regular time intervals to keep an eye on pollution. The results showed that the most tolerant tree species with respect to APTI is Neem tree. These plants can be considered as tolerant species in the industrial areas as well as where vehicle movement is high. The species whose APTI value is low are considered as sensitive species. Further studies on air pollution tolerance index with respect to areas of Surat city indicated that the air pollution was found different at different places on various sampling days.

Key words: Industrial area, Residential area, Commercial area, Developing area, Ascorbic acid, RWC, APTI.

INTRODUCTION

The air pollution act of Government of India (Amendment 1987) defines air pollution as "Air pollution means any solid, liquid or gaseous substances present in the atmosphere in such concentration that may tend to be injurious to human beings or other living creature or plants or property or environment".

Plants play an important role in monitoring and maintaining the ecological balance

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by actively participating in the cycling of nutrients and gases like carbon dioxide, oxygen and also provide enormous leaf area for impingement, absorption and accumulation of air pollutants to reduce the pollution level in the air environment. Sensitivity and response of plants to air pollutants is variable. The plant species, which are more sensitive act as biological indicators of air pollution. The response of plants to air pollution at physiological and biochemical levels can be understood by analyzing the factors that determine resistance and susceptibility. Using plants, as indicator of air pollution the possibility of synergistic action of pollutants can be known.

Selection of plant and study area

Delonix regia species from Fabaceae family was selected. In India, it is known as *Gulmohar* (Hindi and Urdu -'Gul' means flower and 'Mohr' is 'peacock', thus the name suggests a spectacular show of color, like the extraordinary colors of a peacock's tail). It is also known there as *Krishnachura* (Bengali: 'crown of the Lord Krishna).[1] In Vietnamese it is known as Phượng vĩ (means "Phoenix's Tail) (Vietnamese), Malinche and Tabachine. Its availability is high in Surat after Neem (*Azadiracta Indica*) and Asopalav, so this species have been selected for study.

Surat from Gujarat state has been selected for study purpose. Surat is fastest city of Gujarat and is second largest city in population. In last decade population increases 4 folds compare to previous year. Surat having total 27757 industries with total 138389.4 million investments. In last 2 months i.e from August and September 2011 total 25933 vehicles registered and today total 1832213 vehicles are registered in Surat (RTO data – Surat).[2]

Out of 1411315 two/three wheeler, 20% i.e 282263 is 2 stroke vehicles. The previous study showed that 2 stroke engine's exhaust contains almost 15-20% of unburned fuel.

Even many auto and cars has been converted from petrol/diesel to CNG in Surat. Table 1 shows emission benefits of replacing conventional diesel with CNG vehicles. Many researchers has carried out the same study throughout the world for APTI.[3-21]

Table 1: Emission benefits by replacing Diesel with CNG in vehicles

Fuel	Pollution parameters		
	CO	**NO_X**	**PM**
Diesel	2.4 g/Km	21 g/Km	0.38 g/Km
CNG	0.4 g/Km	8.9 g/Km	0.012 g/Km
% reduction	84	58	97

Source: Frailey et al., (2000) as referred in World Bank (2001b:2)

Aims & objectives of study

- To investigate the ambient air quality of Surat city.
- To determine the Air Pollution Tolerance Index.
- To study impact of air pollutants on vegetation.
- To asses pollution and its effect on plant growth.
- The work shows the possibilities of determining trends in the occurrence and intensity of effects of several air pollutants on plants.
- One can know how tolerant a species is to pollution.
- It helps to set a baseline for ambient air quality.
- Helps to maintain the air quality of Surat city.

EXPERIMENTAL

Materials and methods

Chlorophyll

Chlorophyll was extracted in 80% acetone and the absorption at 663 nm and 645 nm are read in a spectrophotometer. Using the absorption coefficients, the amount of chlorophyll was calculated using the empirical formula[5].

Ascorbic acid

Amount of ascorbic acid was determined by weighing exactly about 1 g of leaf sample and adding 50 mL freshly boiled cooled water + 1 test tube 1 N H_2SO_4 + ¼ test tube starch as an indicator in 250 mL conical flask and titrating it against 0.1 N I_2 solution. The blank titration was carried out using L-Ascorbic acid instead of leaf sample[15].

Calculation

Amount of ascorbic acid = Ascorbic acid (mg) equivalent to I_2 soln.

I_2 solution = 4.0 mg ascorbic acid / 0.1 N I_2 solution (mL)

To determine the amount of ascorbic acid in an aliquot of extract (10.0 mL)

= Burette reading x 4.0 mg ascorbic acid x 10 / 0.1 N I_2 solution (mL)

pH

pH measurements were obtained with a pH meter.

Relative water content

All components of leaf water relations change during the day as irradiance and temperatures change. For not more than two hours at and after solar noon, the change is very small. This is the time "window" for leaf sampling, unless a daily curve of RWC is of interest.

Procedure

Fresh weight was obtained by weighing the fresh leaves. 1 g was weighed. The leaves were then immersed in water over night, blotted dry and then weighed to get the turgid weight. Next, the leaves were dried overnight in an oven at 70^{o}C and reweighed to obtain the dry weight[9].

Table 2: APTI at various places during the sampling period

Sampling date	Places	CS/ES	Ascorbic acid	Total chlorophyll	pH	Relative water content	APTI	% Increase in APTI
14.01.2011	Adajan	CS	4.137	31.11	7.25	78.21	23.69	18.65
		ES	4.137	72.19	7.8	92.48	42.34	
28.01.2011	New Adajan	CS	1.379	88.82	7.3	58.34	19.09	2.12
		ES	1.379	80.65	8.31	89.41	21.21	
24.02.2011	Palgam	CS	1.379	70.11	7.6	55.14	16.23	2.76
		ES	1.379	79.88	7.65	69.15	18.99	
01.03.2011	Railway Station	CS	1.379	40.12	8.12	24.69	9.12	0.12
		ES	1.379	32.74	8.27	35.81	9.24	
06.03.2011	Vesu	CS	2.758	15.57	7.62	35.68	9.96	10.84
		ES	1.379	104.06	8.25	53.12	20.8	
11.03.2011	Adajan	CS	1.379	43.16	6.93	39.7	10.88	8.92
		ES	2.758	42.85	7.05	60.37	19.8	
16.03.2011	Pandesara GIDC	CS	2.758	54.23	7.08	65.79	23.49	7.72
		ES	2.758	80.36	7.3	70.37	31.21	

Note: Only high % increase APTI data from fortnight study is showed here
CS: Control site and ES : Experimental site

Table 3: Species category with respect to APTI

S. No.	APTI	Class
1	30-100	Tolerant
2	29-17	Intermediate
3	10-1	Sensitive
4	< 1	Very Sensitive

As per Table 3 and Table 2, it can be summarized as Gulmahor tree is falling under sensitive to intermediate category and hence growing of these species is not much viable for air pollution control.

Preventive steps

As the study was conducted in a city, where a large portion of the city fall only under vehicle movement, Hence the pollution from vehicle can be largely prevented by using good quality of fuel, regular servicing, checking the vehicle for PUC certificate, turning the engine off at red Signals, by not over speeding etc.

Advanced low NOx technology, which can operate on lean burn engines with high efficiency without increasing NOx emissions, Technologies which can not only reduce the mass of PM but also lower the number of ultrafine particles from future diesel and gasoline engines. The pollution can also be prevented by removing the practice of open burning. The study had an industrial site, the pollution from industries can be reduced by having proper stack height, Using scrubbers were necessary, Using good quality of coal in boiler, good maintenance of equipment, doing process change where necessary, advancing the process.

CONCLUSION

An overview of the results obtained from the study revealed that plants at different site responded differently to air pollutions. It was observed that plants with low pH were more susceptible, while pH around 7 was more tolerant in modifying the toxicity of SO_2.

Ascorbic acid played an important role in light reaction of photosynthesis, activated defense mechanisms and under stress condition it could replace water from light reaction II. Ascorbic acid is natural antioxidant, which plays an important role in pollution tolerance. Ascorbic acid plays a role in cell wall synthesis, defense and cell division. It is also a strong reducer and plays important role in photosynthetic carbon fixation, with the reducing power directly proportional to its concentration.

Hence, it is given top priority and used as a multiplication factor in the formula. High pH may increase the efficiency of conversion from hexose sugar to ascorbic acid, while low pH showed good correlation with sensitivity to air pollution.

Depletion of chlorophyll immediately causes a decrease in productivity of plant and thus plant shows poor vigor. Hence plants, which maintain their chlorophyll in polluted environment are said to be tolerant. Total chlorophyll is also related to ascorbic acid productivity and ascorbic acid is mainly found in chloroplast.

Photosynthesis depended on pH hence low pH plants showed low photosynthesis. Thus the APTI formula had p = pH, T = TCH this both were added and then multiplied with ascorbic acid.

Water is important for plants; storage of water may cause severe stress to plants. High water content within a plant body will help to maintain its physiological balance under stress condition such as exposure to air pollution when the transpiration rates are usually high. High RWC favours drought resistance in plants. If the leaf transpiration rate reduces due to the air pollution, plant cannot live due to loss of system which pulls water from roots to supply for photosynthesis. Hence the product of ascorbic acid and sum of pH and TCH is added with RWC(R).

- The variation of the APTI can be attributed to the variation in any of the four physiological parameter which governs the computation of the index.
- The study showed that air pollutants had harmful effects on photosynthesis of plants.
- Exposure to pollutants, results in increase in tissue damage thus the plants in susceptible to pathogens.
- The result showed that the most resistant plant with respect to air pollution is Neem Tree.
- Also the study plant (Gulmohar) showed a less resistivity towards air pollution.
- Considering the air pollution scenario of Surat City we can say that status of pollution in Surat City as a whole is Moderate Air Polution[9].
- Regular water spray will be helpful to fight against air pollutants. Since trees are the first rank fighters of air pollution a plantation and protection programme should be conducted regularly.

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Revised : 05.07.2012 *Accepted : 08.07.2012*