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Air Pollution Tolerance Index of Certain Plant Species-A Study of Madri Industrial Area, Udaipur (Raj.), India

G.S. Mahecha[1], B.R. Bamniya[2], Neelima Nair[3], Dhavan Saini[4]

Research Scholar, Department of Environmental Science, Mohanlal Sukhadia University, Udaipur, Rajasthan, India [1]

Professor, Department of Environmental Science, Mohanlal Sukhadia University, Udaipur, Rajasthan, India [2]

Research Scholar, Department of Environmental Science, Mohanlal Sukhadia University, Udaipur, Rajasthan, India [3]

Research Scholar, Department of Environmental Science, Mohanlal Sukhadia University, Udaipur, Rajasthan, India [4]

Abstract: Air pollution is one of the serious problems faced by the people globally due to its transboundary dispersion of pollutants over the entire world. Plants responses towards air pollution are assessed by air pollution tolerance index (APTI) value. Present study was conducted for evaluating Air Pollution Tolerance Index (APTI) value of three plant species i.e., *Annona squamosa, Ficus racemosa, Santalum album* growing in Madri Industrial area of Udaipur. Four physiological and biochemical parameters which are relative water content, leaf pH, Ascorbic acid, and total chlorophyll were used to compute the APTI. The plant species having higher APTI value can be given priority for plantation program in urbanize and industrial areas; so as to reduce the effects of air pollution and to make ambient atmosphere clean and healthy.

Keyword: Air Pollution Tolerance Index (APTI), Air pollution, Ascorbic acid, Plantation program

I. INTRODUCTION

Air pollution is a serious problem throughout the world. Rapid industrialization and vehicular traffic especially in the urban areas of India lead to the deterioration of air quality by adding toxic gases and other substances to the atmosphere. All combustion releases gases and particulate matter into the air which includes SO_x, NO_x, CO and soot particles as well as smaller quantities of toxic metals, organic molecules and radioactive isotopes (Bhattacharya *et al*. 2013, Agbair en Esiefarienrhe 2009, Chouhan *et al*. 2011). The degradation of air quality is major environmental problem that affects many urban and industrial sites and the surrounding regions worldwide (Kuddus *et al*. 2011). Although various efforts have been done for environmental restoration in India but still it seems to be a formidable task (Thambavai and Maheswari 2012).

Various strategies exist for controlling atmospheric pollution, but vegetation provides one of the best natural way of cleaning the atmosphere by providing an enormous leaf area for impingement, absorption and accumulation of air pollutants level in the environment with a various extent. (Varshney 1985, Lui and Ding 2008, Escobedo *et al*. 2008, Das 2010). Plants are very important for determining and maintaining ecological balance by actively participating in the cycling of nutrients and gases like carbon dioxide and oxygen etc., but air pollution can directly affect plants via leaves or indirectly via soil acidification (Steubing *et al*. 1989, Agbaire 2009, Kumar and Nandini 2013).Several contributors agrees that air pollutants effect plant growth adversely (Rao 2006, Horsefall 1998). Plants act as the scavengers for air pollution as they are the initial acceptors (Joshi and Swami 2009, Randhi and Reddy 2012).

Trees act as air pollution sinks but the better performance comes from the pollution tolerant species. (Miria and Khan 2013). By monitoring plants tolerance toward air pollution they can be screened and can be employed as biological indicators or monitors of air pollution. Then they can be used effectively by planners and green belt developers in managing the urban air pollution.

Study of single parameter may not provide a clear picture of the pollution induced changes; so air pollution tolerance index which was based on four parameters has been used for identifying tolerance levels of plants species. The usefulness of evaluating APTI for the determination of tolerance as well as sensitiveness of plant species were followed

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by several authors (Agrawal and Tiwari 1997, Dwivedi and Tripathis 2007, Yan-Ju and Ding 2008, Lui and Ding 2008, Dwivedi *et al*. 2008, Jyothi and Jaya 2010).

II. MATERIAL AND METHOD

A. Study area

The present study was carried out in Madri Industrial Area of Udaipur district. Udaipur which is known as Lake City located in southern part of Rajasthan, India. Due to industrialization and rapid expansion of city, the environmental problems are increasing especially air pollution.

B. Methodology

Fully matured leaves of *Annona squamosa*, *Ficus racemosa*, *Santalum album* were collected in early morning and brought to laboratory in polythene bags. Three replicates were used for each plant. The leaf samples were analyzed for total chlorophyll, ascorbic acid , leaf pH and relative water content using the standard procedure of Maclachlam & Zalik (1963), Bajaj and Kaur (1981). The air pollution tolerance index was computed by the method suggested by Singh and Rao (1983) using the equation.

$$\text{APTI} = \frac{[A(T+P)]+R}{10}$$

Where A-ascorbic acid (mg g^{-1} FW), T-total chlorophyll (mg g^{-1} FW), P-leaf extract pH and R-relative water content (%) of the leaves.

III. RESULT & DISCUSSION

The tree species with higher and low APTI value can serve as tolerant and sensitive respectively. In this study, changes in parameters such as ascorbic acid, total chlorophyll, relative water content and pH of leaf extract were used in evaluating the degree of tolerance to air pollution by the plant species. All these biochemical parameters that are analyzed for APTI plays significant role to determine resistivity and susceptibility of plant species. In present study APTI is calculated for three plant species growing in industrial area of Udaipur and the data is presented in Table I.

TABLE I
AIR POLLUTION TOLERANCE INDEX OF CERTAIN PLANT SPECIES OF MADRI INDUSTRIAL AREA, UDAIPUR

Plant Species	RWC (%)	pH	Total Chlorophyll (mg/g)	Ascorbic acid (mg/g)	APTI
Annona squamosa L	50	6.16	0.0889	0.0122	5.007624
Ficus racemosa L	38.88	6.08	0.4357	0.0165	3.898751
Santalum album L	66.33	5.93	1.1974	0.0143	6.643192

Relative Water Content- Water is crucial prerequisite for plant life. RWC (Relative Water Content) of a leaf is the water present in it relative to its full turgidity. In the present study *Santalum album* has maximum relative water content. 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.

Leaf extract pH- Plants with lower pH are more susceptible while those with pH around 7 are tolerant (Singh and Verma 2007, Kumar and Nandini 2013). The change in leaf extract pH might influence the stomatal sensitivity due to air pollution. The pH ranges between 5.93 and 6.16. The pH of leaf extract was slightly acidic.

Total Chlorophyll- Chlorophyll is an index of productivity of plant (Raza and Murthy, 1988). Chlorophyll content of plants varies from speices to species, age of leaf and also with the pollution level as well as with other biotic and abiotic condition (Katiyar and Dubey 2001). Whereas certain pollutants increase the total chlorophyll content (Allen *et al*, 1987), other decrease it. It is revealed from the study that *Annona squamosa* has least total chlorophyll due to air pollution.

Ascorbic acid- Ascorbic acid is a strong reductant and it activates many physiological and defence mechanism in the plants. Its reducing power is directly proportional to its concentration (Raza and Murthy 1988, Agbaire and Esiefarienrhe 2009). However it's reducing activity is pH dependent, being more at higher pH levels because high pH may increase the efficiency of conversion of hexose sugar to ascorbic acid and is related to the tolerance to pollution (Lui and Ding 2008, Chouhan *et al* 2012). The result of the study revealed that *Ficus racemosa* has highest ascorbic acid content.

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Air Pollution Tolerance Index- It gives an empirical value for tolerance level of plants to air pollution. In this study it found that *Santalum album (L)* shows the highest APTI value. The tress having a high APTI score has a low acidic pH in their leaves with a high chlorophyll content and maximum relative water content. It reveals from present our study that *Santalum album (L)* has the highest score (6.643192) for APTI with a very low pH of 5.93, chlorophyll content of 1.1974mg/gm, 66.33% Relative Water Content and 0.0143 mg/gm of ascorbic acid and this species may be preferably recommended for green belt plantation in industrial areas.

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