(An Association Unifying the Sciences, Engineering, and Applied Research)
ISSN (Online): 2279-0055
International Journal of Emerging Technologies in Computational and Applied Sciences (IJETCAS)
www.iasir.net

Identification and Evaluation of Air Pollution Tolerance Index of Selected Avenue Tree Species of Urban Bangalore, India

M. Kumar and N. Nandini
Department of Environmental Science, Bangalore University, Jnana Bharathi campus,
Bangalore, Karnataka, INDIA

Abstract: *The resistivity and susceptibility level of tree species to air pollution within avenue's of Urban Bangalore has been evaluated on the basis of Air Pollution Tolerance Index (APTI) value. Four parameters namely Leaf extract pH, Total Chlorophyll Content, Relative Water Content of Leaf and Ascorbic Acid content were determined and APTI was computed. The tree species with higher APTI values like Polyalthia longifolia, Albizia saman, Azadiracta indica, Pongamia pinnata, Swietenia mahogany, Michelia champaca, Millingtonia hortensis and Tamarindus indica are tolerant to air pollutants and can be used as an effectively indicators and pollution scavengers. The tree species having higher APTI value can be given priority for plantation program in newly urbanized areas and avenue's of Urban Bangalore; so as to reduce the stress of motorists at traffic junctions, effect of air pollution and make the environment clean for healthy life.*

Keywords: *air pollution, APTI, Bangalor, avenue, environment, urbanization.*

I. Introduction

The ambient environment of an urban area may be contaminated with several pollutants such as sulphur dioxide, carbon monoxide, oxides of nitrogen and heavy metals and the plants growing there would be exposed not only to one but to many pollutants and their different conditions. Trees play an important role in monitoring and maintaining the ecological balance by actively participating in the cycling of nutrients and gases like carbon dioxide and also provide enormous leaf area for impingement, absorption and accumulation of air pollutants to reduce the pollution level in the ambient air environment[14]. Air pollutions can directly affect plants via leaves or indirectly via soil acidification[13]. It has also been reported that when exposed to air pollutants, most plant experience physiological changes before exhibiting visible damage to leaves[6]. With this background, the study was attempts to understand the air pollution tolerance indices of selected avenue tree in Urban Bangalore.

II. Materials and Methods

a. Study Area: The present study was carried out in Urban Bangalore; one of the fastest growing cites in India, with a population of 8.4 million[4] indicating a development of 741 Sq.Km area; located 920m above mean sea level, has salubrious climate throughout the year with an annual rainfall of about 850-950mm. Bangalore charm as a garden city may have diminished in the last two decades. However, some of the trees that perhaps earned its name are still to be seen and cherished in Cuban park, Lalbagh, IISc-Bangalore campus and Bangalore University-Jnanabharathi campus with rich vegetation.

b. Methodology: Tree species were randomly selected from avenue's of Urban Bangalore. Leaf samples were collected in triplicates of fully matured leaves and were immediately transferred to the laboratory for analysis. Leaf samples were preserved in a refrigerator for further examination. The following are the different methods used to determine APTI;

Leaf extract pH: 5g of the fresh leaves was homogenized in 10ml deionised water. This was then filtered and the pH of leaf extract was determined after calibrating pH meter-HI 98130 with buffer solution of pH 4, pH 7 and pH 9[1].

Total Chlorophyll Content (TCh): 3g of fresh leaves were blended and then extracted with 10 ml of 80% acetone and left for 15 minutes for thorough extraction. Then the liquid portion was poured into another text-tube and centrifuged at 2,500rpm for 3 minutes. The supernatant was then collected and the absorbance was then taken at 645nm and 663nm using Systronics UV-Vis spectrophotometer 118[1] [2]. Calculations were made using the formula:

$$\text{Chlorophyll a} = 12.7_{DX663} - 2.69_{DX645} \text{ x V/1000W mg/g}$$
$$\text{Chlorophyll b} = 22.9_{Dx645} - 4.68_{Dx663} \text{ x V/1000W mg/g}$$

$$\text{TCh} = \text{Chlorophyll a} + \text{b mg/g}$$

Where,

Dx = Absorbance of the extract at the wavelength in nm, V = total volume of the chlorophyll solution (ml), and W = weight of the tissue extract (g).

Relative Water Content of Leaf (RWC): Fresh leaves were weighed and then then immersed in water over night, blotted dry and then weighed to get the turgid weight. Then, the leaves were dried overnight in an hot air oven at 70°C and reweighed to obtain the dry weight[1] [11]. Calculations were made using the formula:

$$RWC = [(FW – DW)/(TW – DW)] \times 100$$

Where,

FW = Fresh weight, DW = dry weight, and TW = turgid weight.

Ascorbic Acid (AA) content: 1g of the leaf sample was measured into a test tube, 4ml of oxalic acid – EDTA extracting solution was added. Then 1ml of orthophosphoric acid followed by 1ml 5% tetraoxosulphate (vi) acid, 2ml of ammonium molybdate and then 3ml of water was added. The solution was then allowed to stand for 15 minutes, after which the absorbance at 760nm was measured with Systronics UV-Vis spectrophotometer 118. The concentration of ascorbic acid in the leaf samples were then extrapolated from a standard ascorbic acid curve[1] [3].

APTI: The air pollution tolerance indices of twelve common plants were determined by the following standard method[1] [12]. The formula of APTI is given as

$$APTI = [A(T+P) + R]/10$$

Where, A = Ascorbic Acid content (mg/g), T = Total Chlorophyll content (mg/g), P = pH of leaf extract, and R = Relative Water content of leaf (%).

III. Results and Discussion

Air Pollution Tolerance Index (APTI) is calculated for 12 tree species growing in Avenue's of Urban Bangalore and the data is presented in Table 1. All biochemical parameters that are analyzed for APTI plays significant role to determine resistivity and susceptibility of tree species.

Table 1: Air Pollution Tolerance Index (APTI) of selected avenue tree species of Urban Bangalore

Species name	RWC (%)	pH	TCh (mg/g)	AA (mg/g)	APTI
Polyalthia longifolia	82.71±0.183	6.2±0.176	3.54±0.219	3.37±0.155	11.55
Ficus religiosa	76.38±0.346	5.5±0.247	4.82±0.183	3.03±0.240	10.76
Ficus benghalensis	81.35±0.134	5.9±0.106	3.27±0.091	2.93±0.148	10.82
Delonix regia	79.83±0.148	5.7±0.155	3.87±0.176	2.45±0.098	10.32
Albizia saman	79.18±0.219	5.9±0.169	2.65±0.120	4.33±0.240	11.62
Azadiracta indica	82.27±0.197	6.1±0.127	3.96±0.070	4.91±0.127	13.16
Pongamia pinnata	81.05±0.148	6.2±0.106	3.58±0.176	3.56±0.190	11.58
Swietenia mahogany	78.24±0.091	6.4±0.070	4.72±0.141	3.96±0.212	12.22
Michelia champaca	79.91±0.212	5.8±0.113	4.18±0.233	3.47±0.141	11.45
Millingtonia hortensis	75.48±0.155	6.4±0.134	4.04±0.155	2.97±0.134	10.64
Spathodea campanulata	81.2±0.084	5.7±0.148	3.29±0.205	3.08±0.148	10.88
Tamarindus indica	72.14±0.197	6.4±0.091	4.26±0.127	4.11±0.070	11.59

Tree species showed variation in leaf chlorophyll content in the study area. Higher chlorophyll content was found in trees like *Ficus religiosa, Swietenia mahogany, Michelia champaca, Millingtonia hortensis, Tamarindus indica, Azadiracta indica* and *Delonix regia* (Table 1). It is already reported that pollution stress decreases the chlorophyll level in tree species[9]. However, the variation in chlorophyll content among the tree species in the study area mat be owing to species tolerant nature, age, genetic makeup and other environmental circumstances in addition to pollution effect.

The leaf extract pH was moderately acidic in the species like *Ficus religiosa, Ficus benghalensis, Delonix regia, Albizia saman, Spathodea campanulata* and *Michelia champaca*, whereas other species are slightly acidic (Table 1). In presence of an acidic pollutants, the leaf extract pH is lowered and decline in greater in sensitive species[8]. Hence, the higher level of leaf pH gives tolerance to the species against pollution.

Ascorbic acid being a strong reculant protects chloroplasts against sulphur dioxide induced hydrogen peroxide, oxygen and OH accumulation and this protects the enzymes of the carbon dioxide fixation cycle and chlorophyll from inactivation[5]. Thus, tree species maintaining higher ascorbic acid level under polluted condition are considered to be tolerant to air pollutants. The results of the study revealed that *Albizia saman, Azadiracta*

indica, *Swietenia mahogany* and *Tamarindus indica* (Table 1) are having higher chlorophyll content and can be considered as pollution tolerant owing to their high ascorbic acid content.

The relative water content is associated with protoplasmic permeability in cells, causes loss of water and dissolved nutrients resulting in early senescence's of leaves[7]. *Polyalthia longifolia, Ficus benghalensis, Delonix regia, Albizia saman, Azadiracta indica, Pongamia pinnata, Michelia champaca, Spathodea campanulata* and *Swietenia mahogany* (Table 1) were present with higher water content. Therefore the tree species with higher water content under polluted condition may be tolerant to pollutants.

The tree species like *Polyalthia longifolia, Albizia saman, Azadiracta indica, Pongamia pinnata, Swietenia mahogany, Michelia champaca, Millingtonia hortensis* and *Tamarindus indica* have secured higher APTI value when compared to other tree species (Table 1). The tree species with higher and low APTI value can serve as tolerant and sensitive respectively. Such tolerant tree species can effectively used as indicators and pollution scavengers[10].

IV. Conclusion

The study concluded that, the tree species having higher APTI value can be given priority for plantation program in newly urbanized areas and avenue's of Urban Bangalore; so as to reduce the stress of motorists at traffic junctions, effect of air pollution and make the environment clean for healthy life. And also, APTI determination are of importance because with increase urbanization and industrialization, there is increasing danger of deforestation due to air pollution and are therefore handing for landscaping. The results of these kind of studies is expected to fulfill the gap to check the further degradation of environment and to provide pollution free environment to forthcoming generation.

V. References

[1] Agbaire.P.O and Esiefarienrhe.E. 2009. Air Pollution Tolerance Indices (APTI) of some plants around Otorogun Gas Plant in Delta State, Nigeria. J. Appl. Sci. Environ. Manage. 13(1): 11 – 14.

[2] Arnon.D.I. 1949. Copper Enzymes in Isolated Chloroplasts Polyphenol Oxidase in Beta vulgaris. Plant physiol. 2 (1): 1-15.

[3] Bajaj.K.L and Kaur.G. 1981. Spectrophoto-metric Determination of L. Ascorbic Acid in Vegetable and Fruits. Analyst. 106: 117-120.

[4] Census of India, 2011. Government of India.

[5] Chaudhary.C.S and Rao.D.N. 1977. Study of some factors in plants in controlling their susceptability to SO2 polltuion. Proc. Of the Indian Nat. Sci. Academy. 43: 236-241.

[6] Dohmen.G.P, Loppers.A and Langebartels.C. 1990. Biochemical Response of Norway Spruce (Picea Abies (L) Karst) Toward 14-Month Exposure to Ozone and Acid mist, effect on amino acid, Glutathione and Polyamine Titers. Environmental Pollution. 64: 375-383.

[7] Masuch.G.H, Kicinski.G, Kettrup.A and Boss.K.S. 1988. Single and combined effets of continuous and disontinuous O_3 and SO_3 emissions on Norway spruce needles. I. Histological and cytological changes. Int. J. of Env. Analytical Chemistry. 32: 213-241.

[8] Paulsamy.S and Senthilkumar.P. 2009. Identification of air pollution tolerant tree species for the industrial city, Tirupur, Tamil Nadu. Nature Environment and Pollution Technology. 8(3): 585-588.

[9] Paulsamy.S, Sivakumar.R and Latha.N. 2000. Evaluation of air pollution tolerant tree species in Coimbatore city. J. Ecol. Res. Biocon. 1(2): 20-23.

[10] Santhoshkumar.E and Paulsamy.S. 2006. Studies on identification of suitable tree species for control of air pollution in Tamil Nadu. Nature Environment and Pollution Technology. 5(4): 591-599.

[11] Singh.A. 1977. Practical plant Physiological. Kalyani Publishers. New Delhi. 197–198.

[12] Singh.S.K, Rao.D.N, Agrawal.M, Pandey.J and Narayan. 1991. Air pollution Tolerance index of Plants. J. Environ. Manag. 32: 45-55.

[13] Steubing.L, Fangmier.A and Both.R. 1989. Effects of SO_2, NO_2, and O_3 on Population Development and Morphological and Physiological parameters of Native Herb Layer Species in a Beech Forest. Environmental Pollution. 58: 281-302.

[14] Suvarna Lakshmi.P, K.Lalitha Sravanti and N.Srinivas. 2008. Air Pollution Tolerance Index of various plant species growing in industrial areas. The Ecoscan. 2(2): 203–206.

VI. Acknowledgments

The Authors would like to thank University Grants Commission, New Delhi for awarding Rajiv Gandhi National Fellowship to conduct the research work.