Available online at www.ijpab.com

ISSN: 2320 – 7051
Int. J. Pure App. Biosci. **2 (5):** 233-238 (2014)

Research Article

INTERNATIONAL JOURNAL OF PURE & APPLIED BIOSCIENCE

Biomonitoring of dust pollution of road side of Harda using Air Pollution Tolerance Index (APTI)

Aruna Jain[1] and C. Sreelatha Kutty[2]*
[1]Sarojini Naidu Govt. Girls P.G. (Auto) College, Bhopal
[2]Govt. College, Timarni, Harda, M.P.
*Corresponding Author E-mail: drsreelatha00@yahoo.com

ABSTRACT

Plant leaves act as biological filters removing large quantities of particles from the urban atmosphere. The loss of trees in our urban areas not only intensifies the "heat island" effect from loss of shade and evaporation, but also we loss a principal absorber of carbon dioxide and trapper of particulate pollution as well. The present study is designed to investigate the Air Pollution Tolerance Indices (APTI) of three dominant species Cassia siamea, Dalbergia sissoo and Delonix regia growing along road sides of Harda in two different sites i.e. Polytechnic college area is taken as polluted site (PS) and Railway colony area as controlled site (CS).The APTI is determined by analyzing four different biochemical parameters that is Relative water content (RWC) of leaf, Ascorbic acid content (AA), Total chlorophyll (Tchl) of leaf and pH of leaf extract. Ascorbic acid content of Cassia siamea growing along PS was higher than CS but RWC, Tchl, has slightly declined in PS, whereas a notable reduction in above parameters observed in Dalbergia siamea and Delonix regia growing in PS. The APTI of Cassia siamea of PS found to be higher than CS, whereas APTI of Dalbergia sissoo and Delonix regia along PS are lower than CS. The seasonal variation of APTI is also recorded in all the selected tree species. In the present study Cassia siamea expressed as tolerant species and Dalbergia sissoo and Delonix regia as sensitive species.

Key words: *Air pollution tolerance index, Polluted site, and Controlled site.*

INTRODUCTION

With the advent of economic growth the environment of India has become predominated by concrete high-rise structure and a place of congestion both from traffic and commercial activities. The degradation of our living environment in urban areas is largely due to new housing and townships, electrification, metro rails, widening of roads, rush of the automobiles etc. As a result the balance of urban climate has been disrupted and most of the vegetation has been destroyed to make away for the so called 'urban development'. Particulate deposition may cause both direct chemical effects on the plant and indirect effects through the soil. It may also increase the plants susceptibility to diseases and reduces photosynthesis. Dry dust appears to have little deleterious effect, but when deposited on the plants in the field over a long period in the presence of dew the dust solidifies into a hard adherent crust that can damage leaf tissue and inhibit growth. Dust may clog leaf stomata and may also produce necrotic spotting if it carries with it a soluble toxicant such as one with excess acidity. Plant provides an enormous leaf area for impingement, absorption and accumulation of air pollutants to reduce the pollutants level in the environment[13]. Pollutants enter into the leaves are accumulated causing chemical transformation resulting into severe injury in some plants where as some shows minimal effects[20].

Biomonitoring of plants is an important tool to evaluate the impact of air pollution. Hence in the latest years urban vegetation became increasingly important not only for social reasons but mostly for affecting local and regional air Study of single parameter may not provide a sufficient evidence for the alterations in plants due to the air pollution, therefore Relative water content (RWC), Ascorbic acid (AA) content, Total chlorophyll (Tchl) content and leaf extract pH has been used to know tolerance levels of trees[27].

MATERIALS AND METHODS

Study area- Harda Tehsil lies in 22 degree 21'N and 77 degree 6'E on the Great Indian Peninsula. Emissions from heavy traffic, continuous development, land clearing etc resulted into dusty atmosphere around Polytechnic college area was selected as polluted site (PS) and the Railway colony area which is 3Km away from Polytechnic college facing less traffic and prohibited construction was selected as controlled site (CS).

Selection of tree species- On the basis of dominance, frequency of damage and economic importance three tree species namely *Cassia siamea, Dalbergia sissoo* and *Delonix regia* were selected from both PS and CS. Leaves of all species were collected from each site thrice a week. Duplicate of fully mature leaves of each species were collected in the morning hours from trees of almost same diameter at breast height (DBH) and height.

Biochemical analysis- The fresh leaf samples were analyzed for total chlorophyll, ascorbic acid, leaf extract pH, and relative water content for determining APTI by following standard procedure. Chlorophyll was extracted in 80% acetone and the absorption at 663 nm and 645 nm were read in a spectrophotometer, by using the absorption coefficients, the amount of chlorophyll was calculated. To determine ascorbic acid content a homogenate was prepared by using 4% oxalic acid and was dehydrated by bromination. The dehydroascorbic acid was then reacted with 2, 4-dinitrophenyl hydrazine to form osazone and dissolved in sulphuric acid to give an orange- red colour solution which was measured at 540 nm using spectrophotometer[2]. Fresh leaf (0.5g) sample was homogenized using 50ml deionized water and the supernatant obtained after centrifugation was collected for detection of pH using pH meter[3]. The percentage relative water content was calculated by using the initial weight, turgid weight and dry weights of leaf samples[33]. The results were statistically analyzed.

The air pollution tolerance index (APTI) was computed by the method suggested by Singh and Rao (1983) using the equation.

$$\mathbf{APTI} = \frac{\mathbf{A\,(T + P) + R}}{\mathbf{10}}$$

A = Ascorbic acid content mg g^{-1} (fresh water)
P = Leaf extract pH
T = Total chlorophyll (mg g^{-1} dry wt.) and
R = Percent relative water content of leaf.

RESULTS AND DISCUSSIONS

Total chlorophyll content - Chlorophyll measurement is an important tool to evaluate the effect of air pollution on plants[16,34]. There was a reduction in chl a, b and total chlorophyll content in all the selected tree species growing in PS than in CS. *Dalbergia sissoo* and *Delonix regia* of PS shows maximum decrease in chlorophyll content which is minimum in *Cassia siamea.* Seasonal variations of chlorophyll in all the species were observed. The maximum value of chlorophyll content was in rainy season may be due to wash out of dust particles. Low level of pollution and high water content of soil is suggested by Shyam *et al*.[25]. Low chlorophyll content in winter season might be due to high pollution level, temperature stress, low sunlight intensity and short photoperiod. Degradation of photosynthetic pigment has been widely used as an indicator of air pollution[18]. The chlorophyll content of plants varies from species to species depending upon the age of leaf, pollution level as well as with other biotic and abiotic conditions[11].

Ascorbic acid- It is a strong reducer and plays important role in photosynthesis. High pH may increase the efficiency of conversion of hexose sugar to ascorbic acid and it is related to the tolerance to pollution[6]. In *Dalbergia sissoo* and *Delonix regia* it was observed that, with the increase in the dust deposition there was decrease in ascorbic acid content in PS, whereas under same condition in *Cassia siamea* the ascorbic acid content increased with the increase in the dust deposition. A positive correlation was observed in ascorbic acid content and dust deposition in *Cassia siamea* and a negative correlation observed in *Dalbergia sissoo* and *Delonix regia.* Tripathi and Gautam[31] reported pollution load dependent increase in ascorbic acid content of the plant species may be due to the increased rate of production of ROS during photo oxidation process.

Leaf Extract pH- Leaf extract pH of the selected tree species exposed to dust pollution slightly shifted towards alkalinity in comparison to CS. The maximum leaf extract pH in both PS and CS was recorded in April and the minimum in July and August. pH had shown increasing trend from winter to summer season and abruptly declined in the rainy season. Hanna *et al*, (2009) reported that the heavy metals emitted from automobiles can affect the pH of the road side soil. The dangerous level of alkaline dust in the air causes degradation of plants in the vicinity[29]. High pH may increase the efficiency of conversion of hexose sugar to ascorbic acid[6]. The pH ranged between 4.4 and 8.8 lies in both intermediately tolerant and sensitive plant species[12].

Relative water content (RWC) - 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 favors drought resistance in plants. There is decrease in relative water content of leaves of all the selected tree species growing in PS and CS. The RWC of *Delonix regia* growing in PS is highly declined especially during April to June.RWC of *Cassia siamea* in PS and CS is more or less similar this shows its drought resistance capacity as well as its physiological balance state under stress condition like exposure to air pollution. Plants with high relative water content under polluted condition are tolerant to pollutants[4,24,26].

Air pollution tolerance index (APTI) - The APTI of trees growing in PS and CS is presented in Table 1, 2 and 3. High APTI is observed in *Cassia siamea* throughout the year and was comparatively less in *Dalbergia sissoo* and *Delonix regia*. In PS this decrease in APTI was contributed due to air pollutants and sensitivity of trees as already reported by, Narsimha *et. al.*[17], Tripathi *et. al*.[32]. Susceptibility to air pollution vary form species to species[5,9,21]. The higher APTI of *Cassia siamea* proved it to be one of the most resistant trees, its dominance in polluted site is an indication of its tolerant nature parallel to its higher APTI. Reports of Mashitha *et al.*[14] shows that *Cassia* species of road sides has high APTI supports our findings. The plants with higher APTI were found to be resistant and also act as a bioaccumulator for air pollutants[19]. Being a resistant species *Cassia siamea* can be grown in and around the industrial areas and along road sides as avenue trees.

Low APTI of *Dalbergia sissoo* and *Delonix regia* shows susceptibility towards the dust pollution, similar observation is made by Karthiyayani *et al.*[10]. These trees being a sensitive species act as bio indicator of pollution as they integrate the effects of all environmental factors including interactions with air pollutants and climatic conditions supporting the studies of Thakur and Mishra[30], Meerabai *et al.*[15], Rai *et al.*[22]. Merely by analyzing the present parameters an early diagnosis of the extent of pollution can be done even in the absence of visible injury.

Table 01. Air pollution tolerance index of *Cassia siamea*

Month	pH of leaf extract		% Relative moisture content		Total Chlorophyll mg/g		Ascorbic acid mg/g		APTI	
	PS	CS	PS	CS	PS	CS	PS	CS	PS	CS
January	7.92	7.28	79.00	80.00	2.89	3.40	8.21	7.90	713.90	689.85
February	7.92	7.28	79.00	80.00	2.88	2.96	8.22	7.92	714.77	691.55
March	7.97	7.28	79.00	80.00	2.48	2.76	8.29	8.00	721.23	698.52
April	7.98	7.28	75.00	79.00	2.47	3.27	8.60	8.21	713.88	708.69
May	7.61	7.20	74.00	75.00	2.81	3.21	8.70	8.22	710.29	676.01
June	7.50	7.10	74.00	75.00	3.00	3.41	8.83	8.22	719.95	675.20
July	7.10	7.00	82.00	84.00	3.16	3.39	7.62	7.01	679.26	638.25
August	7.10	7.00	83.00	83.00	3.32	3.55	7.63	7.02	687.80	632.16
September	7.20	7.00	83.00	83.00	3.52	3.82	7.63	7.02	688.58	632.18
October	7.00	7.00	80.00	82.00	2.95	3.39	7.70	7.25	670.20	645.59
November	7.03	7.10	80.00	82.00	2.91	3.31	7.70	7.34	670.42	654.33
December	7.06	7.18	79.00	81.00	2.76	3.41	7.76	7.52	668.10	663.45

Table 02. Air pollution tolerance index of *Dalbergia sissoo*

Month	pH of leaf extract		% Relative moisture content		Total Chlorophyll mg/g		Ascorbic acid mg/g		APTI	
	PS	CS	PS	CS	PS	CS	PS	CS	PS	CS
January	8.38	7.31	57.00	60.00	2.09	2.35	1.45	2.11	95.01	142.26
February	8.39	7.30	56.00	58.00	2.10	2.37	0.98	2.11	63.31	138.02
March	8.00	7.28	56.00	56.00	2.11	2.40	1.23	2.12	78.93	134.39
April	7.90	7.25	55.00	56.00	2.30	2.47	1.23	2.11	77.60	133.70
May	7.50	7.20	54.00	55.00	2.36	2.56	1.20	2.12	74.04	132.12
June	7.10	7.10	51.00	55.00	2.96	2.62	1.12	2.13	65.37	132.54
July	7.10	7.00	50.00	63.00	2.36	2.85	2.01	2.13	115.01	149.39
August	7.10	7.00	60.00	63.00	2.42	2.99	2.01	2.13	135.11	149.40
September	7.10	7.00	60.00	63.00	2.76	3.04	2.01	2.03	135.15	142.40
October	7.30	7.10	60.00	62.00	2.51	3.03	2.00	2.03	134.85	140.58
November	7.60	7.18	59.00	61.00	2.31	1.64	1.98	2.03	132.10	138.57
December	7.90	7.20	58.00	61.00	1.95	2.34	1.90	2.03	125.41	138.68

Table 03. Air pollution tolerance index of *Delonix regia*

Month	pH of leaf Content		% Relative moisture content		Total Chlorophyll mg/g		Ascorbic acid mg/g		APTI	
	PS	CS	PS	CS	PS	CS	PS	CS	PS	CS
January	8.00	7.30	50.00	52.00	2.20	2.59	3.28	6.22	190.46	369.11
February	7.90	7.28	48.00	50.00	2.22	2.62	3.00	6.21	167.92	355.97
March	7.81	7.28	48.00	50.00	2.23	2.65	2.99	6.20	167.09	355.40
April	7.60	7.20	45.00	48.00	2.29	2.68	3.48	7.00	183.28	386.67
May	7.52	7.20	43.00	47.00	2.34	2.70	3.45	7.13	174.53	386.72
June	7.50	7.10	43.00	47.00	2.39	2.74	3.12	7.20	157.80	389.79
July	7.10	7.10	54.00	57.00	2.49	2.92	7.36	7.48	449.95	479.76
August	7.10	7.00	54.00	57.00	2.59	3.10	7.36	7.49	449.96	479.67
September	7.00	7.00	53.00	56.00	2.68	2.21	7.39	7.49	443.67	472.09
October	7.20	7.10	51.00	55.00	2.66	3.13	5.23	7.00	304.65	435.01
November	7.26	7.10	51.00	53.00	2.46	2.91	5.00	6.23	291.55	374.71
December	7.90	7.10	50.00	53.00	2.36	2.72	4.21	6.23	244.00	374.70

REFERENCES

1. Abida, B. and Harikrishna, S., Evaluation of some tree species to absorb air pollution in three industrial locations of South Bengaluru India, *E- Journal of chemistry*, **7**: 51 (2010)
2. Arnon, D.I. Copper enzyme in isolated chloroplast Plant Physiol., **24**: 1-15 (1949)
3. Bars, H.D. and Weatherly ,P.E.A re-examination of the relaive turgidity technique for estimating water deficit in leaves, *Aust. J. Biol. Sci*., **15**: 413-428 (1962)
4. Chandawat, D.K. Verma, P.U. and Solanki, H.A., Air pollution Tolerance Index (APTI) OF Tree Species at cros road of Ahmadabad city: *Life science Leaflets*., **20**: 935-943 (2011)
5. Chouhan, A. Iqbal, S. Maheshwari, R.S. and Bafna, A., Study of air pollution tolerance Index of plants growing in Pithampur Industrial area sector 1, 2 and 3, *Res. J. Recent Sci.*,**1**:172-174 (2012)
6. Escobedo, F.J. Wagner, J.E. and Nowak, D.J. Maza, De Le Rodriguez, M. and Crane, D.E., Analyzing the cost effectiveness of Santiago, Chile's policy of using urban forest to improve air quality, *J. of Environmental Management.*, **86**:148-157 (2008)
7. Gupta, R. Chaudhary, B. and Wate, S.R. Overview on attenuation of industrial air pollution by greenbelt, *J. Indus. Poll. Con*., **24**: 1-8 (2008)
8. Joshi, P. and Swami, A. Physiological responses of some tree species. Under road sides automobile pollution stress around city of Haridwar, India, *The Environmentalist*, **27**:365-374 (2007)
9. Jissy Jyothi, S. and Jaya, D.S. Evaluation of air pollution tolerance index of selected plants along roadsides in Thiruvananthapuram, Kerala. *Journal of Environmental Biology*, **31**: 379-386 (2010)
10. Karthiyayine, R. Ponnammal, N.R. and Joseph, R., Air Pollution Tolerance Index of certain Plants of Coimbatore Ooty highways near ITI area Coimbatore, *T.N. Pollut. Res*., **24**: 383-365 (2005)
11. Kartiyar, V. and Dubey, P.S., Sulphur dioxide sensitivity on two stage of leaf development in a few tropical tree species, Ind. *J. Environ. Toxicol*. **11**: 78-81 (2001)
12. Lakshmi, P.S. Sarvanti, K.L. and Srinivas, N., Air pollution tolerance index of various plant species growing in industrial areas, *An Int Biannua J. of Environ. Sci*., **2**: 203-206 (2009)
13. Liu, Y.J. and Ding, H. Variation in air pollution tolerance index of plant near a steel factory. Implication for landscape plant species selection for industria area. WSEAS Transaction on Environment and Development, **1(4)**: 23-32 (2008)
14. Mashitha, P.M. and Pise, V.L. Biomonitoring of air pollution by correcting the Pollution Tolerance index of some commonly growing trees of an urban area, *Pollu.Res*., **20(2)**: 195-197 (2001)
15. Meerabai, G. Raman, C.V. and Rasheed, M., Effect of industrial pollutants on physiology of *Cajanus cajan* (L). Fabaceae, *Int. J. Env.Sci*, **2(4)**: 1889-1894 (2012)
16. Mir, Q.A. Yazdani, A. Kumar, A. Narain, K. and Yunus, M. Vehicular population and pigment content of certain avenue trees, *Poll. Res*., **27**: 56-63 (2008)
17. Narsimha, T. Suresh, K. and Srinivas, N. Air Pollution Tolerance Index (APTI) of tree species growing in I ndustrial and Traffic Areas of Visakhapatana, *IJEP*. **25(12)**: 1057-1000 (2005)
18. Ninave, S.Y. Chaudhari, P.R. Gajghate, D.J. and Tarar, J.L., Foliar biochemical features of plants as indicators of air pollution. *Bull. Environ. Contam. Toxicol*, **67**: 133-140 (2001)
19. Prasanna, R.T, Despande, U.K. and Awaid, U.G. Effect of sulphur dioxide on protein and carbohydrate of some macrophytes, *Pollu.Res*., **24(2)**: 427-430 (2005)
20. Priyanka, C. and Dibyendu, B., Biomonitoring of air quality in the industrial town of Asansol using the air pollution tolerance index approach. *Res. J. Chem. Environ*., **13**: 46-51 (2009)
21. Radhapriya, P., A.N. Gopalkrishnan, P. Malini and Ramachandran ,A., Assessment of air pollution tolerance levels of selected plants around cement industry, Coimbator, India , *J. Environ. Biol*., **33**: 635-641 (2011)
22. Rai, P.K. Panda, L.L.S. Chutia, B.M. and Singh, M.M., Comparative assessment of air pollution tolerance index (APTI) in the industrial (Rourkela) and non industrial area (AIZWAL) of India. An ecomanagement approach, *Afr. J. Env.Sci. and Tech*., **7(10)**: 944-948 (2013)

23. Sadasivam, S. and Balasubramaniam, T., Practical manual in Biochemistry Tamil Nadu Agricultural University Coimbatore. **14**: (1987)
24. Sasmita, D. and Prasad, P. Seasonal variation in air pollution Tolerance Indices and Selection of Plant Species for Industrial Areas of Rourkela, *IJEP*., **30(12)**: 978-988. (2010)
25. Shyam, S. Verma, H.N. and Bhargava, S.K., Air pollution and its impact on plant growth. New India Publishing Agency, New Delhi (2006)
26. Seyyednejad, S.M. Majdian, K. Koochak, H. And Nikneland, M., Air pollution Tolerance Indices of some plants around Industrial Zone in South of Iran, *Asian Journal of Biological Sciences,* **4 (3)**: 300-305 (2011)
27. Singh and Verma, Phytoremediation of Air Pollutants, A review, In, Environmental Bioremediation Technology, Singh, S.N. and R.D. Tripathi (EDS.), *Springer, Berlin Heidelberg*., **1**: 293-314 (2007)
28. Singh, S.K. and Rao, D.N., Evaluation of plants for their tolerance to air pollution. In: Proceedings of symposium on air pollution control. Ind. Asso. *Air Pollu. Cont*., New Delhi, 218-224 (1983)
29. Swiercz, A., Suitability of fine bark to evaluate pollution caused by cement-lime dust. *J. Forest Sci.*, **52**: 93-98 (2006)
30. Thakur, B.K. and Mishra, P.C., Dust collection potential and air pollution tolerance of vegetation around Vedanta aluminium limited, Jharsuguda, *Int. Q. J. Lif. Sci*., **3**: 603-612 (2010)
31. Tripathi, A.K. and Gautam, M., Biochemical parameter of plants as indicator of air pollution, *J. Environ. Bio*, **28**: 127-132 (2007)
32. Tripathi, A.K. Tiwari, P.B. and Singh, D. Assessment of air pollution tolerance index of some trees in Moradabad city, India, *J. Environ. Biol*., **30**: 545-550 (2009)
33. Varshney, C.K. Buffering capacity of trees growing near a coal field thermal power station. In: Tropical ecosystems: Ecology and Management (Eds.: K.P. Singh and J.S. Singh). Wiley Eastern LTD., New Delhi. (1992)
34. Wagh, N.D. Poonam, V. Shukla, P.V., Tambe ,B.S.and Ingle, S.T., Biological monitoring of roadside plants exposed to vehicular pollution in Jalgaon city, *J. Env. Biol*, **27(2)**: 419-421 (2006)