APTI (AIR POLLUTION TOLERANCE INDEX) OF TREES IN LOHAGAON AREA IN PUNE CITY IN DIFFERENT SEASONS

Erum F H Kazi  
Asst- Professor, Department of Environmental Science, Abeda Inamdar Senior College, Pune, India.

Dr. Satish Kulkarni  
Associate Professor, HOD, New Arts Commerce and Science College, Ahmednagar, Maharashtra

ABSTRACT

Air Pollution is having severe impact on Roadside trees of Lohagao area. Plant samples were collected in and around Airport area. It was found that concentration of PM 10 was found to be highest in all seasons studied and had impact on trees. Plant studied were Indian Rosewood, Tamarind tree, Mango tree, Rain tree, Neem tree, Peepal tree. pH was found to be highest in Mango tree, Relative water content (RWC) was found to highest in Tamarind tree, Total Chlorophyll content in Mango tree, Ascorbic acid was found to be highest in Peepal tree. APTI was found to be highest in Peepal and lowest in Tamarind tree.

KEYWORDS: Air Pollutants, APTI of plants, Total Chlorophyll, Ascorbic acid, pH of leaf Relative water Content (RWC)

INTRODUCTION

Air Pollution is turned out to be major problem in Pune city. Urbanization & increased number of vehicles in Pune city are the cause of rise in Air pollution in Pune City. These air pollutants are having major impacts on the plants and trees. Plants susceptibility and tolerance towards air pollution can be determined by calculating APTI of plants using parameters like –Total Chlorophyll, Relative water content (RWC), Ascorbic acid content and pH of plant.

MATERIALS AND METHODS

Study area

Lohagaon area is known for Pune International Airport and has Air Force Base. Located in 18°35’45.6864”N & 73°55’28.9128”E. Samples were collected twice each month of October, November, December, January and February 2017-2018. Plant samples were analysed for APTI calculations. Trees that were selected are as follows- Indian rosewood (Dalbergiasissoo), Tamarind tree (Tamarindusindica), Mango tree ( Mangiferaindica), Rain tree (Samaneasaman), Neem tree (Azadiractaindica), Peepal tree (Ficusreligiosa).

1. Estimation of Leaf-extract pH 0.5 g of leaf material was ground to paste and dissolved in 50 ml of deionized water and Leaf-extract pH was measured by using calibrated digital pH meter (model).

2. Estimation of relative moisture content- Fresh leaf samples collected from the study area were brought immediately to the laboratory and washed thoroughly. The excess water was removed with the help of blotting paper. The initial weight of samples were taken (W1 g) and
kept in oven at 60°C until constant weight was obtained and the final weight was taken (W2 g).

3. Estimation of Total Chlorophyll and Ascorbic acid

Acetone extraction method (Arnon 1949) and ascorbic acid was estimated by 2,6-dichlorophenol indophenol’s dye method.

Total chlorophyll - The total chlorophyll was estimated principally by the method of Arnon. One gram fresh leaf was macerated with 80% (v/v) chilled acetone and a pinch of magnesium carbonate in a prechilled pestle and mortar. The extract was centrifuged at 2500 rpm for 10 minutes. The process was repeated till the extract becomes colourless and the extracts were pooled and the volume was made up to 15mL. All operations were carried in the ice bath under dark condition. The absorbance was measured at 645, 663 and 750nm using UV-visible spectrophotometer.

\[ T\text{Ch} = 20.2A_{645} + 8.02A_{663} \times V / (1000 \times W) \]

Where, TCh = Total chlorophyll in mg/g

A645 = Absorbance at 645nm minus the absorbance at 750nm

A663 = Absorbance at 663nm minus the absorbance at 750nm

V = Total volume of the extract in mL

W = Weight of the sample in g

Ascorbic acid - One gram fresh leaf was homogenized in 4mL of freshly prepared oxalic acid (0.4% w/v), filtered and centrifuged at 1000 rpm for 20 minutes. Final volume was made up to 10mL using oxalic acid. About 5mL of the extract was titrated against standardized 2,6-dichlorophenol-indophenol [11].

\[ AA = I \times S \times D / A \times 1 / W \]

Where

AA = Ascorbic acid in mg/g

I = mL of indophenol used for titration

S = mg of ascorbic acid reacting with 1mL indophenol

D = total volume of the extract in mL

A = Aliquot titrated in mL

W = Weight of the sample in gm.

APTI (Air Pollution Tolerance Index) was calculated using formula -

\[ \text{Air pollution tolerance Index of species} = \left[ A \times (T+P) \right] + R / 10 \]

Where

A = ascorbic acid content of leaf in mg/g dry weight

T = Total chlorophyll content of leaf in mg/g dry weight

P = Leaf extract pH

R = Relative water content (RWC)

Total sum is divided by 10 to obtain APTI values.

RESULTS AND DISCUSSION

Table 1 - Showing Air Quality data & Graphs for Lohgaon area – IITM (Indian Institute of Tropical Meteorology)

| Year | Month   | PM 10 | PM 2.5 | NOx | SOx |
|------|---------|-------|--------|-----|-----|
| 2017 | October | 73    | 23     | 23  | 52  |
| 2017 | November| 122   | 24     | 24  | 47  |
| 2017 | December| 134   | 24     | 24  | 46  |
| 2018 | January | 136   | 80     | 42  | 44  |
| 2018 | February| 109   | 65     | 100 | 42  |

It was found that NOx level was high and above the permissible limit in the month of March 2018 as compared to October, November, December 2017.
Concentration of SO was found to be within permissible limits but slightly higher in October 17 and March 17.

Concentration of PM 2.5 was found to be highest in the month of January 18, February 18 while at other times it was below the permissible limits.

It was found that concentration of PM 10 was higher and above permissible limits in October 17 – March 18, but highest in Nov, Dec, 17 January, February 18.
It was found that PM 10 concentration was found to be above permissible limit, PM 2.5 was found to be high in month of January and February 2018. NOx concentration was found to be highest in the month of January and February 2018. Concentration of SOx was found to be slightly high in the month of October 2017.

| Table 2-Showing Graphs of Relative water Content, Ascorbic acid, Total Chlorophyll, pH levels, APTI of plants in October, November, December 2017 & January, February 2018. |
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Tamarind tree showed pH acidic, followed by other trees. Most of the trees studied showed acidic pH indicating of pollutant impact of NOx and PM 10 on them.

Trees showed low chlorophyll content. Except Mango tree this was again due to presence of air pollutants.

It was found that Tamarind tree showed highest Relative water content followed by Peepal, mango tree. Low RWC indicates intolerance towards air pollution.
Peepal tree showed highest Ascorbic acid content in all seasons followed by Rain tree, Tamarind, Mango.

Tolerant plant to air pollution was Peepal tree, Rain tree and Mango tree.

1. **Leaf pH**
   Plants with lower pH are more susceptible, while those with pH around 7 are tolerant. It was found that most of the plants showed pH below 7. Indian Rosewood (Dalbergia sissoo) showed highest pH level followed by Mango (Mangifera indica), Neem (Azadirachta indica), Rain tree (Samaneasaman), Peepal tree (Ficusreligiosa), Tamarind tree (Tamarindusindica) showed lowest pH.

2. **Relative Water Content**
   Water is crucial prerequisite for plant life. RWC of a leaf is the amount of water present in it relative to its full turgidity. Relative water content is associated with protoplasmic permeability in cells and causes loss of water and dissolved nutrients, resulting in early senescence of leaves. Under stress conditions of air pollution when the transpiration rates are usually high, higher water content in a leaf will help to maintain its physiological balance. It was found that Tamarind tree showed highest Relative water content followed by Peepal, Mango, Neem, Rain tree & Dalbergia sissoo tree.

3. **Total Chlorophyll**
   Chlorophyll content of plants varies from species to species, age of leaf, and also with the pollution level as well as with other biotic and abiotic conditions. Thus, plants having high chlorophyll content show tolerance to air pollution.
   It was found that Total Chlorophyll was highest in Mango tree followed by Tamarind tree, Peepal tree, Rain tree, Dalbergia sissoo and Neem tree.

4. **Ascorbic acid**
   Ascorbic Acid plays an important role in cell division, defences, and cell wall synthesis. It is a natural detoxicant, which may prevent the effects of air pollutants in the plant tissues. Thus, plants maintaining high Ascorbic Acid under pollutant conditions are considered to be tolerant to air pollution.
   It was found that Peepal tree has highest Ascorbic acid content followed by Rain tree, Tamarind tree, Mango tree, Neem and Dalbergia sissoo had lowest Ascorbic acid content.

5. **APTI of Plants**
   APTI gives an empirical value for tolerance level of plants to air pollution. It was found that plants with high index values are tolerant to air pollutants, whereas low index values were generally sensitive to air pollutants.
   It was found that Peepal showed highest APTI values followed by Rain tree, Mango, Indian rosewood tree, Neem and tamarind tree.
CONCLUSION
It can be concluded that PM 10 (Particulate matter 10) is above the permissible limit in all seasons. It is one of the major pollutants having impact on Leaf pH, Relative water content (RWC), Total chlorophyll content, Ascorbic acid content, thus finally having impact on Plant APTI. It can be concluded that Peepal tree was found to be tolerant in all seasons to the Pollution levels, especially Particulate matter and Tamarind tree was found to be Sensitive to pollution levels in all seasons.

BIBLIOGRAPHY
1. Aceves-Fernandez, M. A., Pedraza-Ortega, J. C., Sotomayor-Olmedo, A., Ramos-Arreguin, J. M., Vargas-Soto, J. E., & Tovar-Arriaga, S. (2012). Analysis of Key Features of Non-Linear Behavior Using Recurrence Plots. Case Study: Urban Pollution at Mexico City. Journal of Environmental Protection, 3(29), 1147–1160.
2. Augustine, C. (n.d-a). Impact of air pollution on the environment in Port Harcourt, Nigeria. Retrieved from http://www.wudpeckerresearchjournals.org/JESWR/Pdf/2012/April/Augustine.pdf
3. Augustine, C. (n.d-b). Impact of air pollution on the environment in Port Harcourt, Nigeria. Retrieved from http://www.wudpeckerresearchjournals.org/JESWR/ Pdf/2012/April/Augustine.pdf
4. Barman, S. C., Kumar, N., Singh, R., Kisku, G. C., Khan, A. H., Kidewi, M. M., & Verma, A. K. (2010). Assessment of urban air pollution and its probable health impact. Journal of Environmental Biology, 32(6), 913–920.
5. Begum, B. A., Biswas, S. K., Markwitz, A., &Hopke, P. K. (2010). Identification of sources of fine and coarse particulate matter in Dhaka, Bangladesh. Aerosol Air Qual. Res., 10, 345–353.
6. Brunekreef, B., & Holgate, S. T. (2002). Air pollution and health. Lancet, 360, 1233–1242.
7. Chattopadhyay, S., Gupta, S., &Saha, R. N. (2010). Spatial and Temporal Variation of Urban Air Quality: A GIS Approach. Journal of Environmental Protection, 3(3), 264–277.
8. Chouhan A, Sanjeeda I, Maheshwari RS, Bafna A. Study of air pollution tolerance index of plants growing Pithampur Industrial area sector 1, 2 and 3. Research Journal of Recent Sciences.2012; 1:172–177.
9. Davidson, C. I., Phalen, R. F., & Solomon, P. A. (2005). Airborne particulate matter and human health: A review. Aerosol Science and Technology, 39(8), 737–749.
10. Dubey, N., & Perez, S. (2008). Investigation of Variation in Ambient PM10 Levels within an Urban-Industrial Environment. Aerosol Air Qual. Res., 8, 54–64.
11. Ediagbonya, T. F., Tobin, A. E., &Ukpebor, E. E. (2013). The level of suspended particulate matter in wood industry (sawmills) in Benin City, Nigeria. Journal of Environmental Chemistry and Ecotoxicology Vol, 5(1), 1–6.
12. ELAssouli, S. M. (2011). Airborne particulate matter (PM10) composition and its genotoxicity at two pilgrimage sites in Makkah, Saudi Arabia. Journal of Environmental Chemistry and Ecotoxicology, 3(4), 93–102.
13. Fujita, E. M., Croes, B. E., Bennett, C. L., Lawson, D. R., Lurmann, F. W., & Main, H. H. (1992). Comparison of emission inventory and ambient concentration ratios of CO, NMOG, and NOx in California’s South Coast. Air Basin. Journal of the Air & Waste Management Association, 42(3), 264–276.
14. Hao, J., & Wang, L. (2005). Improving urban air quality in China: Beijing case study. Journal of the Air & Waste Management Association, 55(9), 1298–1305.
15. Horaginamani, S. M., &Ravichandran, M. (2010a). Ambient air quality in an urban area and its effects on plants and human beings: a case study of Tiruchirappalli, India. Kathmandu University Journal of Science, Engineering and Technology, 6(2), 13–19.
16. Horaginamani, S. M., &Ravichandran, M. (2010b). Ambient air quality in an urban area and its effects on plants and human beings: a case study of Tiruchirappalli, India. Kathmandu University Journal of Science, Engineering and Technology, 6(2), 13–19.
17. Horaginamani, S. M., &Ravichandran, M. (2010c). Ambient air quality in an urban area and its effects on plants and human beings: a case study of Tiruchirappalli, India. Kathmandu University Journal of Science, Engineering and Technology, 6(2), 13–19.
18. Isabal, M. Z., & Shafiq, M. (2001). Periodical effect of cement dust pollution on the growth of some plant species. Turk. J. Bot, 25, 19–24.
19. Jova, vsević, Družić, Ž., & Bartonova, A. (2010a). Current state of particulate matter research and management in Serbia. Chemical Industry and Chemical Engineering Quarterly, 16(3), 207–212.
20. Jova, vsević, Družić, Ž., & Bartonova, A. (2010b). Current state of particulate matter research and management in Serbia. Chemical Industry and Chemical Engineering Quarterly, 16(3), 207–212.
21. Jyothi, S. J., & Jaya, D. S. (2010). Evaluation of air pollution tolerance index of selected plant species along roadsides in Thiruvananthapuram, Kerala. J. Environ. Biol., 31, 379–386.
22. Kathuria, V. (2005). Vehicular Pollution Control—Concept note. Madras School of Economics, Gandhipuram Road, Chennai, 600, 025.
23. Kgabli, N. A. (2010). An assessment of common atmospheric particulate matter sampling and toxic metal analysis methods. African Journal of Environmental Science and Technology, 4(11), 718–728.
24. Kgabli, N. A., Mokgwetsi, T., & Molefe, M. M. (2011). Inhalable particulate matter associated with mining and smelter activities. African Journal of Environmental Science and Technology, 5(4), 268–279.
25. Kuddus, M., Kumari, R., & Ramteke, P. W. (2011). Studies on air pollution tolerance of selected plants in Allahabad city, India. E3 Journal of Environmental Research and Management, 2(3), 042–046.