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RESEARCH ARTICLE

Assessment of trees exposed to air pollutants in traffic and industrial sites at a tropical dry environment

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SUMMARY : The study examined the monthly variation of Air Pollution Tolerance Indices (APTI) of trees around the selected sites of study area. Site -1 is a residential area which was considered as control site, site-2 is located in a heavily polluted traffic junction and site-3 is in a industrially polluted region. Bio monitoring of air pollution had been carried out in these sites. Biochemical parameters taken in to consideration were total chlorophyll, relative moisture content, pH and ascorbic acid of matured leaf samples. The present study suggests that plants have the potential to serve as excellent monitors of air pollution. The study summarized the results on biomonitoring of local plant species along various sites. Mangifera indica showed higher tolerance for automobile pollution through out the study period (Dec., 2010 to May, 2011). Tree species *Eugenia jambolana* showed higher tolerance for industrial pollution during this period of analysis. In the months of December, 2010 and January, 2011, Millingtonia hortensis became sensitive for air pollutants. So it can be an effective indicator for air pollution in these months. And overall high tolerance of plants was observed in the month of May, 2011.

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Key Words :
APTI, Biochemical parameters, Total chlorophyll, Mangifera indica, RWC

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Vegetation is an effective indicator of the overall impact of air pollution and the observed result is more reliable one in a short period. However, plants maintained a balance between the injury caused by the pollutants and the homeostatic process governing repair. Analysis of four parameters such as ascorbic acid content, total chlorophyll content, leaf extracts pH and relative water content are considered as bio indicators of pollutants. The air pollutants from various sources include oxides of nitrogen, oxides of sulphur and particulates. Oxides of nitrogen damage the leaves of plants, retard the photosynthetic activity (Tthambavani and Kamala, 2010).

Ascorbate reduces glutathione and peroxidase are important superoxide scavengers in the chloroplast. The significance of each of these scavengers is dependent on their concentration and rate constant for the conversion of superoxide radicals. Freebairn and Taylor (1960) made tissue analysis of smog sensitive plants sprayed with ascorbic acid. They found that concentrations of ascorbic acid in the leave increased and resulted in partial to complete protection from air-pollution injury. One of the most common impacts of air pollution is the gradual disappearance of chlorophyll. The decrease in chlorophyll content was depending upon the increasing pollution load in high traffic areas .The level of toxicity may be responsible for lowering the levels of total chlorophyll (Joshi and Swami, 2007).

The high pH may increase the efficiency of the conversion from hexose sugar to ascorbic acid (Escobedo *et al.,* 2008) while low leaf pH extract showed good correlation with sensitivity to air pollution and also reduces photosynthesis in plants. The photosynthetic efficiency strongly is dependent on leaf pH (Yan-ju and Hui ding, 2008) the photosynthesis was reduced in plants with low pH (Turk and Wirth, 1975). The leaf extract pH in plants increased due to basic pollutants present at the polluted site. The relative water

content (RWC) of leaves is an indicator of the plants water status with respect to physiological consequences of cellular water. RWC is a useful indicator of the state of the water balance of the plant. The large quantity of water in plant body helps in maintaining its physiological balance under stress conditions (Gonalez *et al.*, 2001).

The plants with high and low APTI values serve as tolerant and sensitive species, respectively. Also the sensitivity levels of pollution differ for different plants (Singh and Rao, 1983). APTI of 15 plant species at residential, heavy traffic and industrial sites of the study area were examined for monthly variation during the study period.

EXPERIMENTAL METHODOLOGY

Study location:

This research work was carried out in Virudhunagar which is in southern part of Tamil Nadu, India. Virudhunagar is a town spread over an area of 6.39 sq.km holding a population of 72,081 as of 2001 (adopting population projection, it is interpolated the population of this town was 77449 in 2009).It is located at $9^0$35' North latitude and $77^0$57' East longitude, at 101.3m above mean sea level. The climate of the town is hot and dry throughout the year with April to June being the hottest months. The different locations identified were Madura coats colony (Site-1), Pavali (Site-2), Perali (Site-3). Site-1 may be considered as control site because it is comparatively free from any source of pollution. Site-2 is located in a heavily polluted traffic junction and Site-3 is in an industrially polluted region. The study was conducted from December, 2010 to May, 2011.

Plant selection:

Fifteen species which are common in all the three stations in the study area were selected for this purpose:

1. *Delonix regia*, 2. *Tarmarindus indica*, 3. *Moringa olifera*, 4. *Azardiracta indica*, 5. *Mangifera indica*, 6. *Millingtonia hortensis*, 7. *Pongamia glabra*, 8. *Polyalthia longifolia*, 9. *Eugenia jambolana*,10. *Pithecellobium dulce*, 11. *Ficus religiosa*,12. *Ficus benghalensis*,13. *Tectona grandis*,14. *Eucalyptus globulus*,15. *Ficus benjamina*.

Sample collection:

Trees were randomly selected from the immediate vicinity of the station and were labeled for experiment. Two replicates of fully matured leaf samples of the selected plant species were collected monthly, mixed to get a homogeneous sample. Then plant leaves were kept in polythene bags preserved in refrigerator for further analysis.

Analysis of selected biochemical parameters:

RWC is determined by using the method described by Barrs and Weatherly (1962). Each sample was placed in a pre-weighed airtight vial. Leaf sample should be placed in a vial slightly longer than the sample, with its basal part to the bottom. Samples should reach the lab as soon as possible. In the Lab, vials were weighed to obtain leaf sample weight (W), after which the sample was immediately hydrated to full turgidity for 3-4 h under normal room light and temperature. After hydration, the samples were taken out of water and were well dried of any surface moisture quickly and lightly with filter/ tissue paper and immediately weighed to obtain fully turgid weight (TW). Samples were then oven dried at 80^0C for 24h and weighed (after being cooled down in a desiccator) to determine dry weight (DW).

Calculation:

$$\mathbf{RWC(\%) = \frac{(W - DW)}{(TW - DW)} x100}$$

where,

W – Sample fresh weight

TW – Sample turgid weight

DW – Sample dry weight

For the measurement of leaf extract pH, 2g of the sample was homogenized with 20 ml of deionised water and the pH of the suspension was measured with a digital pH meter with a glass combined electrode.

Estimation of total chlorophyll content (TCH) was done according to the method described by Arnon (1949). 3 g of fresh leaves were blended and then extracted with 10 ml of 80 per cent acetone and left for 15 min. The liquid portion was decanted into another test-tube and centrifuged at 2,500 rpm for 3 min. The supernatant was then collected and the absorbance was then taken at 645 nm and 663 nm using a spectrophotometer.

Ascorbic acid was determined following the method of Agarwal (1985). 10 g of the leaf samples were transferred into a glass pestle mortar and macerated well with 4 per cent oxalic acid .The contents were transferred to a 100ml volumetric flask by filtering through a muslin cloth. And repeated the extractions with 4 per cent oxalic acid. Titrated against 0.02 per cent of a selective reagent 2, 6 dichlorophenol indophenol dye solution taken in the burette, a permanent pale pink color is obtained.

Determination of APTI:

The air pollution tolerance indices of fifteen common plants were determined following the method of Singh and Rao (1983). The formula of APTI is given as:

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

where,

A = Ascorbic acid content (mg/g), T = Total chlorophyll (mg/g),

P = pH of leaf extract and R = Relative water content of leaf (%).

The results were statistically analyzed and interpreted using Spss software version 17. To isolate which group(s) differed from the others with respect to the months, plants and study stations.

EXPERIMENTAL FINDINGS AND DISCUSSION

The values obtained for the monthly analysis (December 2010-May 2011) of selected bio chemical parameters of plants were analyzed statistically. All the bio-chemical parameters exhibited significant variation from species to species and station to station as shown 0.07 per cent ($p<0.04$).

Air pollution tolerance index:

APTI of 15 plant species at residential, heavy traffic and industrial sites of the study area are given in Fig. 1-6. All biochemical parameters that were analyzed for APTI plays significant role in determine resistivity and susceptibility of plant species.

In the month of December 2010 (Fig. 1) APTI value ranged from 2.97 to 12.09. At Site-1 the lowest value was observed in *F. bengamina* (2.97) and the highest value was observed in *A. indica* (9.96). Almost all the species showed variation in their tolerance towards air pollution between control and polluted sites. Exceptionally, *M. hortensis* showed no significant variation (4.94 at S-1, 4.83 at S-2, 4.75 at S-3). Species like, *T. indica* (4.82 to 7.24), *P. longifolia* (6.89 to 8.43), *F. religiosa* (5.98 to 7.46), *F. benghalensis* (6.35 to 9.49), *T. grandis* (5.52 to 7.50) and *F. bengamina* (2.97 to 8.69) showed tolerance towards polluted sites. *F.bengamina* showed maximum variation. Plants such as *M.indica* (12.09) and *E.jambolana* (9.73) showed higher tolerance at S-2 and S-3, respectively.

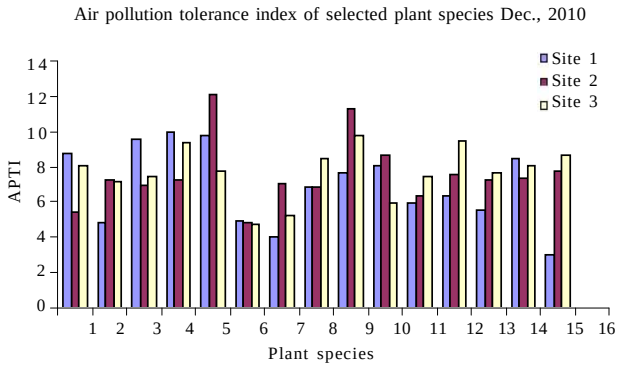

Fig. 1: Variation of air pollution tolerance index of plant species in selected sites at Virudhunagar for the month of Dec., 2010

During January, 2011 (Fig. 2), the calculated values ranged between 2.40 to 10.97. Plants like *P.longifolia*, *E.jambolana*, *F.benghalensis* and *E.globulus* exhibited steady increase of APTI value from Site-1 to Site-3. The values found to be decreased from control to polluted sites in trees like *M.olifera* (9.14 to 7.19) and *P.dulce* (9.82 to 6.04). Decrease may be due to reduction in the tolerance for pollutants during that cold month .Notable increase was observed in *F.benghalensis* (4.25 to 9.86), *T.grandis* (5.13 to 7.51), *E.globulus* (5.12 to 8.27) and *F.bengamina* (3.84 to 9.01) at Site-3 and these trees showed higher tolerance for industrial pollution and *M.indica* (9.96) showed higher tolerance for automobile pollution.

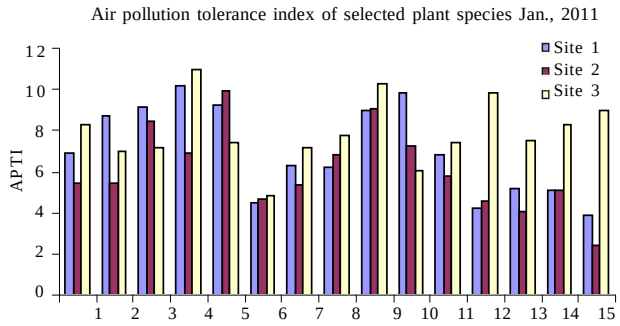

Fig. 2: Variation of air pollution tolerance index of plant species in selected sites at Virudhunagar for the month of Jan., 2011

It was observed in the month of Feb., 2011(Fig. 3) that almost all the species observed with higher tolerance. In contrary, species like *T.indica* (6.22 to 1.49), *M.olifera* (10.32 to 2.51), *A.indica* (9.95 to 8.07) and *F.benghalensis* (7.42 to 5.91) became sensitive. The maximum and minimum values observed were 10.91 and 2.89, respectively. It was observed that *M.indica* showed higher tolerance at S-2 (10.91) and *A.indica* showed higher tolerance for S-3 (8.07).

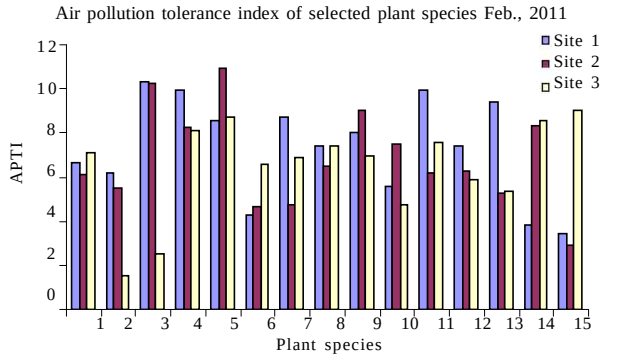

Fig. 3: Variation of air pollution tolerance index of plant species in selected sites at Virudhunagar for the month of Feb., 2011

It was evident in the month of March, 2011(Fig. 4), higher *F.religiosa* (17.83) at S-3. The

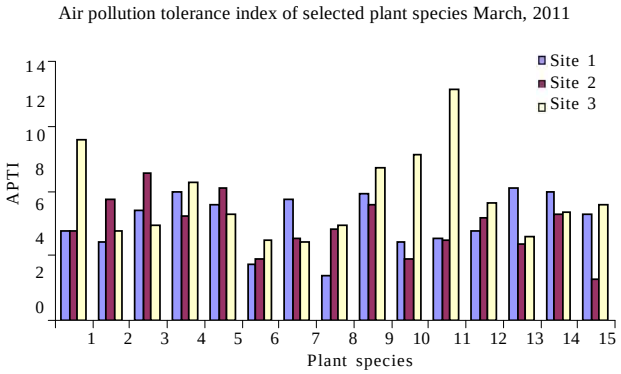

Fig. 4: Variation of air pollution tolerance index of plant species in selected sites at Virudhunagar for the month of March, 2011

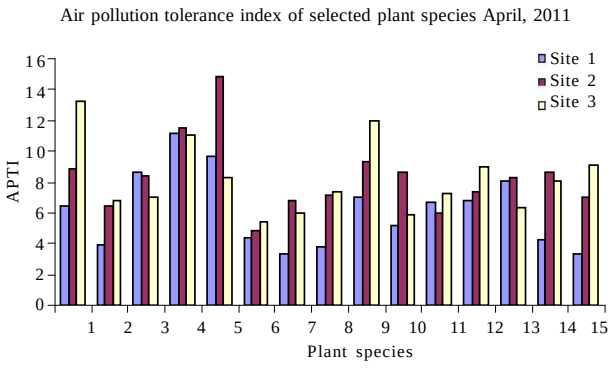

Fig. 5: Variation of air pollution tolerance index of plant species in selected sites at Virudhunagar for the month of April, 2011

On the basis of APTI data for the month of May. 2011(Fig. 6) the tolerance value ranged between 1.45 to 19.12. High tolerance was shown by *D.regia* at industrial site. Least value

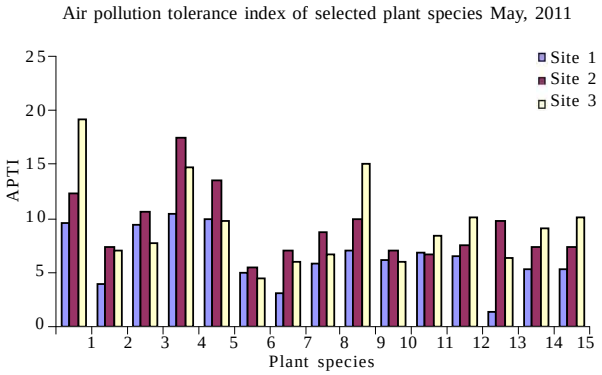

Fig. 6: Variation of air pollution tolerance index of plant species in selected sites at Virudhunagar for the month of May, 2011

analyzed values ranged between 3.16 to 17.83. Species like *T.indica* (6.01 to 9.31), *M.hotensis* (4.25 to 6.25), *P.longifolia* (3.38 to 7.38) and *F.benghalensis* (6.95 to 9.12) showed increased tolerance to air pollution. Trees such as *D.regia* (13.89), *E.jambolana* (11.82) and *P.dulce* (12.82) showed significant increase in their tolerance towards industrial air pollutants.

In view of data obtained for the month of April, 2011(Fig. 5), most of the selected species showed increased APTI at all the stations but it varied with the pollution load. The calculated values ranged between 3.36 to 14.86.The highest value of tolerance was shown by *M.indica* at the area polluted by . Least value of tolerance was shown by *F.benjamina* at S-1.Tree species *M.olifera* (8.60 to 6.98) exhibited decreasing values of tolerance in traffic and industrial sites. Plants such as *D.regia* (13.25), *E.jambolana* (11.96), *F.benghalensis* (8.96) and *F.benjamina* (9.03) were observed with significant higher tolerance at S-3.

was exhibited by *T.grandis* at residential area. Plants such as *A.indica* (17.49), *M.indica* (13.55), *P.longifolia* (8.80) and *T.grandis* (9.73) in S-2 showed higher values than other selected sites. *D.regia* (19.12), *E.jambolana* (15.14), *F.benghalensis* (10.06) and *F.bengamina* (10.12) exhibited significant tolerance at S-3.

Conclusion:

The present study suggests that plants have the potential to serve as excellent monitors of air pollution. The study summarized the results on biomonitoring of local plant species along various sites.*M.indica* showed higher tolerance for automobile pollution throughout the study period (December, 2010 to May, 2011). From the biochemical parameter analysis, the tolerance may be due to the increase of chlorophyll content. Several researchers such as Tripathi and Gautam (2007) have exhibited increase in chlorophyll content under air pollution. Tree species, *E. jambolana* showed higher tolerance for industrial pollution during this study period. It is inferred from the biochemical analysis that increase of ascorbic acid content may be responsible for tolerance of that species in industrial site. Pollution load dependant increase of ascorbic acid content of plant species may be due to the increased rate of production of reactive oxygen species (ROS) during photo-oxidation of SO_2 to SO_3 where sulphites are generated from SO_2 absorbed (Jyothi and Daya, 2010). During the months of December and January the tree species, *M.hortensis* became sensitive for air pollutants. So, it can be an effective indicator for air pollution in December and January. Overall high tolerance of plants was observed in the month of May, 2011.

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REFERENCES

Agarwal, M. (1985). Plants factors as indicators of SO_2 and O_3 pollutants. Symp on Bio-monitoring state environment. New Delhi, Proceedings, pp. 225-231.

Arnon, D.I. (1949). Copper enzymes in isolated chloroplasts. *Plant Physiol*., **24** :1-15.

Barrs, H.D and Weatherly, P.T. **(**1962). A re-examination of the relative turgidity technique for estimating water deficits in leaves. *Australian J. Biol. Sci.,* **15**:413-428.

Escobedo, F.J., Wagner, J.E. and Nowak, D.J. (2008). Analyzing the cost effectiveness of Santiago, Chile's policy of using urban forests to improve air quality. *J. Environ. Mgmt.*, **86**:148-157.

Freebairn, H.T. and Taylor,O.C.(1960). Prevention of plant damage from air-borne oxidizing agents. *Proc. American Soc.Hort.Sci*., **76**: 693-696.

Gonalez, L., Gonalez-Vilar, M. and Reigosa, M.J. (2001). Determination of relative water content. In: *Handbook of plant ecophysiology* . Techniques kluwer academic publishers. Dordrecht, The Netherlands. pp. 207-212.

Joshi, P.C and Swami, A. (2007). Physiological responses of some tree species under roadside automobile pollution stress around city of Haridwar, India. *Environmentalist*, **27**: 365-374.

Jyothi, J.S. and Daya, D.S. (2010). Evaluation of air pollution tolerance index of selected plant species along road sides in Thiruvananthapuram, Kerala. *J. Environ.Biol.*, **31**: 379-386.

Singh, S.K and Rao, D.N. (1983). Evaluation of plants for their tolerance to air pollution. In: Proc. of symposium on air pollution control. Indian Association for Air Pollution Control. NEW DELHI (INDIA) pp. 218-224.

Thambavani, D. Sarala and Kamala, C. (2010). Air pollution tolerance index (APTI) of some tree species growing near rail roads of Madurai,T.N. (India). *J.Environ. Sci. & Engg.*, **52**(4): 285-290.

Tripathi, A.K and Gautam, Mukesh (2007). Biochemical parameters of plants as indicators of air pollution. *J.Environ. Biol*., **28** :1127-1132.

Turk, R. and Wirth,V. (1975). The pH dependence of SO_2 damage to lichens. *Oecologia*., **19**: 285-295.

Yan-ju and Hui ding (2008).Variation in air pollution index of plants near a steel factory: Implications for landscape plant species selection for industrial areas.*WSEAS Trans. Environ. & Dev.*, **4**(1): 24-32.

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