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Evaluation of Tolerant plant species in Urban Environment: A case study from Hyderabad, India

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Abstract:

For the evaluation of tolerant capacity of the plant species to air pollution, four physiological and bio-chemical parameters namely leaf Relative Water Content, Ascorbic acid, leaf Chlorophyll content and leaf extract pH were used. By computing these parameters together in a formulation, it signifies the Air Pollution Tolerance Index (APTI) of plants. In the present study, sixteen plant species were selected which are commonly growing in different areas like residential areas, traffic areas, industrial areas and peri-urban areas of Hyderabad, Andhra Pradesh state, India. On the basis of tolerance index value, the plant species were characterized into sensitive, intermediately tolerant, moderately tolerant and tolerant plant species. *Delonix regia Hook., Peltophorum pterocarpum DC., Alestonia scholaris L., Ficus religiosa L., Samania saman Jacq. and Azardirachta indica A. Juss.* expressed high APTI values and these are suitable sinks to mitigate the air pollution. *Millingtonia hortensis L.f., Clerodendrum paniculatum L., Terminalia arjuna Roxb., Pongamia pinnata L., Polyalthia longifonia Sonn. and Emblica officinalis Gaertner.* showed intermediate tolerance capacity and the other four plant species *Syzygium cumin L.i, Terminalia catappa L., Swietenia mahagoni L. and Saraca indica L.* acts as bio-indicators of air pollution stress as these are sensitive to the air pollution.

Keywords: Bio-indicator, Air Pollution Tolerance Index, Chlorophyll content and ascorbic acid

1.0 Introduction:

Air is important for life on the earth. Rapid increasing of population and development leads to the deterioration of quality of air. From one year to next year, the concentration of pollutions are increasing even there is some differences in between the nations. Every year, more than 308 crore tons of co_2 and other pollutants are releasing into the earth's atmosphere. Plants are very imp to maintain ecological balance but they can severely get effect directly or indirectly by air pollution (Steubing et al., 1989;Agbaire, 2009).Plants acts as the scavengers for air pollution as they are the initial acceptors (Joshi and Swami, 2009). Various pollutants can be absorbed accumulated by the plants results in reducing the pollutant levels in the environment (Liu and Ding, 2008). Plants when exposed constantly to environmental pollutants, it induces functional weakening and structural simplification and finally leads to negative effects on other biotic communities. The resistance and susceptibility of plants to air pollutants can be determined by its physiological and bio-chemical levels. Now a day, urban vegetation became very important because it affects the local and regional air quality (Jissy Jyothi and D.S. Jaya, 2010). The impact of air pollution on plants can be evaluated by manipulating the tolerance levels of plant species.

2.0 Materials and Methods:

2.1 Study area:

The area of study is Hyderabad city, the capital of Andhra Pradesh state, India. Due to industrialization and rapid expansion of city, the environmental problems are increasing especially air pollution. To evaluate the impact of air pollution on plant species, five different areas were selected in the study area. These areas are control area (urban Forestry nursery, Erragadda) as area-1, Residential areas as area-2, Traffic areas as area-3, Industrial areas as area-4 and peri-urban areas of Hyderabad as area-5.

This study was conducted during summer (March to April), monsoon (July to August) and winter

(November to December) seasons respectively. Sixteen plant species, which are widely located in the study area, were selected for the purpose.

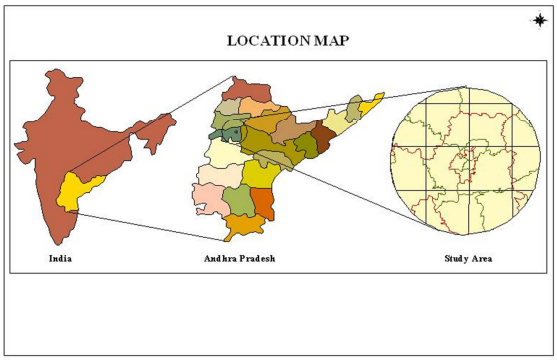


Fig. 1: Image of the Study area

The selected plant species are *1. Peltophorum pterocarpum DC. (P_1), 2.Syzygiumcumini L. (P_2), 3.Millingtonia hortensis L.f. (P_3), 4. Terminalia catappa L. (P_4), 5. Swietenia mahagoni L. (P_5), 6.Clerodendrum paniculatum L. (P_6), 7. Saraca indica L. (P_7), 8. Samania saman Jacq. (P_8), 9. Terminalia arjuna Roxb. (P_9), 10. Delonix regia Hook. (P_{10}), 11. Pongamia pinnata L. (P_{11}), 12. Alestonia scholaris L. (P_{12}), 13. Ficus religiosa L. (P_{13}), 14.Azardirachta indica A. Juss. (P_{14}), 15.Polyalthia longifonia Sonn. (P_{15}) and 16.Emblica officinalis Gaertner. (P_{16}).*

Fully mature leaves were collected in morning hours from the selected trees, almost at the same height. For the evaluation of Air Pollution Tolerance Index (APTI), the fresh leaf samples were analyzed for leaf extract pH, leaf Relative Water Content, Total Chlorophyll Content and Ascorbic Acid by using standard procedures. 0.5g of fresh leaf was homogenized with 50ml of deionized water and then filtered. The filtrate was collected for the detection of pH by using digital pH meter. 2.5g of fresh leaf tissues were homogenized with 10ml of 4% oxalic acid and centrifuged at 1800 rpm for 25mm. 10ml of extract was filtrated with DCPIP dye till pink color persists and calculated by the method described by Sadasivam (2007).

0.10g of fresh leave tissues were extracted with 10ml of 80% acetone and centrifuged at 2,500 rpm for 3min. The absorbance was taken at 645nm and 663nm and calculated as per the method described by Arnon (1949). As per Singh (1977), the initial weight, turbid weight and dry weight of leaf samples were calculated to get the percentage of Relative Water Content. By calculating these four bio-chemical parameters, the APTI was computed as

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

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

The APTI index range is as follows:

APTI value	:	Response
<1	:	Very sensitive
1 to 16	:	Sensitive
17 to 29	:	Intermediate
30 to 100	:	Tolerant

3.0 Results and Discussion:

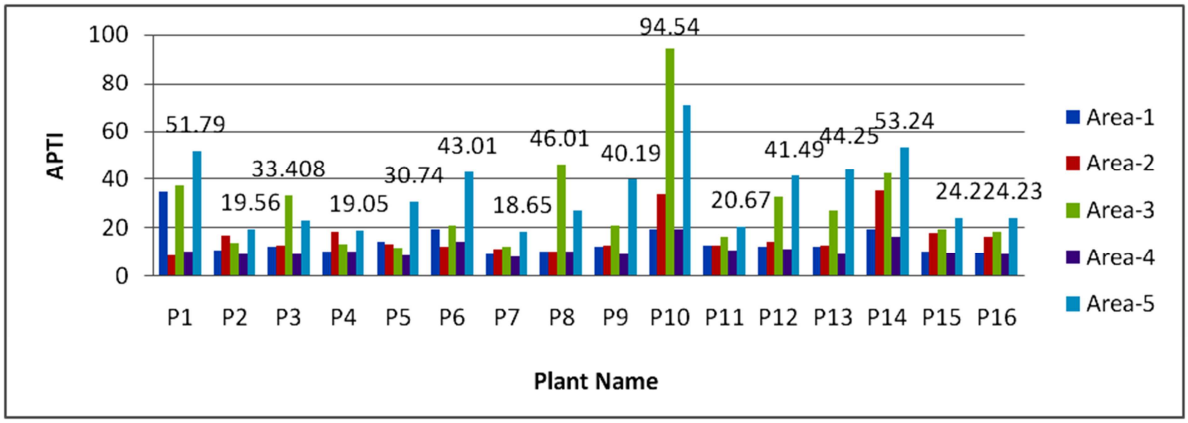
Air Pollution Tolerance Index (APTI) of plants plays major role in determining the resistivity and susceptibility. In urban areas, air pollutants may get absorbed or accumulated by plant body, if these are toxic in nature, may injure the plants in various ways. The air pollution effects are high in sensitive plant species and low in tolerant plant species. Normally, these tolerant plant species help in abatement of air pollutants and the sensitive plant species help in indicating air pollution (S.M. Seyyednjad *et. al.,* 2011). APTI was analyzed for sixteen plant species growing in the study area in three different seasons, summer, monsoon and winter respectively.

Amendments in pH: The photosynthetic efficiency of plant species strongly depends upon the leaf pH. The plant species at peri-urban areas (area-5) contained high pH range while the remaining four areas had almost equal pH values in three seasons. According to Scholz and Reck (1977), the leaf pH is lowered in presence of acidic pollutants and decline is greater in sensitive species. Low pH value indicated the sensitivity of the plant species to air pollutants while high pH value increases the hexo sugar conversion efficiency to ascorbic acid. The development of detoxification mechanism which is necessary for the tolerance in the plant species can be indicated by its alkalinity (Ninave et al., 2000).

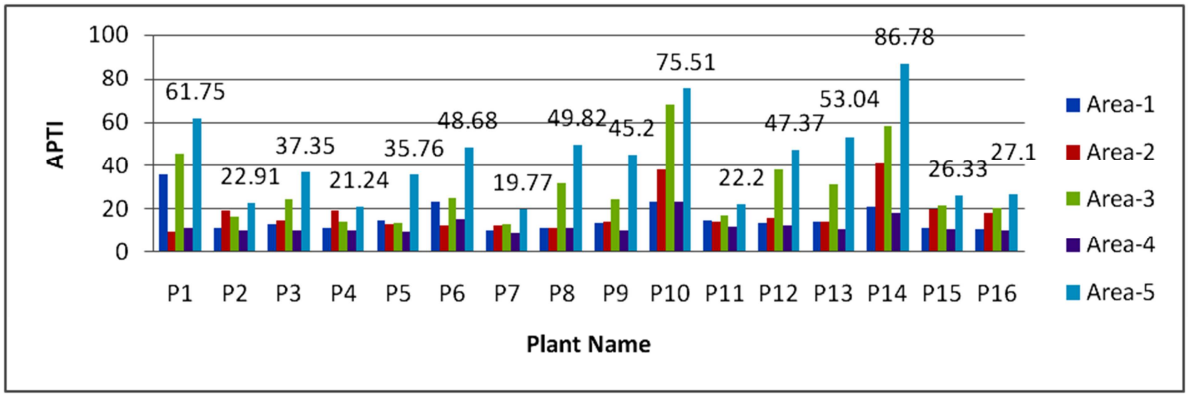
Amendments in Relative water content: The average Relative Water Content of the plant species was high during the monsoon with a decline in the level during the winter season followed by summer. When the plants exposed to air pollution, usually

their transpiration rates are high. Under these conditions, the Relative Water Content within the plant body helps to maintain its physiological balance. Therefore, the high Relative Water Content in the plants under polluted conditions, possibly tolerant to pollutants (Jissy Jyothi and D.S. Jaya, 2010).

(a) Summer



(b) Monsoon



(c) Winter

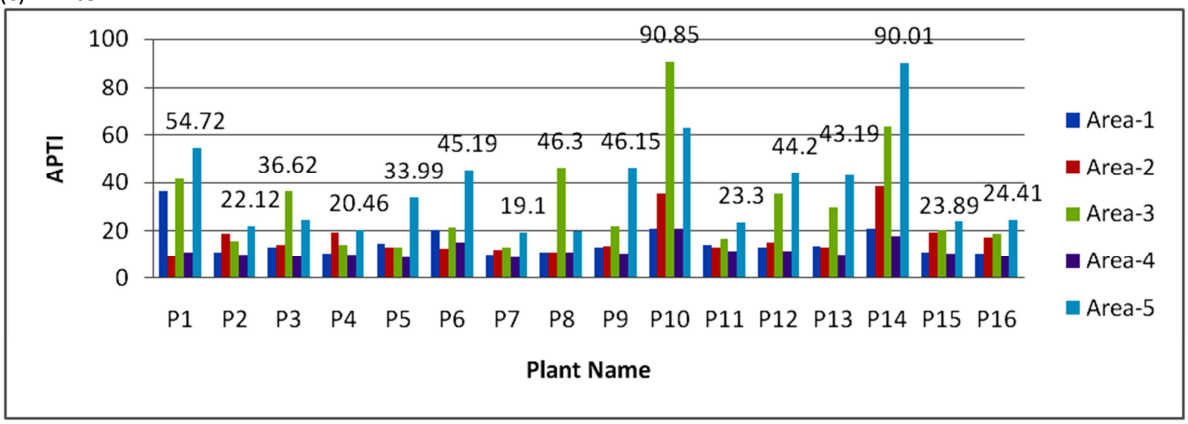


Fig: 2 Air Pollution Tolerance Index during different seasons (a), (b), (c)

Amendments in Total chlorophyll content: Higher baseline levels of chlorophyll content in plant species were observed in monsoon season. At area-5, Total Chlorophyll content is high but in other areas; equal chlorophyll content levels were observed. Photosynthetic pigment degradation has been widely considered as an indication of air pollution (Ninave et al., 2000).Present study revealed that Total Chlorophyll content in all the urban plants varies with the pollution status of the area. The higher pollution level in the form of industrial and urban pollution lowers the chlorophyll content.

Amendments in Ascorbic acid content: Ascorbic acid plays important role in cell division, defense and cell-wall synthesis. It is a natural detoxicant, which may prevent the effects of air pollutants in the plant tissues (Mohammed Kuddus et. al., 2011). The average ascorbic Acid in the sixteen urban plant species of peri-urban areas (area-5) and traffic areas of study area (area-3) exhibited higher baseline levels. According to Chaudhary and Rao (1977) and Varshney and Varshney (1984), the higher Ascorbic Acid content in the plants is an indication of its tolerance against sulphur dioxide pollution. Lower Ascorbic Acid contents in the plant species support the sensitive nature towards the pollutants particularly automobile exhausts.

3.1 Air Pollution Tolerance Index: The average air pollution tolerance index [APTI] calculated for each plant species studied during different seasons were exemplified in fig-1(a), (b), (c). The APTI values for 16 plant species at area-2 (residential areas), area-4 (industrial areas) were found to be intermediately tolerant and sensitive. As the pollution load is more within the city limits the APTI values at area-1 (control site) also exhibited same values as area-2, area-4. As per Raza et al. (1985) and Das s. and Prasad P. (2010), the plant species known to be tolerant or sensitive in one area may behave differently in another area. These 16 plant species showed good tolerance capacity at area-3 (traffic areas); perhaps they have tolerant capacity to the auto-exhaust pollutants. These plant species from area-5 (peri-urban areas) exhibits higher baseline levels of APTI because the influence of vehicular and industrial pollutants is less in the city outskirts. This would be useful in identifying indicator species, sink plants and tolerant plants for effective air pollution management programs.

4.0 Conclusion:

Day-by-day, with increasing urbanization and industrialization, the air quality is degrading. Plants plays significant role in mitigation the air pollution and maintains ecological balance. The determination of Air Pollution Tolerance Index (APTI) to the plant species in urban area is important to implement pollution control methods. The identification of the tolerant plant species suggests suitable plant species to green-belt development and social-forestry programs. This study also helps in maintaining cost-benefit methods.

Air Pollution Tolerance Index (APTI) of sixteen plant species was high in monsoon season which might be due to the washout of the dust particles from the leaf surface as it increases the photosynthetic activity. Out of all selected plant species, *Delonix regia Hook., Peltophorum pterocarpum DC., Alestonia scholaris L., Ficus religiosa L., Samania samanJacq.* and *Azardirachta indica A. Juss.* expressed high APTI values. These are suitable sinks to mitigate the air pollution. *Millingtonia hortensis L.f., Clerodendrum paniculatum L., Terminalia arjuna Roxb., Pongamia pinnata L., Polyalthia longifonia Sonn. and Emblica officinalis Gaertner.* showed intermediate tolerant capacity. The other four plant species *Syzygium cumin L.i, Terminalia catappa L., Swietenia mahagoni L. and Saraca indica L.* are sensitive to the air pollution in the study area. These four sensitive species can be used as the bio-indicators of air pollution stress.

5.0 Acknowledgement:

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