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Research Paper

Air Pollution Tolerance Levels of Selected Urban Plant Species in Industrial Areas of Hyderabad (A.P), India

Environment

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

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ABSTRACT

By computing the four foliar biochemical features i.e. Ascorbic acid, Total Chlorophyll content, Relative Water Content and Leaf extract pH together in a formulation, it signifies the Air Pollution Tolerance Index (APTI) of plants. Of the 16 plant species analysed two tree species such as Delonix regia Hook. exhibited higher APTI value. Clerodendrum paniculatum L., Samania saman Jacq. and Azardirachta indica A. Juss. showed intermediate tolerance capacity and the other plant species Syzygium cumin L.i, Terminalia catappa L., Millingtonia hortensis L.f., Terminalia arjuna Roxb., Pongamia pinnata L., Polyalthia longifonia Sonn. and Emblica officinalis Gaertner., Swietenia mahagoni L. and Saraca indica L. The remaining plant species, Peltophorum pterocarpum DC., Alestonia scholaris L., Ficus religiosa L., acts as bio-indicators of air pollution stress as these are sensitive to the air pollution.

1.INTRODUCTION:

In recent times there has been significant development activity in terms of industrialization and urbanization in almost all cities in India.The impact of such anthropogenic emission into the atmosphere and their movement into the biosphere by transformation, reaction and modification is responsible for variety of chronic and acute diseases at the local, regional and global scale. Impact on the plant community has also been studied worldwide in terms of plant – environment interactions, since the plants are much more sensitive in comparison to other organisms (Abbasi et al. 2004). Plants are very important to maintain ecological balance but they can severely get effect directly or indirectly by air pollution (Agbaire, 2009).

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 plants response to air pollutant vary from species to species and also in terms of type of pollutant, its reacting mechanisms, concentration and duration of exposure.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 (S. JissyJyothi and D.S. Jaya, 2010).The selection and growing of the resistant plant species is another facet of the problem of pollution. Planting of certain tolerant plant species can with stand the increasing air pollution will be significantly useful for the air pollution control. Singh and Rao (1983) have suggested a method to determine Air Pollution Tolerance Index by synthesizing the values of four different foliar biochemical features i.e. Total chlorophyll content, Relative Water Contents, leaf extract pH and Ascorbic acid. In the present study, a periodic evaluation of Air Pollution Tolerance Index of urban plant species growing in and around of the industrial areas at Hyderabad, Andhra Pradesh state was carried out with a view to find out the tolerance as well as sensitivity of the common plant species subjected to air pollution.

2. MATERIALS AND METHODS:

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. In the study area, thousands of industries were located mainly in Jeddimetla, Balanagar and Pathancheru areas and strongly showing effects on the air quality. This study was carried out 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. The selected plant species are *1. Peltophorum pterocarpum DC. , 2. Syzygium cumini L., 3.Millingtonia hortensis L.f., 4. Terminalia catappa L., 5. Swietenia mahagoni L., 6.Clerodendrum paniculatum L., 7. Saraca indica L., 8. Samania saman Jacq., 9. Terminalia arjuna Roxb., 10. Delonix regia Hook., 11. Pongamia pinnata L., 12. Alestonia scholaris L., 13. Ficus religiosa L., 14.Azardirachta indica A. Juss., 15.Polyalthia longifonia Sonn.and 16. Emblica officinalis Gaertner.*

2.1 The Bio-Chemical analysis of plant species are

1. pH
2. Relative water content
3. Total chlorophyll content
4. Ascorbic acid

The leaf fresh weight was taken immediately upon getting to the laboratory. Samples were preserved in a refrigerator for other analyses.

2.1.1Leaf extracts pH: 5 g of the fresh leaves were homogenized in 50 ml deionised water. This was then filtered and the pH of leaf extract determined after calibrating pH meter with buffer solution of pH 4 and pH 9.

2.1.2Relative leaf water content (RWC): Following the method described by Singh (1977), leaf RWC was determined and calculated with the formula:

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

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

Fresh weight was obtained by weighing the fresh leaves. The leaves were then immersed in water over night, blotted dry and then weighed to get the turgid weight. Next, the leaves were dried overnight in an oven at 70°C and reweighed to obtain the dry weight.

2.1.3 Total chlorophyll content (TCH): This 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% acetone and left for 15 min. The liquid portion was centrifuged at 2,500 rpm for 3 min. The supernatant was collected and the absorbance was taken at 645 nm and 663 nm using a spectrophotometer. Calculations were made using the formula below:

$$\text{Chlorophyll a} = 12.7DX663 - 2.69DX645 \times V/1000W \text{ mg/g}$$

$$\text{Chlorophyll b} = 22.9DX645 - 4.68DX663 \times V/1000W \text{ mg/g}$$

TCh = chlorophyll a + b mg/g, Dx = Absorbance of the extract at the wavelength Xnm,

V = total volume of the chlorophyll solution (ml) and W = weight of the tissue extract (g).

2.1.4 Ascorbic acid: The ascorbic acid content of leaf tissue was estimated by the method given by Sadasivam(2007). Fresh leave tissue of 2.5 g was homogenized in a pre-chilled mortar and pestle with 10 ml of 4% oxalic acid solution. The homoge-

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nate was centrifuged at 1800 rpm in centrifuge at 4^0 C for 25 min. 10 ml of supernatant was titrated with DCPIP dye till pink colour persists. The amount of ascorbic acid in the sample was calculated using the following formula:

Mg of Ascorbic acid in g sample = 0.5/V1 X V2/V X 100/W X 100

Where, V = volume of leaf extract taken for titration, V1 = ml of dye used for standard ascorbic acid titration, V2 = ml of dye used for titration and W = weight of leaf material

2.1.5 Air Pollution Tolerance Index: The APTI was calculated by calculating the Ascorbic acid, Total Chlorophyll, pH and Relative Water Contents in leaves.

The APTI was calculated by using the formula:

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

Where, A = Ascorbic acid (mg/g dry wt.), T = Total Chlorophyll content (mg/g dry wt.),

P = pH of leaf extract and R = Relative Water Content of leaf tissue (%)

3. RESULTS AND DISCUSSION:

An overview of the results obtained from this study reveals that different plants respond differently to air pollutants. Air Pollution Tolerance Index plays significant role to determine resistivity and susceptibility of plant species. Based on the APTI values the plants were conveniently grouped as follows:

<1 Very sensitive

1 to 16 Sensitive

17 to 29 Intermediate

30 to 100 Tolerant

The photosynthetic efficiency has been reported to be strongly dependent on leaf pH. The pH ranged from 5.69 to 7.08 in both tolerant and sensitive species. High pH may increase the efficiency of conversion from hexose sugar to ascorbic acid while low pH value showed good relation with sensitivity to air pollutants and also reduce photosynthesis process in plants. The relative content did not show any significant relation but high water content within plant body helps to maintain its physiological balance under stress conditions such as exposure to air pollution when the transpiration rates are usually high.

From fig-1, D. regia Hook., A. indica A. Juss., S. saman Jacq., C. paniculatum L. and P. pterocarpum DC. exhibited higher baseline levels of Ascorbic acid content during all seasons. Varshney and Varshney (1984) are of the opinion that higher ascorbic acid content of the plant is a sign of its tolerance against sulphur dioxide pollution. In the present study, higher baseline levels of ascorbic acid content in the leaves of urban plant species suggests its tolerance towards the pollutants which are normally affecting the industrial vegetation.

From fig-2, higher baseline levels of chlorophyll were observed in D. regia Hook. And A. indica A. Juss. during monsoon season. In winter season, S. cumini L. and M. hortensis Lf. exhibited higher chlorophyll levels. Compared to other seasons, in summer season less chlorophyll content levels were observed. Present study revealed that chlorophyll content in all the urban plants varies with the pollution status of the area i.e. higher the pollution level in the form of urban and industrial pollution lower the chlorophyll content. It also varies with the tolerance as well as sensitivity of the plant species i.e. higher the sensitive nature of the plant species lower the chlorophyll content.

In monsoon and winter seasons, D. regia Hook. showed good tolerance to air pollutants and in summer season it exhibited moderate tolerance level (Fig-3). But on an average, it is a tolerant tree to mitigate air pollutants in the study area. *Clerodendrum paniculatum L., Samania saman Jacq.* and *Azardirachta indica A. Juss.* showed intermediate tolerance capacity during monsoon and winter seasons . In summer season these plants behaved as sensitive species. The remaining plants are sensitive to air pollutants during all seasons.

4.CONCLUSION:

Out of all selected plant species, it is concluded that *Delonix regia Hook.* has good tolerance capacity and suitable sink for air pollution.These tolerant plant species can be utilized for urban plantation and green belt development to mitigate air pollution. The identification of tolerant species also helps in maintaining ecological balance by loss of soil fertility and enhances the precipitation and ground water recharge. *Clerodendrum paniculatum L., Samania saman Jacq.* and *Azardirachta indica A. Juss.* showed intermediate tolerance capacity and the other plant species *Syzygium cumini L., Terminalia catappa L., Millingtonia hortensis L.f., Terminalia arjuna Roxb., Pongamia pinnata L., Polyalthia longifonia Sonn. and Emblica officinalis Gaertner., Swietenia mahagoni L. and Saracaindica L.* The remaining plant species, *Peltophorum pterocarpum DC., Alestonia scholaris L., Ficus religiosa L.,* acts as bio-indicators for air pollutants in urban environment. Since biomonitoring of plants is an important tool to evaluate the impact of air pollution on plants; these sensitive species can be used as bio-indicators of air pollution stress.

5.ACKNOWLEDGEMENT:

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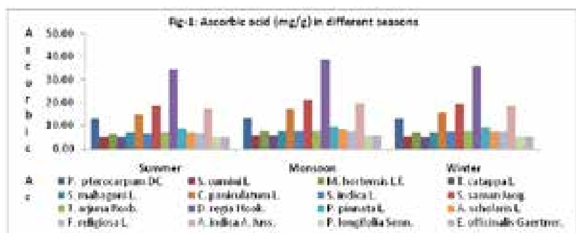
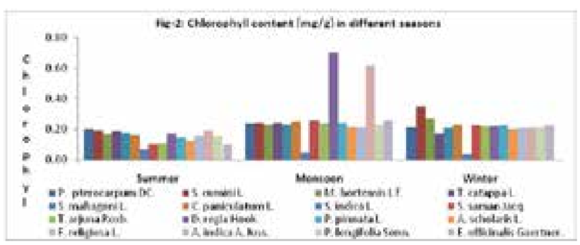
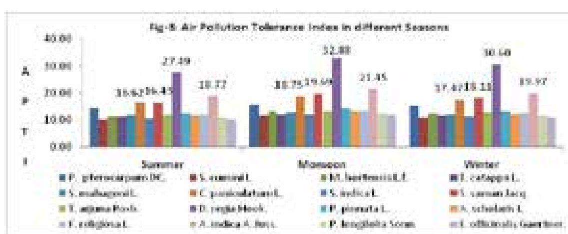
FIGURES:







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