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SEASONAL VARIATIONS IN AIR POLLUTION TOLERANCE INDEX IN SOME SELECTED PLANT SPECIES

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ABSTRACT

Some plant species are tolerant to air pollution and other plant species are susceptible to air pollution. Susceptible plant species are considered as air pollution indicators whereas tolerant plant species considered for green belt development. In this study the seasonal variations in Air Pollution Tolerance Index was assessed by taking 18 plant species such as *Pongamia pinneta, Bougainvillea glabra, Tinospora cardifolia, Hibiscus rosasinencis, Lantana camara, Annona reticulata, Syzygium cumini, Couroupita guianensis, Baliospermum solanifolium, Catharanthus roseus, Ficus religiosa, Azadirachta indica, Senna auriculata, Casia fistula, Albizia lebbeck, Pdilanthus tithimiloides, Psidium guava*, *Mangifera indica* that are commonly available in the selected study area. Among the studied plant species physicochemical parameters such as total chlorophyll content, leaf extract p^H, relative water content and ascorbic acid are recorded as these are responsible for changing APTI (Air pollution Tolerance index) values. These changes were observed during three seasons in a year. The highest APTI values were found during winter season followed by monsoon and summer season. Among the plant species studied, the highest APTI value was found in *Mangifera indica* (15.89) during winter season and lowest APTI value was found in *Baliospermum solanifolium*(6.73) during summer season.

Key Words: *Air pollution, Chlorophyll, Relative water content, Tolerance.*

INTRODUCTION

Urban vegetation became an essential part of planned urbanisation and it impacts the quality of local and regional air. Plants play an important role in maintaining all types of ecosystems. Plants act as primary receptor of large number of air pollutants and considered as most affected species due to air pollution. Impact of air pollution on plants can be evaluated by Bio-monitoring of various physicochemical parameters of different parts of the plants. Most of the effects of air pollution can be seen in plant leaves. The impact of air pollution on plant can be assessed by Air Pollution Tolerance Index. The insights for the evaluation of APTI for finding the tolerance as well as sensitiveness of plant species were given by several authors (*Agrawal and Tiwari, 1997; Dwivedi and Tripathi, 2007; Liu and Ding, 2008; Dwivedi et al., 2008*). All these studies provided important information for the green belt developers and

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land scape developers as they enumerated tolerant and sensitive plant species. Plant species which has shown high value of APTI are considered as tolerant species. Tolerant plant species were considered for the green belt development and sensitive plant species as air pollution indicators. In the present study, the seasonal variations in various physicochemical parameters were enumerated and APTI was calculated by using Singh et al., 1992. The research was carried out by taking 18 commonly available plant species in Katedan Industrial Region (KIR), Hyderabad city, Telangana State.

MATERIALS AND METHODS

Katedan Industrial Region (KIR) located in the outskirts of Hyderabad city in the state of Telangana was selected as the study area. The study area lies between 17.3080^0 N and 78.4324E, latitude and longitude respectively. 18 plant species that are commonly available in the area were selected for the study, out of which 11 are large tree species and 7 are shrub species. The 18 plant species selected for the study are *Pongamia pinneta*, *Bougainvillea glabra*, *Tinospora cardifolia*, *Hibiscus rosasinencis*, *Lantana camara*, *Annona reticulate*, *Syzygium cumini*, *Couroupita guianensis*, *Baliospermum solanifolium*, *Catharanthus roseus*, *Ficus religiosa*, *Azadirecta indica*, *Senna auriculata*, *Casia fistula*, *Albizia lebbeck*, *Pdilanthus tithimiloides*, *Psidium guava*, *Mangifera indica*. The study was conducted during summer, monsoon and winter seasons in 2020-2021.

Mature leaves of these 18 plant species were collected in polythene bags. Utmost care was taken during sample collection by taking these plant species from Isoecological conditions. Plant leaves were analysed for Total Chlorophyll content, Ascorbic acid content, Leaf Extract pH and Relative water content by using the standard procedure of Arnon (1949), Sadashivam and Manickam(1996) Varshney(1992) and Barr and Weatherly(1962) to calculate APTI.

Ascorbic acid content was measured by the titration method. 1 gram of leaves were crushed and homogenised in deionised water. The homogenised mixture was filtered and after filtration, the samples were titrated with iodine solution using starch as an indicator. Ascorbic acid content was expressed in mg g^{-1}

The chlorophyll content was measured by extracting the chlorophyll from the leaf (1g) tissue with 5 ml of 96% ethanol, followed by spectrophotometric analysis. The chlorophyll content calculated using the equation given below and is expressed in mg g^{-1} fresh weight.

$$\mathbf{TChl = (17.12 \times E_{666} - 8.68 \times E_{653}) \times v/m \times 1000}$$

Where, V is the volume (ml) of leaf extract, m is the fresh weight (g) of the leaf sample and E666 and E653 are the absorbance at 666 nm and 653 nm minus the absorbance at 750 nm.

The acidity of the leaf extract was measured by using a digital pH meter.

Relative water content (RWC) was calculated by using the following formula

$$\mathbf{RWC = (FW - DW) / (TW - DW) \times 100}$$

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Where, FW is the fresh weight of leaves, TW is the turgid weight of leaves and DW is the dry weight of leaves. To determine TW, leaves were immersed in water overnight before weighing. Leaves were weighed after desiccation in an oven at 70 °C to determine DW of the leaves.

The leaf samples collected from 18 selected plants were analysed for total chlorophyll content (T), mg g^{-1}; ascorbic acid content (A), mg g^{-1}; pH of leaf extract (P) and relative water content (R). APTI was calculated from these four parameters using the equation given by Singh et al., (1991).

$$APTI = A (T+P) +R /10$$

RESULTS AND DISCUSSION:

The Total Chlorophyll Content of selected plant species during summer, monsoon and winter seasons were illustrated graphically in Fig.1 Among the tree species studied, *Ficus religiosa* showed high levels of total chlorophyll with a value of about (7.767 mg g^{-1} FW) followed by *Mangifera Indica* (7.47 mg g^{-1} FW) . Among the shrubs, high chlorophyll content was observed in the leaves of *Baliospermum solanifolium,* in which the value was (6.869 mg g^{-1} FW) followed by *Bougainvillea glabra* (3.541 mg g^{-1} FW). In all plant species the chlorophyll value was highest during monsoon season and the chlorophyll content found to be decreased in winter and during summer seasons. From the analysis of the results of Total chlorophyll content, it has been obvious that in all the plant species, a considerable reduction in Total chlorophyll content was found during summer and winter seasons compared to Monsoon season.

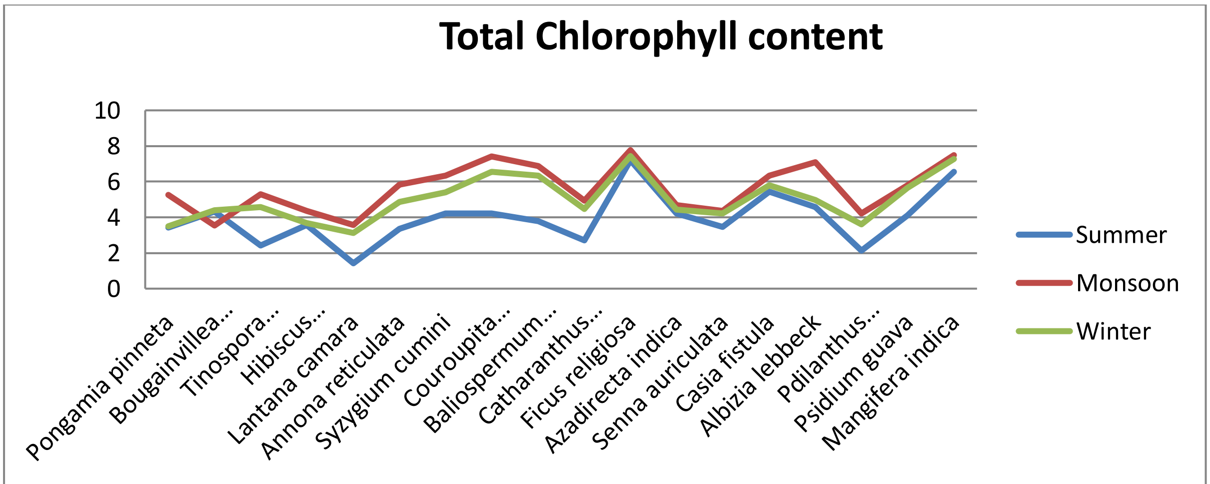

Figure 1: Total chlorophyll content in selected plant species of KIR during summer, monsoon and winter seasons.

Chlorophyll content of plants signifies its photosynthetic activity as well as the growth and development of biomass. It is well evident that chlorophyll content of plants varies from species to species and also with the pollution level as well as with other biotic and abiotic

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conditions (Katiyar and Dubey, 2001). Degradation of photosynthetic pigment has been widely used as an indication of air pollution (Ninave et al., 2001).) In all the plant species, chlorophyll content was higher in monsoon season which might be due to the washout of dust particles from the leaf surface (which will increase photosynthetic activity), low level of pollution and water content of soil as suggested by Shyam et al. (2006). Low chlorophyll content in winter season might be due to the high pollution level, temperature stress, low sunlight intensity and short photoperiod.

Changes in ascorbic acid content: Fig 2 is the graphical illustration of leaf ascorbic acid contents in the selected plant species during summer, monsoon and winter seasons. Ascorbic acid was found to be higher during summer followed by a winter season and monsoon. Being a very important reducing agent, ascorbic acid also plays a vital role in cell wall synthesis, defence and cell division (Conklin, 2001). *Mangifera indica*(4.9) and *Tinospora cardifolia* (5.2) have shown the highest amount of ascorbic acid among the tree and shrub species respectively.

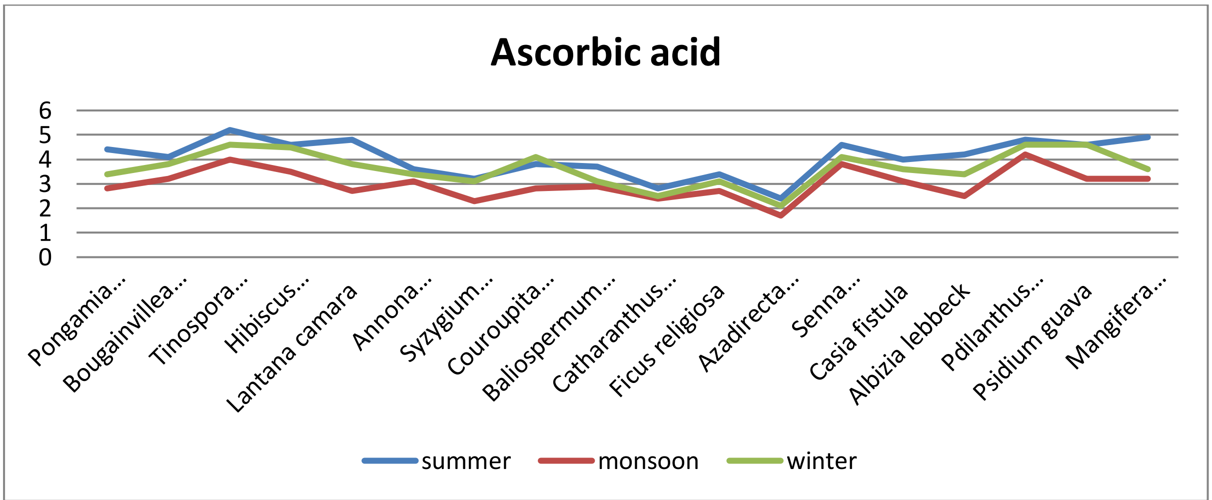

Figure 2: Ascorbic acid content in selected plant species of KIR during summer, monsoon and winter seasons

Changes in leaf extract pH: The leaf pH values of the selected plant species for different seasons are depicted in Fig. 3 The value of leaf pH showed the maximum during monsoon with a gradual reduction through winter reaching the lowest value in summer season. A shift in cell sap pH towards the acid side in presence of an acidic pollutant might decrease the efficiency of conversion of hexose sugar to ascorbic acid. However, the reducing activity of ascorbic acid is pH dependent that is being more at higher and lesser at lower pH. Hence the leaf extract pH on the higher side gives tolerance to plants against pollution (Agrawal, 1988).

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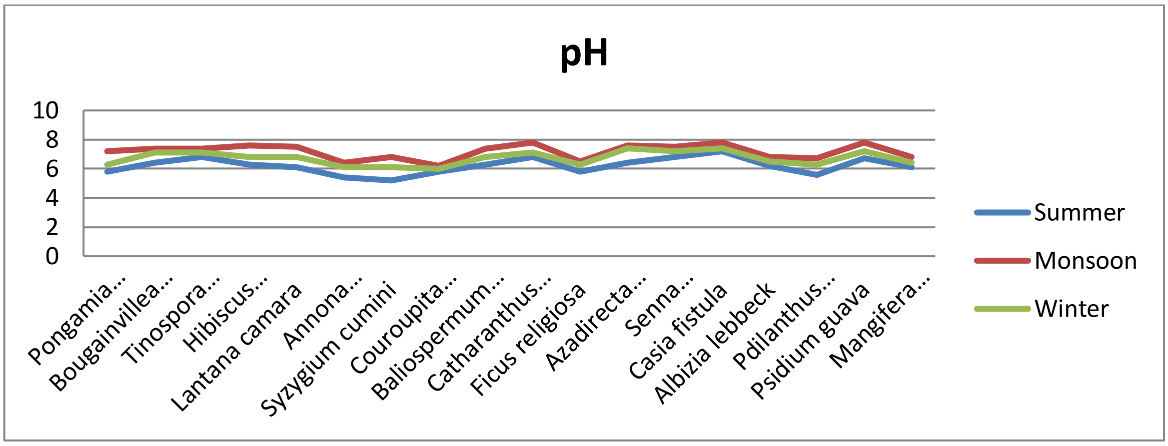

Figure 3: p^{H} of selected plant species of KIR during summer, monsoon and winter seasons.

Changes in relative water content: The relative water content was high among the plant species studied during monsoon with a decline in the level during winter followed by summer which is exemplified graphically in Fig.4. Relative Water Content (RWC) of a leaf is the water present in it relative to its full turgidity. Relative water content is associated with protoplasmic permeability in cells causes' loss of water and dissolved nutrients, resulting in early senescence of leaves (Agrawal and Tiwari, 1997). Therefore, the plants with high relative water content under polluted conditions may be tolerant to pollutants.

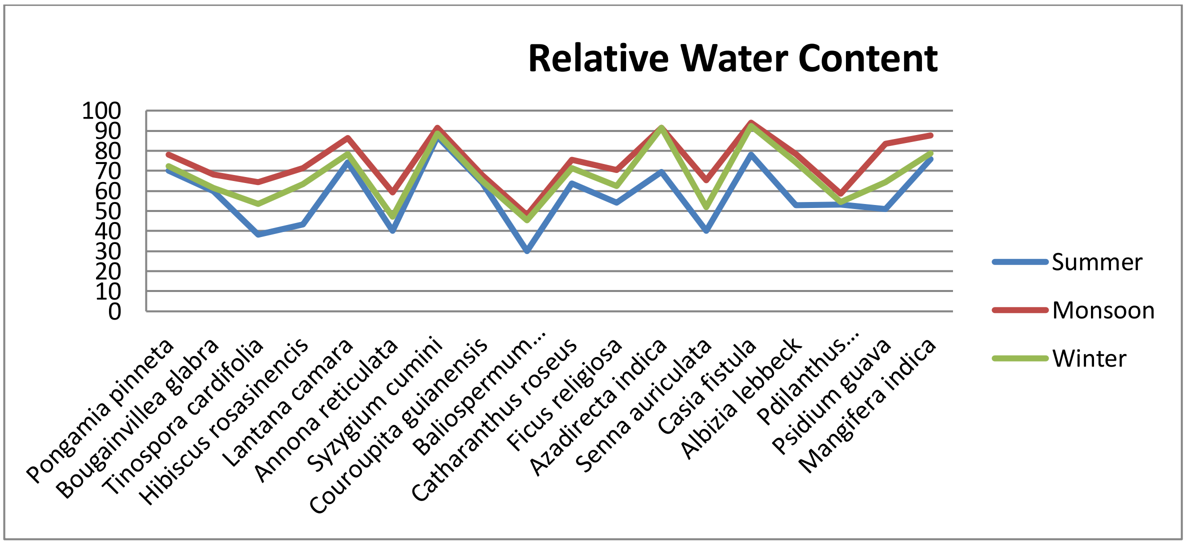

Figure 4: Relative Water Content in selected plant species of KIR during summer, monsoon and winter seasons

Air Pollution Tolerance Index: The results of air pollution tolerance index [APTI] were calculated for each plant species studied during different seasons is depicted in Figure 5. *Casia fistula* has shown the highest APTI among tree species with a value of 16.97 followed by *Mangifera indica*, (15.89). Among the shrubs studied, highest APTI value (LS) of about 13.96 was observed in the leaves of *Lantana camara* (13.96).

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Table No.1: APTI in selected plant species of KIR during summer, monsoon and winter seasons

S.No	Plant Species	Summer	Monsoon	Winter
1	*Pongamia pinneta*	11.06	11.28	12.86
2	*Bougainvillea glabra*	10.39	10.31	13.19
3	*Tinospora cardifolia*	8.61	11.50	13.51
4	*Hibiscus rosasinencis*	8.86	11.32	13.60
5	*Lantana camara*	11.02	11.62	13.96
6	*Annona reticulate*	7.15	9.70	10.98
7	*Syzygium cumini*	11.71	12.16	15.02
8	*Couroupita guianensis*	10.2	10.61	14.57
9	*Baliospermum solanifolium*	6.73	8.93	11.54
10	*Catharanthus roseus*	9.02	10.61	12.59
11	*Ficus religiosa*	9.82	10.89	13.54
12	*Azadirachta indica*	9.5	11.24	14.19
13	*Senna auriculata*	8.71	11.04	12.57
14	*Casia fistula*	12.86	13.78	16.97
15	*Albizia lebbeck*	9.80	11.32	13.97
16	*Pdilanthus tithimiloides*	9.04	10.45	12.46
17	*Psidium guava*	10.06	12.68	15.36
18	*Mangifera indica*	13.77	13.34	15.89

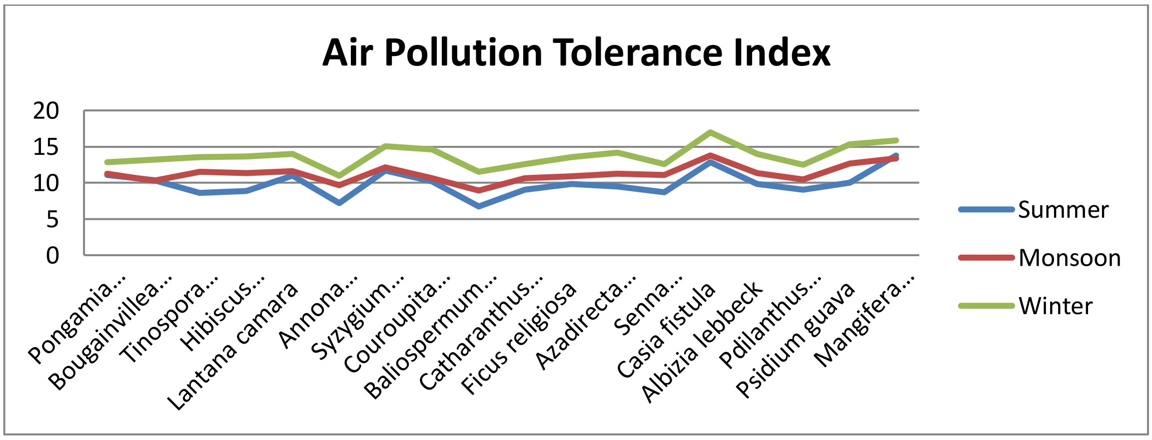

Figure 5: APTI in selected plant species of KIR during summer, monsoon and winter seasons

Different plant species shows considerable variation in their susceptibility towards air pollution. The plants with high and low APTI can serve as tolerant and sensitive species respectively. Also, the sensitivity levels of plants to air pollutants differ for shrubs and trees. With identical values, a tree may be sensitive but a shrub may be tolerant to a given pollutant.

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Therefore, the indices for different plant types should be considered separately (Singh and Rao, 1983). In the present study, among the tree species *Casia fistula (*16.97) with highest APTI was found tolerant to automobile and industrial pollutants whereas *Annona reticulata (*7.15) is susceptible to the same. In the case of shrubs, *Baliospermum solanifolium (*6.73) showed highest APTI values and found to be more tolerant compared to the other shrub species studied. High dust collecting capacity may be one of the reasons for the sensitive plant species studied to become highly susceptible to the industrial pollutants, making reduction or increase of different biochemical and physiological parameters (Singh, 2005). The observations in this study suggest that plants have the potential to serve as excellent quantitative and qualitative indices of pollution. Since bio monitoring of plants is an important tool to evaluate the impact of air pollution on plants.

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