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ASSESSMENT OF THE AIR POLLUTION TOLERANCE INDEX (APTI) OF SOME COMMON TREES ON THE ANNASALAI TO THEAGARAYA NAGAR STRETCH OF CHENNAI CITY NEAR THE GOVERNMENT ARTS COLLEGE AT NANDANAM

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ABSTRACT

The present investigation has been undertaken in a three-kilometre stretch from Arts College to Loyola college. A tree census for the designated stretch was taken and the total number of tree species available was ascertained. Based on the dominance, five species namely *Samanea saman, Azadirachta indica, Pongamia pinnata, Polyalthia longifolia* and *Ficus religiosa* were selected to determine the APTI values. The biochemical parameters for APTI such as Relative water content, pH, Total Chlorophyll content and Total Ascorbic acid content of leaf tissue was determined. Zone- wise, species- wise and parameter- wise comparison was done to study the effects of Air Pollution in the designated zones. The Control Zone showed low levels of Ascorbic acid and high levels were seen in Zones II,III and I. Total Chlorophyll content was minimum in Zone IV and maximum in the control zone. The APTI value was highest for Zone I followed by Zone III and then Zone II and was minimum in Zone IV. The most sensitive species is *Ficus religiosa* and the most resistant species is *Samanea saman* and the moderately resistant one is *Azadirachta indica* .

KEY WORDS: Tree-census, sequestration, air-pollutants, Neem, Pipal, Rain- tree.

INTRODUCTION

Air pollution is defined by the Air Pollution Control Act of the Government of India as " the presence of any solid, liquid or gaseous substance in the atmosphere in such a concentration that tends to be injurious to human beings, or other living creatures or plants or property or environment". Since atmosphere is the blanket of air surrounding the earth, pollution of the air becomes a matter of concern as its effects are always seen on a global scale rather than local or regional. The inadequacies of one area in keeping the air clean have a global connotation which needs to be addressed on a war footing.

In industrial cities, the Air Quality is very poor due to the high level of vehicular traffic and smoke output from industrial units. The particulate matter and toxicants in the air pose health hazards to man, affecting the lungs causing asthma and other pulmonary disorders[1]. The dust that settles on the leaves interferes with pollination and photosynthesis, which affects plants the most as they are static in their locations[2]. The affected plants show necrosis and growth retardation due to reduction in photosynthetic rates. Still plants are able to withstand these effects by closure of stomata in order to prevent the entry of poisonous gases.

Plants show varied sensitivity and response to air pollution and those that are highly sensitive serve as the biological indicators of the same[3]. To assess the responses of plants to the pollutants in the air, the Air Pollution Tolerance Index (APTI) is used[4]based on four biochemical parameters namely total chlorophyll, pH, relative water content and Ascorbic acid content. These parameters are indicators of specific physiological responses that have been triggered due to pollution and the changes in these can be used to predict the health status of the plant under polluted conditions. Degradation of the green pigment chlorophyll is an indicator of air pollution and rise in ascorbic acid levels indicates the activation of physiological and defence mechanisms. pH and water content are used to indicate the level of pollution in the ambient environment.

Chennai is a metropolitan city, highly industralised and urbanized with a high population density. It is the capital city of the Tamil Nadu State of India and as a result Air pollution is very high here. There are many locations in the city that are commercial hubs with a very high volume of automobile usage and industrial activity. These areas are particularly more polluted than the others and a survey of the vegetation especially the tree species will be able to throw light on the fact as to how they are able to survive such conditions and whether these species are really able to sequester the air pollutants. If so, then what will be the level that they can attain. There is also a concern for noise pollution in cities and it is seen that vegetation cover can reduce noise[5] With these pertinent questions in mind the present study has been taken up and a location close to the institution has been selected to carry out the investigation. .

The selected area is a three-kilometre stretch from Annasalai near Nandanam signal up to Loyola college via Theagaraya Nagar Bus depot passing through Usman Road. This stretch is completely dotted with commercial establishments, multi-storeyed shopping mall complexes, offices and schools. The vehicular traffic is enormous and traffic jams occur several times in a day. The problem of exhaust from automobiles is alarming though the entire stretch has trees growing on both sides of the road. This was the main factor that encouraged the study of the common tree species along this area to determine their APTI . The results of the study will be helpful in making these species as candidates for sequestration of Air pollutants to clean the air in this location. The model thus obtained could be applied to such other locations in the city.

The review of previous literature showed that not much work on these lines has been done for the city of Chennai. The Air pollution Tolerance Index of some trees in Moradabad City, India has been investigated[6]. Tree species in three industrial locations of South Bengaluru, India were evaluated for their capacity to absorb Air pollutants[7].

Seasonal variation in the Air Pollution Tolerance Index of various plant species of Baroda city was studied[8] to determine how APTI changes with climate and to identify plant species that are able to maintain a steady physiology under varying climates and levels of pollution. Identification and evaluation of APTI of selected tree species in Urban Bangalore, India, was done[9] and tree species with higher APTI were given priority for plantation programs. Air Pollution tolerance Index of some trees in Haridwar city, Uttarakhand has been reported[10]. APTI and anticipated performance index of some species for the development of urban forests has been studied[11].

MATERIALS AND METHODS

Selection of the study area and zonation

The study area for the present investigation was decided based on the proximity to the college and the level of pollution also keeping in mind the vegetation cover present. The study area was divided in to four zones which have been described as given hereunder:

ZONE I : From Nandanam College on Annasalai upto Hyundai showroom on CIT Nagar

ZONE II: From Hyundai Showroom to GRT Jewellers on South Usman Road

ZONE III : From GRT Jewellers to Kodambakkam Bridge on North Usman Road

ZONE IV : From Kodambakkam Bridge on North Usman Road to Loyola college

CONTROL : Control zone was a location inside the college which is far away from the roadside and where all the five species were available

Census taking and selection of dominant tree species

The census of the trees located in the various zones was taken by drawing the road map of the zones and plotting the position of the trees on both the sides of the road after photographing them for identification. The zone wise census was tabulated and counted to determine the dominant species for each zone.

In each of the zones studied five trees were selected that were represented in higher number in the census and were used for calculating the APTI comparing with the control zone. The selected species were *1. Samanea saman* (Rain tree) *2. Azadirachta* indica (Neem) 3. *Pongamia pinnata* 4. *Polyalthia longifolia* (Asoka tree) and 5. *Ficus religiosa* (Pipal)

Collection of leaf samples
Leaf samples were collected in triplicates from the selected species in all the five zones for analytical studies and calculation of APTI. The leaf samples were taken from branches facing the road and were put into zip-lock bags, sealed and labeled, brought to the lab and stored in the refrigerator until further use.

Determination of Relative Water content (RWC)
Relative water content was estimated with the help of data on fresh weight, turgid weight and dry weight of the respective leaf samples[12].

$$RWC = \frac{FW - DW}{TW - DW} \times 100$$

FW = Fresh weight
DW = Dry weight
TW = Turgid weight

Determination of pH of leaf tissue
5g of the fresh leaves was homogenized in 10ml de-ionised water. This was then filtered and the extract was used for estimation of pH. [13]

Estimation of Total chlorophyll (TCh)
Total chlorophyll was estimated following standard methods. [14]

Ascorbic acid (AA) content analysis
Ascorbic acid content was estimated by standard procedures.[15] The procedure was repeated twice and the two resulting supernatants were mixed together. All extractions were carried out in duplicate.

Calculation of APTI
The Air Pollution Tolerance index (APTI) was computed using the formula:

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

Where
A- Ascorbic acid content
T- Total chlorophyll,
P- pH
R – Relative Water Content

RESULTS AND DISCUSSION
The tree species selected in the present study were in accordance with earlier reports.[9,10] (Table 1) It has been established that these tree species grow in areas of high levels of Air pollution and the effects of pollution have led to deformation of leaf shape and reduction in size.

Table 1: showing the data on the tree census for the different zones studied

Genus	Zone I	Zone II	Zone III	Zone IV
Samanea	16	15	23	17
Polyalthia	11	10	08	05
Pongamia	03	04	01	01
Azadirachta	08	11	04	07
Ficus	02	10	04	12
Terminalia	-	-	01	06
Tecoma	01	04	-	-
Mangifera	01	01	02	04
Aegle	-	-	01	02
Ceiba	-	-	-	02
Delonix	-	-	-	09
Bambusa	01	01	-	-
Tamarindus	02	-	-	-
Moringa	01	01	-	-
Cocos	01	03	01	03

Relative Water Content (RWC)
Relative water content was computed with the values of fresh weight, turgid weight and dry weight. RWC is associated with protoplasmic permeability. A high value of relative water content makes the plants drought resistant. Species with higher RWC may be tolerant to air pollution. The study revealed that in all the zones the selected plants showed a high RWC in comparison to the control zone. Of the four zones, I and III showed a consistent high value in all the species studied (Table 2). This result corroborates the previous reports [6,9]. Of the plants investigated, *Azadirachta* and *Samanea* in the polluted zones had very high RWC.

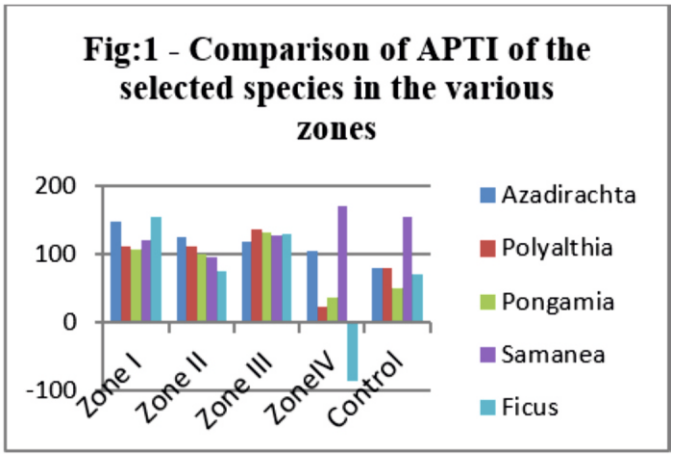
pH of Leaf extract
pH of the leaf extract is determined to study the physiological condition of the plant. Generally the pH of the leaf extract is high for plants growing in polluted areas. In the present study, the pH is on the acidic side in most cases except for *Azadirachta* in Zone I (Table 2) . The results on pH substantiate the previous reports[7] which show acidic pH which could be due to the presence of carbon, nitrogen and sulphur oxides in the air that are the causes of acid rain. Higher pH in the leaf extract may particularly help them in combating the acidic air pollutants but such a condition is not seen in the present investigation.

Total Chlorophyll content
The total chlorophyll content was found to be lower than that of the control zone in all the polluted zones. (Table 2) Zones I and III particularly showed Total chlorophyll levels close to that of the control zone and so the plants in that zone are more air pollution tolerant or rather pollution in these zones is less compared to the other zones.. In Zone IV , *Polyalthia* and *Ficus* showed negative Chlorophyll values, a situation where there is complete necrosis and the leaf has become almost non-functional.

The results on total chlorophyll content have been in accordance with earlier reports[10] where polluted conditions showed a reduction in total Chlorophyll content. Among the four zones studied the total chlorophyll is maximum in all the selected species in control Zone followed by Zone I, then Zone II, Zone III and it was least in Zone IV showing that it is this zone that has high pollution levels comparatively.

Ascorbic Acid content
Ascorbic acid plays a vital role in cell wall synthesis, defense and cell division[16]. Ascorbic acid is an antioxidant that influences the resistance of the plants to stress conditions and in involved in carbon fixation reactions. Increase in ascorbic acid content is an indicator of better performance and is useful to help plants cope with the unusual conditions. In the present investigation Ascorbic acid content was the maximum in *Azadirachta* for zones I , II and III and *Polyalthia* showed maximum Ascorbic acid content in Zone IV. *Samanea* had high ascorbic acid content in the control zone. Level of Ascorbic acid in all the selected species was highest in Zone IV followed by Zone I and then Zone III and Zone II but it was minimum in the control zone proving that Ascorbic acid content increase is stress induced. (Table 2)

APTI value
Air Pollution tolerance Index of the selected species in the four zones and the control zone was calculated based on the four Biochemical parameters namely, Relative water content, pH, Total Chlorophyll content and Total ascorbic acid content of the leaf tissue. In the present investigation, APTI was the highest for *Samanea* in Zone IV and control zone and for *Azadirachta* in Zones II and for *Ficus* in Zones I and III. (Table2; Fig: 1). Minimum APTI values were observed in the case of *Polyalthia* for Zone IV and *Pongamia* in Control zone and *Polyalthia* in Zone IV.



The level of APTI was seen to vary from species to species and from Zone to Zone. APTI was minimum in Zone IV for all the selected species which indicates that that this zone is less polluted and so less stressful for the plants growing here. An analysis of the Biochemical parameters for APTI shows that the control zone is less stressed in terms of Air pollution as it is located away from the road and a similar situation exists in Zone four which is closer to Loyola College. In this zone *Ficus* seems to show a negative value for APTI indicating that it is the least resistant. The present study corroborates the previous studies[10] which have shown that *Azadirachta* and *Samanea* have high APTI values.

CONCLUSION
The present study has revealed that the stretch studied is subjected to a high level of Air pollution and there are a varied number of plant species growing here. The study has brought to light the fact that among the five species studied all are commonly represented in areas of Air pollution and these show resistance to this

condition. They have evolved to combat the problems of air pollution and can be recommended to be grown for the greening of affected areas. The will help sequester the pollutants and cleaning of the environment. Tropical cites like Chennai can exploit these tree species in afforestation programmes.

Table 2: showing the data on the various parameters for APTI calculation of the selected species in the different zones

Sample name	Zone no.	RWC %	pH	Total chlorophyll (mg/g)	Ascorbic acid (mg/g)	APTI
Azadirachta	I	93.289	7.20	34.83	33.19	148.83
Polyalthia		83.165	4.05	28.94	31.81	113.28
Pongamia		81.699	1.29	35.69	27.01	108.05
Samanea		112.10	2.05	34.65	30.29	122.38
Ficus		91.294	3.58	25.91	49.37	154.73
Azadirachta	II	146.696	3.41	29.85	33.43	125.86
Polyalthia		75.474	3.92	26.80	34.10	112.29
Pongamia		72.483	1.40	26.56	33.57	101.11
Samanea		82.471	1.35	25.38	32.58	95.33
Ficus		92.515	3.50	12.04	42.95	75.98
Azadirachta	III	84.433	3.50	35.11	28.44	118.23
Polyalthia		94.545	3.91	34.68	33.00	136.83
Pongamia		94.182	3.90	28.75	37.52	131.92
Samanea		119.886	3.10	33.07	32.24	128.61
Ficus		86.837	4.20	18.73	53.36	131.07
Azadirachta	IV	84.906	3.81	35.62	24.68	105.81
Polyalthia		121.528	3.57	-2.45	103.74	23.82
Pongamia		78.631	3.40	0.79	69.30	36.90
Samanea		74.609	3.75	20.03	69.20	172.02
Ficus		99.847	3.11	-16.20	72.91	-85.46
Azadirachta	Control	54.861	3.62	42.93	15.88	79.40
Polyalthia		70.358	3.53	41.86	16.35	81.27
Pongamia		52.950	3.40	43.01	9.69	50.29
Samanea		-11.594	3.50	37.27	38.28	154.93
Ficus		59.441	4.40	40.68	14.40	70.87

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