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Air Pollution Tolerance Index And Anticipated Performance Index Of Selected Tree Species In The Bengaluru Urban, Karnataka

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Abstract
Air pollution causes severe health problems and environmental hazards such as acid rain, global warming, depletion of the ozone layer, and are leading causes of climate change. In the present study, Air pollution tolerance index and Anticipated Performance index was calculated for selected plant species at two sites at outer ring road Gorguntepalya to Nayandahalli (experimental site) and the Bangalore University (the control site) of Bengaluru city, India. The leaf samples were collected from 30 commonly present tree species. Four physiological and biochemical parameters of leaf relative water content, Ascorbic acid content, total leaf chlorophyll content and leaf extract pH values were used to compute the air pollution tolerance index values. The results were showed significant effects of various air pollutants on the vegetation. APTI values for 30 common tree species at both sites showed varied tolerance, categorizing into high, intermediate, and sensitive groups. Species with higher APTI values are significant pollutant sinks, while lower values were serve as bioindicators for air pollution monitoring. Trees like Swietenia mahagoni and Saraca asoca, with favourable morphological and economic characteristics, are recommended for urban green maintenance.
Keywords: *Dust deposition, Urban pollution, Air quality, Mitigation measure*

INTRODUCTION

Air pollution is one of the serious environmental concern of the metropolitan cities in India including Bengaluru, where majority of the population is exposed to poor air quality due to urbanisation and vehicular movement. Air pollution is a significant environmental and public health issue, threatening plants, animals, and humans (Gupta et al. 2020). Air pollution, especially in urban areas, significant health impacts, with particulate matter (PM) classified by size and containing harmful substances like heavy metals and PAHs posing one of the greatest risks (Popek et al., 2017).

Industrial advancements have enhanced life styles but increased pollution. Plants helps in mitigating air pollution by absorbing harmful elements, though which suffer from exposure (Pillai, 2023). Around 90% of the global population resides in areas with air quality below WHO guidelines (Sabina et al., 2021). The levels of common pollutants, including carbon monoxide, ozone, nitrogen oxides, sulfur dioxide, and particulate matter, are typically monitored with fixed stations (Kumar et al., 2015, Vanda et al., 2020).

In the open field, atmospheric pollutants induce stress symptoms in plants, affecting directly by clogging leaf surfaces or indirectly through soil absorption (Bohn, 1972, Popek et al., 2017, Papazian and Blande 2018). The Air Pollution Tolerance Index highlights the potential of vegetation to purify the air and act as biomonitors, with various plant species showing different responses to pollutants (Steubing et al., 1989, Raina et al., 2006, Mingorance et al., 2007, Agbaire 2009, Vintia et al., 2010, and Panda et al., 2018).

Understanding the impact of air pollution on plant physiology and ecology requires the knowledge of its sources, transport, and uptake by vegetation, with the latter being less well-understood (Winner, 1994). Incorporating trees effects on momentum, temperature, moisture, and pollutants requires careful boundary

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conditions to achieve a stable and homogeneous urban boundary layer (Grylls and Reeuwijk, 2022). Vegetation traits influence the wind turbulence and air flow, but universal conclusions on air quality are challenging due to complex interactions with tree traits, urban street designs, and local weather conditions (Amorim et al., 2013, Grote et al., 2016). Most gaseous and particle pollutants would settle on leaf surfaces, with uptake through stomata depending on photosynthesis and environmental conditions (Fares et al., 2014, Grote et al., 2016). Vehicle emissions are the main source of air pollutants in many areas, with traffic congestion worsening the air quality, especially near major roads. These emissions heighten health risks for drivers, commuters, and nearby residents, as evidenced by various studies and assessments (Transportation Research Board (TRB), 2002, World Health Organization (WHO) 2005, Health Effects Institute (HEI), 2010, Zhang and Batterman, 2013).
Greenbelts along streets enhance urban aesthetics, control temperature and moisture, improve air quality by absorbing pollutants, and reduce noise, with effectiveness varying by plant type, local conditions, and pollution levels (Islam et al., 2012). The plant species which are more sensitive act as biological indicators of air pollution (Lakshmi et al., 2009). The response of plants to air pollution at physiological and biochemical levels can be understood by analyzing Air pollution tolerance index (APTI).

MATERIALS AND METHODS

Study area

The study was carried out in Bangalore urban district, centrally located in the South-Deccan plateau of peninsular India, south-eastern Karnataka, spans from 12° 39' N to 13° 18' N latitude and 77° 22' E to 77° 52' E longitude, covering approximately 2,196 square kilometres with an average elevation of about 900 meters. Two sampling sites were selected as control and experimental sites to clearly define the objective and comparing the tolerance limit of different plant species to air pollution and to assess changes in a specific area. The first sampling area comprises a stretch of 12km from Goraguntepalya to Nayandahalli Signal an Outer Ring Road (ORR) was selected as an experimental site with known higher levels of air pollution source from industrial area and heavy traffic movement. The second sampling area is the Bangalore University as a control site with 1100-acre campus, home to over 500,000 trees, acts as a significant carbon sink and green lung space for the city and away from industrial and traffic sources.

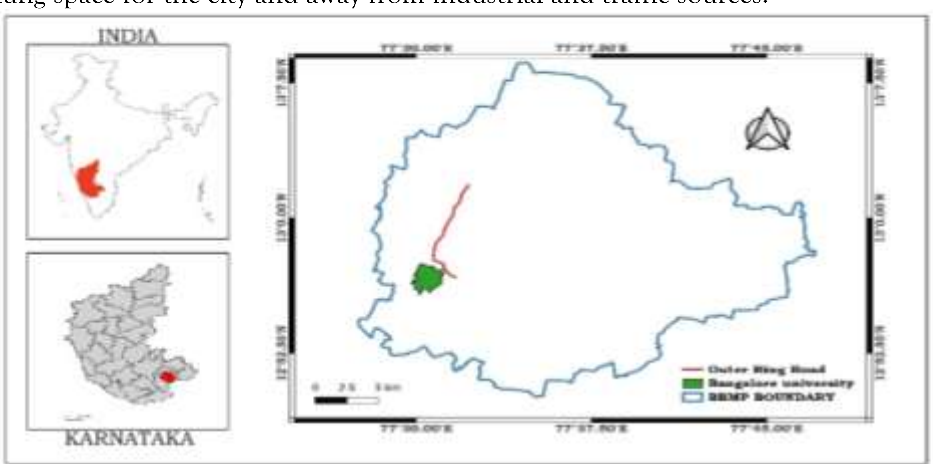

Fig 1. Map showing Sampling Area

Sample collection

The study was carried out during June 2024, to understand the impact of air pollution on different plant species and a total of 30 different plants species were selected from the immediate vicinity of campus which are exposed to road side automobile pollution stress and referred as experimental site (ES). The University campus, with similar ecological conditions was selected as the control site (CS). The plants used for the study at control site where same as those available at the experiment site with similar light, water and soil conditions. Three replicates of fully matured leaves were collected. These leaves were stored in Zip covers with labelled and brought to the laboratory for analysis.

Biochemical Characteristics Analysis

The plant samples were analyzed for different parameters within 24 hours of harvesting period. To assess the air pollution tolerance index, biochemical parameters like pH of leaf extract (P), Total Chlorophyll (T), Ascorbic acid (A), and Relative Water Content (R) were estimated.

Leaf extract pH: The pH of the leaf extract was measured using the method by Singh and Rao (1983). A 5g leaf sample was crushed and homogenized in 20 mL of distilled water, filtered, and the pH was measured with a calibrated pH meter (Eutech Digital pH Tutor).

Relative water content (RWC): The Relative Water Content (RWC), a measure of water availability in leaf tissue compared to its fully turgid state, was calculated according to Barrs and Weatherly, (1962). The fresh weight (FW) was recorded after harvesting, turgid weight (TW) after immersing leaves in water overnight, and dry weight (DW) after drying in a hot air oven at 105°C for 2 hours.

$$\text{Relative water content} = \frac{FW\text{-}DW}{TW\text{-}DW} \times 100$$

where,

FW= Fresh weight of leaf,

DW= Dry weight, and

TW= Turgid weight

Total chlorophyll (TCh): Total chlorophyll was determined by adding 10 mL of 80% acetone to 5g of crushed leaves and allowing the extraction to proceed for 15 minutes. The mixture was then decanted into centrifuge tubes and centrifuged at 2500 rpm for 10 minutes. The absorbance of the supernatant was measured at 645 nm and 663 nm using a spectrophotometer.

$$T\,Ch = \frac{[20.2(A645) + 8.02(A663)] \times [V]}{1000 \times W}$$

where,

TCh= Total Chlorophyll (mg/g),

A645 = Absorbance at 645 nm, A663= Absorbance at 663 nm,

V = Total volume of extract, and
W = Weight of sample

Ascorbic acid (AA): The AA in the leaf samples was measured using a spectrophotometric method (Bajaj and Kaur, 1981), involving weighing 1g of leaf sample, adding 4ml oxalic acid-EDTA, 1ml ortho phosphoric acid, 1ml sulphuric acid, 2ml ammonium molybdate, and 3ml water, allowing the solution to stand for 15 minutes, then measuring absorbance at 760nm with a spectrophotometer and extrapolating ascorbic acid concentration from a standard curve.

Air Pollution Tolerance Index

The APTI was calculated according to the method described by (Singh and Rao 1983).

$A(T+P)+R$

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$$APTI = \frac{\qquad}{10}$$

A = Ascorbic acid content mg/g
P = pH of leaf extract
T =Total chlorophyll (mg/g)
R = Relative water content (%) of fresh leaves
10 = Total Sum is divided by 10 to obtain APTI Values
The APTI results are further classified as sensitive (1–11), intermediate tolerant (12–16), and tolerant (≥ 17) to assess the vulnerability and resistance of various plant species to air pollution (Agbaire and Esiefarienrhe, 2009; Ogunkunle et al., 2015).

Anticipated performance index (API)

The API was determine, and laminar structure) with the APTI of each species (max grade of 16) and assigning an API score per Prajapati and Tripathi (2008), with the percentage score calculated using a following formula;

$$API = \frac{\text{Number of grade obtained}}{\text{Total number of plant species}} \times 100$$

Table 1. Anticipated performance index of plant species

Sl. No	Grading character	Characteristics	Pattern of assessment	Grade allotment
1	Tolerance	APTI	9.0-12.0	+
			12.1 – 15.0	++
			15.1 – 18.0	+++
			18.1 – 21.0	++++
			21.1 – 24.0	+++++
2	Biological and Socio economic	Plant Habit	Small	-
			Medium	+
			Large	++
		Canopy structure	Sparse/irregular/globular	-
			Spreading crown/open/semi-dense	+
			Spreading dense	++
		Type of plant	Deciduous	-

			Evergreen	+
3	Laminar structure	Size	Small	-
			Medium	+
			Large	++
		Texture	Smooth	-
			Coriaceous	+
		Hardiness	Delineate	-
			Hardy	+
		Economic value	Less than 3	-
			3 or 4 uses	+
			5 or more uses	++

Table 2. Grading of plant species based on the API percentage

Grade	**Score (%)**	**Assessment Category**
0	Up to 30	Not Recommended
1	31 – 40	Very Poor
2	41 – 50	Poor
3	51 – 60	Moderate
4	61 – 70	Good
5	71 – 80	Very Good
6	81 – 90	Excellent
7	91 - 100	Best

RESULTS AND DISCUSSION

Leaf extract of pH

The pH values were used to measure the hydrogen ion activity, adsorbed by metallic ions, and hydrogen. In the present study, it was observed that all the plant species collected from the experimental site exhibited a pH towards the acidic side, ranging from 4.5 to 7.8. Plants like Ficus benjamina (7.85), Tabebuia aurea (7.82) recorded high pH. Low leaf pH extract showed a good correlation with sensitivity to air pollution and also reduced the photosynthetic process in plants. Plants like Gliricidia sepium (4.57), Jacaranda mimosifolia (4.94). A higher pH improved tolerance against air pollution. The pH range between 5.7 and 7.3 indicated both intermediately tolerant and sensitive plant species. The highest value was observed in Ficus religiosa (7.62). It was observed that all the plant species collected from the control site exhibited a pH towards the acidic side, ranging from 2.9 to 8.9 pH. Plants that recorded high pH values among them were Ficus racemosa (8.23), Tabebuia aurea (7.74). The lowest pH was recorded in Swietenia mahagoni (2.93), Ficus religiosa (4.68). The pH range between 4.9 and 6.5 indicated both intermediately tolerant and sensitive plant species. Thus, all plant species were both intermediately tolerant and sensitive to air pollutants.

The pH content of the foliar tissue for all the species significantly differed between the polluted site and the control site. The presence of acidic pollutants (SO_2 and NOx) in the ambient air increased the acidic nature of the leaf by decreasing pH. In sensitive species, the rate of decrease was greater than in tolerant species, and a higher level of pH increased the tolerance level to air pollutants by converting hexose sugar to ascorbic acid in the foliar tissue of plants.

Relative water content (RWC)

Relative water content was the total amount of water in the leaf relative to its turgidity and permeability of the cell membrane. This study reported different RWC values ranging from 35.76% to 95.53% at the experimental site and 55.63% to 98.67% at the control sites, respectively. The difference in RWC could be due to irradiance, temperature, humidity, soil salinity, and pollution. The value of RWC inclined at the experimental site for most of the species and was highest for Ficus religiosa (95.53%), Ficus benghalensis (93.83%). The lowest value of RWC was recorded for Markhamia lutea (35.76%).

In the control site, Ficus religiosa (98.67%), Bauhinia purpurea (97.49%) had the maximum RWC values. Tecoma stans (55.63%), Muntingia calabura (64.60%) had the minimum RWC values. According to the results, the RWC of plants in the experimental site was lower in comparison to the control site. In the study by Rajakaruna and Masakorala (2019), the RWC of city area plants was significant over the control site. High RWC aided the survival of plants during long dry seasons in the polluted environment. This indicated an adaptive response towards stressors and balance in physiological parameters.

Dhankar et al., (2017) found that the relative water content was an indicator of stress and that its concentration increased with the induction of stress in the form of air pollutants. Airborne pollutants were extensively reported to increase the loss of water and nutrients from plant leaves affected by increased protoplasmic permeability, leading to senescence. Higher RWC helped plants in regulating physiological functions under stress induced by airborne pollutants. Higher water-holding capacity of leaves under polluted environments might impart tolerance against toxic airborne pollutants. The RWC played a significant role in various plant processes such as growth, respiration, transpiration, and metabolic activities. The impact of pollutants on the transpiration rate in plant leaves could reduce the relative water content (RWC) in the leaves. Dust on the plant could also absorb water from non-cutinized plant surfaces, such as leaves, stems, and branches, particularly in high-temperature conditions. This could lead to an increase in evaporation from the plant, resulting in a decrease in the RWC.

Total chlorophyll content (TChl)

Total chlorophyll content was an important biochemical factor that impacted photosynthetic activity, which determined plant growth. In the present study, the maximum total chlorophyll content in the experimental site was recorded for Muntingia calabura (3.59 mg/g), Bougainvillea spectabilis (3.33 mg/g). The minimum value of total chlorophyll content was recorded for Gliricidia sepium (0.30 mg/g), Plumeria rubra (0.46 mg/g. In the control site, the maximum total chlorophyll content was recorded for Delonix regia (2.80 mg/g), Swietenia mahagoni (2.48 mg/g). The minimum value of total chlorophyll content was recorded for Saraca asoca (0.22 mg/g), Psidium guajava (0.23 mg/g).

Several studies have been reported a reduction in total chlorophyll content in plants exposed to air pollutants. The effect of PM in polluted areas on the reduction of chlorophyll content at the enzyme level and its correlation with increased activity of chlorophyllase enzyme activity was studied. The reduction in total chlorophyll content to reduce gaseous exchange due to the blockage of stomatal openings in response to air pollutants was analysed.

The study on the inverse relationship of total chlorophyll content with dust accumulation on leaves in polluted environments was reported. The total chlorophyll (TChl) content was significant in photosynthetic activity as well as the growth and development of biomass. The TChl content of plants varied from species to species, age of leaf, level of pollution from different sources, and other biotic and abiotic conditions. Degradation of photosynthetic pigment in leaves was widely used as an indication of air pollution. The chlorophyll content in plant species varied with the pollution status of the area; higher pollution levels resulted in lower chlorophyll content. It also varied with the tolerance and sensitivity of the plant species; higher sensitivity resulted in lower chlorophyll content.

Ascorbic acid content

Ascorbic acid was an essential ingredient of leaves as it played an important role in cell wall division of plants, defence, and cell wall synthesis. In the present study, the maximum value of ascorbic acid in the experimental site was recorded for Caesalpinia pulcherrima (51.56 mg/g), Swietenia mahagoni (46.49 mg/g). The minimum value of ascorbic acid was recorded for Jacaranda mimosifolia (-0.19 mg/g), Delonix regia (0.83 mg/g).

In the control site, the maximum value of ascorbic acid was recorded for Samanea saman (67.30 mg/g), Gliricidia sepium (49.69 mg/g). The minimum value of ascorbic acid was recorded for Delonix regia (0.1 mg/g), Lagerstroemia speciosa (2.75 mg/g). The concentration of foliar ascorbic acid in the leaves varied significantly with tree species. The presence of ascorbic acid influenced the resistance of plants to adverse environmental conditions, and being a strong reductant, its reducing power was directly proportional to its concentration. However, its reducing capacity was dependent on plant pH, being more effective at higher pH levels. Ascorbic acid was a major contribution in affecting the behaviour of plants. Increases in ascorbic acid in plants were speculated to be favoured by the increasing production of reactive oxygen species (ROS). Researchers opined that higher ascorbic acid content signalled plant species' tolerance against air pollution. Lower ascorbic acid contents in plant species supported their sensitive nature towards pollutants. Ascorbic acid having a strong reduced power that helps to convert sulphite to hydrogen sulphide to reduce the toxicity of SO_2. It also enhanced photosynthesis by protecting chlorophyll from H_2O_2.

Air pollution tolerance index (APTI)

The air pollution tolerance index (APTI) was an indicator used to describe the ability of plants to survive against air pollution stress by controlling pollution-induced problems. Through this study, the increased APTI values in the experimental site were recorded for Caesalpinia pulcherrima (48.50) and Swietenia mahagoni (45.51).

The minimum APTI values were recorded for Markhamia lutea (6.09) and Jacaranda mimosifolia (7.16). In the control site, the maximum APTI values were recorded for Samanea saman (58.63) and Gliricidia sepium (50.79). The minimum APTI values were recorded for Delonix regia (8.58) and Lagerstroemia speciosa (11.31). Plants with higher APTI values were tolerant to air pollution and were used as sinks for air pollution in polluted sites. Plants with low APTI were sensitive and acted as indicators. APTI indices in plants revealed that the plants varied in their response to environmental pollution, and their tolerance to air pollution was determined by the ability to undergo physicochemical adaptation to either prevent pollutants or mitigate the stress induced by pollutants through antioxidants. Ascorbic acid content of plants could be used for screening plants with favourable tolerance to air pollution. Therefore, plants with high APTI were tolerant to pollutants and could be used as sustainable filters to alleviate deteriorated air quality. On the other hand, plants with low APTI could be used as indicators of air pollution.

Table 3. Results of Air pollution tolerance index of trees

Sl. No	Species Name	pH		RWC		TC		AA		APTI	
		ES	CS	ES	CS	ES	CS	ES	CS	ES	CS
1	Azadirachta indica	6.75	6.51	70.05	83.33	1.92	0.36	9.26	18.03	15.04	20.70
2	Bauhinia purpurea	7.43	6.62	91.98	97.49	2.55	0.23	24.07	11.77	33.22	17.82
3	Bougainvillea spectabilis	6.12	5.92	70.82	75.91	3.33	1.21	12.79	12.92	19.17	16.80

4	Delonix regia	6.15	5.98	71.11	85.80	1.52	2.80	0.83	0.01	7.75	8.58
5	Ficus benghalensis	7.56	6.41	93.83	92.94	1.98	1.02	3.34	39.56	12.58	38.67
6	Ficus benjamina	7.85	5.36	89.82	87.43	1.57	1.54	9.56	5.43	17.98	12.49
7	Ficus religiosa	7.75	4.68	95.53	98.67	1.99	0.42	1.09	6.54	10.61	13.20
8	Ficus racemosa	7.38	8.23	60.44	77.87	0.62	1.45	2.83	5.22	8.31	12.83
9	Gliricidia sepium	4.57	6.26	76.81	81.94	0.30	2.31	13.17	49.69	14.10	50.79
10	Jacaranda mimosifolia	4.94	4.96	72.67	79.38	0.88	0.92	0.19	12.15	7.16	15.08
11	Lagerstroemia speciosa	6.12	5.89	78.75	94.84	0.47	0.75	12.28	2.75	15.97	11.31
12	Mangifera indica	6.18	5.43	72.83	91.78	1.17	0.53	10.15	12.88	14.74	16.86
13	Magnolia champaca	5.36	6.12	83.38	88.15	1.24	0.87	30.37	39.51	28.38	36.43
14	Muntingia calabura	7.16	6.1	55.89	64.60	3.59	0.57	12.66	23.05	19.21	21.83
15	Nerium oleander	6.4	5.99	82.87	79.86	0.59	0.59	8.15	7.09	13.98	12.65
16	Pongamia pinnata	7.43	6.47	90.44	92.58	1.61	1.33	13.56	10.24	21.29	17.25
17	Plumeria pudica	6.75	6.11	74.39	92.91	1.03	0.55	4.07	8.07	10.60	14.67
18	Plumeria rubra	6.38	6.14	67.06	82.15	0.46	0.49	18.92	6.11	19.65	12.26
19	Caesalpinia pulcherrima	6.68	6.44	75.00	80.00	1.27	0.47	51.56	41.00	48.50	36.34
20	Psidium guajava	6.55	4.85	85.23	93.39	1.71	0.23	7.69	4.49	14.87	11.62
21	Samanea saman	6.43	5.93	89.29	83.72	2.11	1.54	33.30	67.30	37.37	58.63
22	Saraca asoca	7.1	5.68	91.52	96.07	0.55	0.22	18.15	25.22	23.03	24.48
23	Spathodea companulata	6.18	5.74	76.02	77.37	1.32	2.17	12.07	11.56	16.65	16.88
24	Swietenia mahagoni	7.14	2.93	76.99	96.35	0.99	2.48	46.49	11.05	45.51	15.61
25	Syzygium cumini	5.11	4.97	85.39	93.17	1.54	2.31	7.39	7.05	13.45	14.45
26	Tabebuia aurea	7.82	7.74	91.78	85.78	0.53	0.26	13.94	26.20	20.82	29.54
27	Markhamia lutea	6.96	5.63	35.76	88.41	0.97	0.66	3.17	5.86	6.09	12.52
28	Tecoma stans	7.13	6.25	82.31	55.63	1.97	1.23	23.73	37.47	29.81	33.58
29	Terminalia catappa	5.76	7.49	81.06	88.34	0.64	1.52	35.39	7.77	30.75	15.83
30	Thespesia populnea	7.26	6.31	86.26	89.63	1.50	0.77	13.47	10.32	20.43	16.27

Note: ES: Experimental Site, CS: Control Site

Anticipated Performance Index (API)

The grading pattern of 30 plant species was evaluated in Table 4, and plant species that fit into the grading pattern with respect to anticipated performance index (API) were recommended (Table 5) for the development of urban planning in Goraguntepalya Outer Ring Road. Magnolia champaca was identified as the best performer. Ficus benghalensis, Swietenia mahagoni, Saraca asoca, and Pongamia pinnata were expected to be excellent performers. On the other hand, Mangifera indica, Ficus religiosa, and Muntingia calabura were recorded as very good performers. Similarly, eight tree species were recorded as good performers, while four tree species were recognized as very poor performers. Jacaranda mimosifolia was not recommended for plantation.

Table 4. Evaluation of plant species based on APTI

Sl. No	Grading character	APTI Value	Tree Habit	Canopy Structure	Tree Type	Laminar			Economic Values	Total Plus	% Score
						Size	Texture	Hardness			
1	*Azadirachta indica*	++	++	-	-	-	+	+	+	7	43.8
2	*Bauhinia purpurea*	+++++	++	+	-	+	-	+	+	11	68.8
3	*Bougainvillea spectabilis*	++++	++	-	+	-	+	+	+	10	62.5
4	*Delonix regia*	+	+	+	-	++	-	-	+	6	37.5
5	*Ficus benghalensis*	++	++	++	+	++	+	+	++	13	81.3
6	*Ficus benjamina*	+++	++	+	+	-	-	+	-	8	50.0
7	*Ficus religiosa*	+	++	++	++	++	-	+	++	12	75.0
8	*Ficus racemosa*	+	++	-	-	++	-	+	+	7	43.8
9	*Gliricidia sepium*	++	+	+	-	+	+	-	-	6	37.5
10	*Jacaranda mimosifolia*	+	+	+	-	-	-	-	-	3	18.8
11	*Lagerstroemia speciosa*	+++	++	-	-	+	-	+	+	7	43.8
12	*Mangifera indica*	++	++	++	+	++	+	-	++	12	75.0
13	*Magnolia champaca*	+++++	++	+	+	++	+	+	++	15	93.8
14	*Muntingia calabura*	++++	+	+	+	++	-	+	++	12	75.0
15	*Nerium oleander*	++	-	-	+	++	+	+	+	8	50.0
16	*Pongamia pinnata*	+++++	+	+	+	++	+	+	++	14	87.5
17	*Plumeria pudica*	+	+	+	+	+	-	-	+	6	37.5
18	*Plumeria rubra*	++++	-	-	-	+	+	-	+	7	43.8
19	*Caesalpinia pulcherrima*	+++++	-	+	+	-	-	-	+	8	50.0
20	*Psidium guajava*	++	-	+	+	+	+	+	++	9	56.3
21	*Samanea saman*	+++++	++	++	-	-	-	-	++	11	68.8
22	*Saraca asoca*	+++++	++	-	+	++	+	-	++	13	81.3
23	*Spathodea companulata*	+++	++	+	+	+	-	+	++	11	68.8
24	*Swietenia mahagoni*	+++++	+	+	+	+	+	+	++	13	81.3
25	*Syzygium cumini*	++	++	++	+	+	-	-	++	10	62.5

26	*Tabebuia aurea*	++++	++	-	-	-	-	-	++	8	50.0
27	*Markhamia lutea*	+	+	-	+	+	+	-	+	6	37.5
28	*Tecoma stans*	+++++	+	+	+	+	+	-	+	11	68.8
29	*Terminalia catappa*	+++++	++	+	-	+	-	-	++	11	68.8
30	*Thespesia populnea*	++++	+	+	+	+	-	-	++	10	62.5

Table 5. Assessment of API of plant species.

Sl. no	Species Name	Grade		API value	Assessment Category
		Total (+)	% Score		
1	*Azadirachta indica*	7	43.8	2	Poor
2	*Bauhinia purpurea*	11	68.8	4	Good
3	*Bougainvillea spectabilis*	10	62.5	4	Good
4	*Delonix regia*	6	37.5	1	Very Poor
5	*Ficus benghalensis*	13	81.3	6	Excellent
6	*Ficus benjamina*	8	50.0	2	Poor
7	*Ficus religiosa*	12	75.0	5	Very Good
8	*Ficus racemosa*	7	43.8	2	Poor
9	*Gliricidia sepium*	6	37.5	1	Very Poor
10	*Jacaranda mimosifolia*	3	18.8	0	Not Recommended
11	*Lagerstroemia speciosa*	7	43.8	2	Poor
12	*Mangifera indica*	12	75.0	5	Very Good
13	*Magnolia champaca*	15	93.8	7	Best
14	*Muntingia calabura*	12	75.0	5	Very Good
15	*Nerium oleander*	8	50.0	2	Poor
16	*Pongamia pinnata*	14	87.5	6	Excellent
17	*Plumeria pudica*	6	37.5	1	Very Poor
18	*Plumeria rubra*	7	43.8	2	Poor
19	*Caesalpinia pulcherrima*	8	50.0	2	Poor
20	*Psidium guajava*	9	56.3	3	Moderate
21	*Samanea saman*	11	68.8	4	Good
22	*Saraca asoca*	13	81.3	6	Excellent
23	*Spathodea companulata*	11	68.8	4	Good
24	*Swietenia mahagoni*	13	81.3	6	Excellent
25	*Syzygium cumini*	10	62.5	4	Good
26	*Tabebuia aurea*	8	50.0	2	Poor
27	*Markhamia lutea*	6	37.5	1	Very Poor
28	*Tecoma stans*	11	68.8	4	Good
29	*Terminalia catappa*	11	68.8	4	Good
30	*Thespesia populnea*	10	62.5	4	Good

CONCLUSION

Air Pollution Tolerance Index (APTI) and Anticipated Performance Index (API) of various tree species was determined to assess the suitability for urban greening and pollution mitigation. APTI, based on biochemical parameters like ascorbic acid content, leaf extract pH, relative water content, and total chlorophyll content, indicates plant tolerance to air pollutants. Higher APTI values denote greater tolerance, ideal for green belt development. The research was conducted at Bangalore University and the Outer Ring Road of Goraguntepalya, revealed that Caesalpinia pulcherrima and Swietenia mahagoni were showing the highest APTI values, indicating a strong resistance to air pollution, while Markhamia lutea and Jacaranda mimosifolia were sensitive species. APTI values of 30 common tree species at both sites showed varied tolerance, categorized into high, intermediate, and sensitive groups. Species with higher APTI values are significant pollutant sinks, while lower values serve as bioindicators for air pollution. Trees like Swietenia mahagoni and Saraca asoca, with favourable morphological and economic characteristics, are recommended for urban greening. Particularly, effective as traffic barriers, provide aesthetic and functional benefits, reducing noise pollution and improving air quality. Ficus benghalensis, Swietenia mahagoni, Saraca asoca, and Pongamia pinnata were of excellent performers, while Jacaranda mimosifolia is not recommended for planting.
The average values of different parameters for APTI and API were analysed, showing varied sensitivity and responses among the plant species. This variation was reflected in respective APTI and API values. The top twenty tree species at both control and experimental sites were exhibited different APTI values. Species with lower APTI serve as bio-indicators for air pollution, while the higher values are more tolerant and are used to develop green belts in urban areas. A positive correlation between API and APTI suggests that higher APTI leads to higher API, highlighting the potential for green eco-management development. Integrating APTI and API into urban planning promotes a sustainable urban development and long-term air pollution management in local regions.

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