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Evaluation of Air Pollution Tolerance Index (Apti) of Selected Tree Species of Industrial Areas in Dindori, District Nasik, Maharashtra, India

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ABSTRACT

The present study assessed the Air Pollution Tolerance Index (APTI) of thirteen tree species growing in the industrial zone of Nasik, Maharashtra, with particular emphasis on the Dindori Maharashtra Industrial Development Corporation (MIDC) area, over the period from August 2022 to July 2024. Four biochemical and physiological parameters—total chlorophyll content, ascorbic acid concentration, leaf extract pH, and relative water content (RWC)—were analyzed to evaluate the tolerance or sensitivity of plant species to air pollution stress. The results revealed considerable interspecific variation in APTI values, reflecting differential responses to industrial air pollutants. Ficus benghalensis L. (APTI = 13.71) and Ficus religiosa L. (APTI = 12.87) exhibited the highest tolerance levels and demonstrated strong potential for urban greenbelt development. In contrast, *Eucalyptus tereticornis* Sm. recorded a comparatively low APTI value (9.02), indicating greater susceptibility to air pollution. Seasonal analysis showed that RWC and chlorophyll content were highest during the monsoon season, likely due to the washout of atmospheric pollutants, and lowest during summer and winter, when plants experienced increased stress from gaseous and particulate pollutants. The study concludes that the strategic plantation of tolerant and moderately tolerant species such as *Samanea saman, Ficus religiosa*, and *Ficus benghalensis* can play a significant role in mitigating air pollution and improving environmental quality in industrial areas such as Dindori MIDC

Keywords: Air Pollution Tolerance Index (APTI), ,Tree Species, Industrial Pollution, Relative Water Content, Ascorbic Acid, Chlorophyll Content, Dindori MIDC, Bioindicators, Urban Greenbelt.

INTRODUCTION

Industrialization and urbanization are two examples of human activities that have contributed to an increase in the level of pollution in the air that we breathe. As a result of the fact that it has a detrimental impact on plants and animals, particulate matter is now a significant cause for concern [1]. The identification and classification of plants into tolerant and sensitive groups is of the utmost importance [2]. This is due to the fact that sensitive plants have the potential to operate as an indicator, while tolerant plants have the ability to act as a sink for pollutants in urban and developed environments. Alterations to the conditions of the atmosphere have an immediate effect on the biochemistry and physiology of plants.

This is due to the fact that plants are highly reliant on their natural environment. Due to the fact that vegetation works as a sink for air pollution, there is less pollution in the air [3].

As a result of being subjected to air pollution, the majority of plants undergo internal changes before their leaves exhibit any outward symptoms of harm [4]. Therefore, the objective of this study was to assess the biochemical changes and the influence that they had on the air pollution tolerance index. This index is an essential component that defines the degree to which plants are sensitive to and tolerant of high levels of pollution. The air pollution tolerance index [5] provides an indication of the likelihood that plants will be exposed to different levels of air pollution. The air is cleaned by plants without the assistance of humans since they consume dust and smoke. One of the potential bio-indicators is the species of trees that are susceptible [6]. Any section of a tree has the potential to operate as a bio-monitor [7], and various kinds of pollutants cause plants to behave in a variety of different ways. When it comes to the nutrient cycle and the gas balance, they are very important to the field of ecology. It is possible to see both direct and indirect impacts of air pollution on plants by observing the characteristics of their leaves and the acidity of the soil [8,9]. Research conducted by a multitude of researchers [10, 11] indicates that air pollution has a detrimental impact on the growth of plants. By virtue of the fact that they are continually exposed to the environment, trees are able to attract, collect, and mix contaminants that come into contact with the surface of their leaves.

Because of this, they display changes that are either visible or small; depending on the degree of sensitivity they possess [13]. Initially, plants are able to tolerate air pollution and perform the function of scavengers for contaminants [12]. Air pollution causes plants to go through physiological changes, which eventually appear as damage to their leaves [14]. These changes may be seen in the leaves of the plant. Leaves have the potential to act as a natural filter, removing a wide variety of airborne pollutants and so recovering air quality in areas that are polluted [15]. On the other hand, the sort that is tolerant of pollution is the most suitable for the endeavor of lowering the amount of pollutants [16]. Because of this, APTI is a helpful instrument that can be used to choose species that are tolerant to air pollution as well as to monitor how well plants are able to survive being exposed to it. Because of this, it is very important to assess plants according to the amount of air pollution they can tolerate. As a result, APTI, which is based on biochemical characteristics, is often used in order to determine the amount of tolerance that the plants possess.

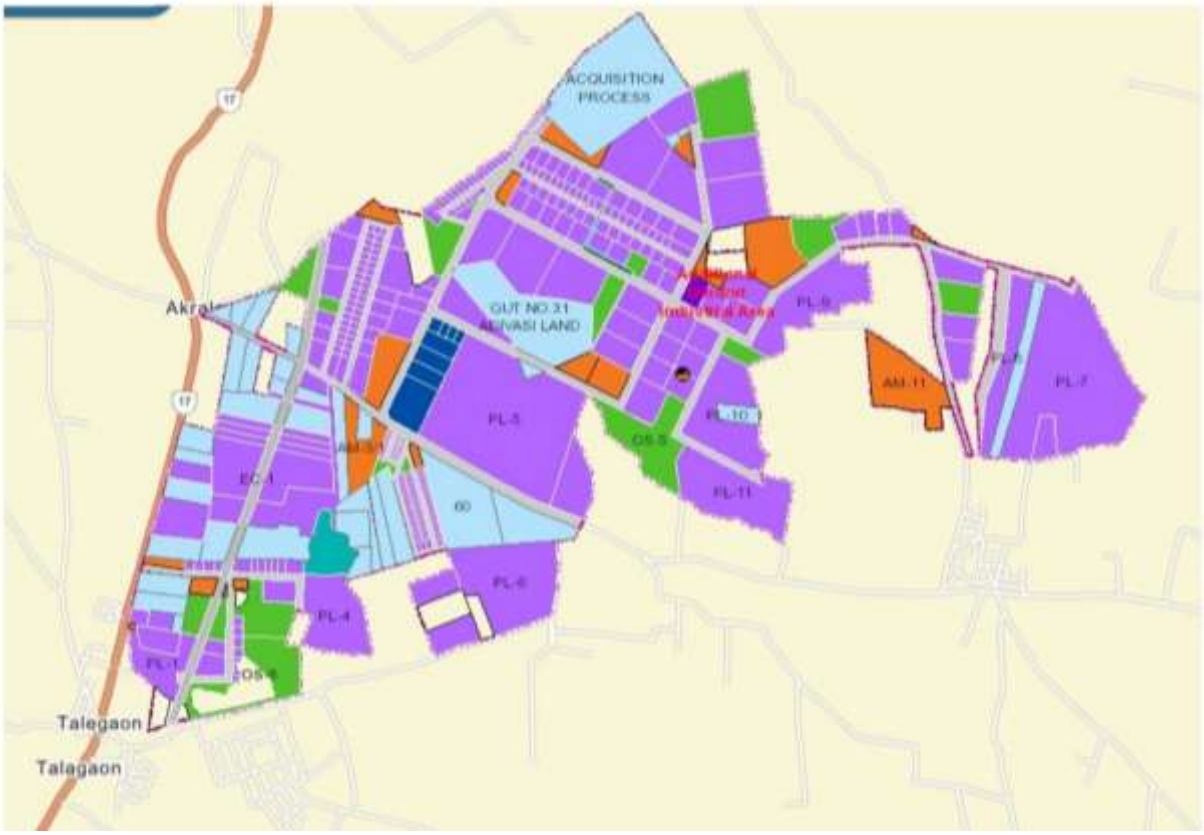
OBJECTIVES

1. To assess Air Pollution Tolerance Index (APTI) of certain tree species in Dindori Nashik, Maharashtra's industrial sectors.
2. To identify and classify tree species for use in urban greenbelt development according to their sensitivity or tolerance to air pollution.

MATERIAL AND METHOD

The study was conducted in the Dindori Municipal Industrial Development Corporation (MIDC) area of Nashik District, Maharashtra, India. The study area lies between latitudes 18.33° N and 20.53° N and longitudes 73.16° E and 75.16° E. The Dindori MIDC region is characterized by a high concentration of industrial units and heavy vehicular activity, resulting in continuous emission of air pollutants [17], Due to these conditions, the area was selected as a suitable sampling site for assessing the impact of air pollution on tree species using the Air Pollution Tolerance Index (APTI). Leaf samples were collected from trees growing along roadsides, near industrial units, and within the industrial premises. The site

provides representative conditions for evaluating pollution-induced physiological and biochemical responses of plants and for identifying tolerant and sensitive species suitable for greenbelt development in industrial environments.



Map1. - Showing industrial Area of Dindori , District Nashik

Plant Species Selection

Thirteen plant species that are typically found in the research region were chosen for the examination. These species have been chosen:

- *Terminalia catappa* L.
- *Mangifera indica* L.
- *Ficus religiosa* L.
- *Ficus benghalensis* L.
- *Azadirachta indica* A. Juss
- *Monoon longifolium* (Sonn.) B. Xue & R. M. K. Saunders
- *Senna siamea* (Lam.) H. S. Irwin & Barneby
- *Delonix regia* (Bojer ex Hook.) Raf.
- *Dalbergia sissoo* Roxb. ex DC
- *Samanea saman* (Jacq.) Merr.
- *Pongamia pinnata* (L.) Pierre
- *Eucalyptus tereticornis* Sm.
- *Millingtonia hortensis* L. f

Collecting and Analyzing Samples

Polythene bags were used to transport the mature leaves of the selected plant species after they had been properly collected. This was done to ensure that the samples were taken from an isoecological environment. In the leaves that were collected, the following four primary physicochemical features were analyzed in order to determine the Air Pollution Tolerance Index (APTI):

1. Total Chlorophyll Content

A single gram of the leaves with the most verdant appearance was selected by hand, rinsed thoroughly with water, and then allowed to dry for a short period of time at room temperature. A pestle and mortar was then used to grind the samples after 20–25 milliliters of acetone with an 80% concentration was added to them. For the purpose of preventing the degradation of chlorophyll, a small quantity of magnesium carbonate was given to the sample before to the extraction process. A cooling centrifuge was used to spin the combination of leaf extract at a speed of two thousand revolutions per minute for a period of fifteen minutes. After transferring the extract into a volumetric flask, I added acetone at a concentration of 80 percent until the volume reached fifty milliliters. At a wavelength of 645 nm (D645) and 663 nm (D663), the optical densities of the green solution were determined by using a spectrophotometer and the total chlorophyll formula that was created by Arnon. Adding or subtracting 8.02 (D663) from 20.2 (D645) is the value that was computed for CT.

2. Ascorbic Acid Content

During the year 1986, Ranganna's paper was published [19]. Produce and grocery items are the subject of this analysis guide. It was published by Tata McGraw-Hill. This book provides a comprehensive overview of an assortment of ascorbic acid measuring techniques, including spectrophotometric methodologies. Ascorbic acid is extracted from the leaves by combining them with a buffer solution, such as phosphate buffer, in order to do this.

Reaction with Reagents: The extract undergoes a transformation from blue to colorless after being treated with DCPIP, which is then decreased by ascorbic acid.

Spectrophotometric Measurement: By comparing the solution's absorbance at 515–520 nm with a standard calibration curve, we may calculate the content of ascorbic acid.

Leaf Extract pH

For the purpose of calibrating the digital pH meter before it was put to use, standard buffer solutions with pH values of 4.0 and 7.0 were used. After homogenizing the fresh leaf tissue in distilled water, the pH of the leaf extract was evaluated by following the technique described by Kakde, U. M. (2017) [20]. This was done in accordance with the recommended procedure.

Relative Water Content (RWC)

$$RWC = \left(\frac{FW - DW}{TW - DW}\right) \times 100$$

Where:

- TW = Turgid weight of leaves (obtained after soaking leaves in water overnight)
- FW = Fresh weight of leaves
- DW = Dry weight of leaves, as measured in an oven at 70°C.

The Air Pollution Tolerance Index (APTI) is calculated as follows:

There were a number of factors that were measured from the leaf samples that were collected. These parameters included the quantity of total chlorophyll, ascorbic acid, pH of the leaf extract, and relative water content. For the purpose of calculating the Air Pollution Tolerance Index (APTI), the approach that was presented by Singh et al. (1991) [21] was used.

$$APTI = \frac{A(T+P)+R}{10}$$

This formula takes into consideration all of the biochemical and physiological elements that are involved in the process of determining how plants respond to air pollution.

RESULT:

Table 1. Concentration Of Various Tree Species' Chlorophyll Content (Mg/Gm) In The Dindori MIDC Area (August 2022–July 2023)

S. N.	Tree Species	Aug 2022	Sep 2022	Oct 2022	Nov 2022	Dec 2022	Jan 2023	Feb 2023	Mar 2023	Apr 2023	May 2023	Jun 2023	Jul 2023	Average
1	*Terminalia catappa* L.	4.1	3.94	3.88	3.82	3.66	3.78	3.68	3.24	3.44	3.72	3.8	3.8	3.73
2	*Mangifera indica* L.	3.02	3.12	2.78	2.46	2.66	2.74	2.38	2.32	2.4	2.04	2.24	2.56	2.56
3	*Ficus religiosa* L.	4.8	4.66	4.52	4.3	4.14	4.12	3.98	3.84	3.56	3.48	3.52	3.66	4.04
4	*Ficus benghalensis* L.	4.84	4.78	4.98	4.88	4.74	4.68	4.62	4.28	4.12	4.3	4.28	5.56	4.67
5	*Azadirachta indica* A. Juss.	3.32	3.3	3.44	3.24	3.18	3.1	3.1	2.98	2.56	2.44	2.64	2.66	2.99
6	*Monoon longifolium* (Sonn.) B. Xue & R.M.K. Saunders	2.83	2.77	2.64	2.72	2.55	2.67	2.34	2.42	2.32	2.18	2.46	2.76	2.55
7	*Senna siamea* (Lam.) H.S. Irwin	3.96	4.12	3.98	3.58	3.46	3.88	3.4	3.42	3.54	3.36	3.44	3.58	3.64

	& Barneby													
8	*Delonix regia* (Bojer ex Hook.) Raf.	3.1	2.98	2.76	2.66	2.42	2.66	2.34	2.33	2.1	2	2.16	2.42	2.49
9	*Dalbergia sissoo* Roxb. ex DC.	3.82	3.74	3.66	3.54	3.12	3.34	3.44	3.74	3.46	3.14	3.78	3.88	3.55
10	*Samanea saman* (Jacq.) Merr.	4.22	4.1	3.98	3.72	3.66	3.46	3.32	3.44	3.48	3.66	3.68	3.74	3.7
11	*Pongamia pinnata* (L.) Pierre	2.78	2.74	2.56	2.66	2.14	2.22	2.44	2.56	2.74	2.78	2.88	3.12	2.63
12	*Eucalyptus tereticornis* Sm.	2.88	2.7	2.66	2.46	2.28	2.2	1.88	2.08	1.78	1.66	2.1	2.12	2.23
13	*Millingtonia hortensis* L.f.	3.56	3.48	3.42	3.36	3.26	3.12	3.24	3.33	3.14	2.04	3.1	3.32	3.19

Table 1 Illustrates Seasonal fluctuations were found in the Total Chlorophyll Content (TCC) of several plant species. Among these plant species, *Ficus benghalensis* L. had the highest average values (5.56 mg g^{-1} FW), while *Eucalyptus tereticornis* Sm. displayed the lowest (1.66 mg g^{-1} FW). The concentration of chlorophyll decreased over the winter and summer months as a result of pollution, temperature stress, and inadequate sunlight. The concentration reached its highest peak during the monsoon season. There is a possibility that the high levels of chlorophyll, which are responsible for enhancing photosynthesis, are the result of rainwater washing away impurities during the monsoon season. On the other hand, it is likely that the low levels of chlorophyll that were seen during the winter month were caused by increased pollution and environmental stress. The variability that occurs over the seasons is evidence of the impact that environmental conditions and contaminants have on the physiology of plants

Table 2. Concentration Of Various Tree Species' Ascorbic Acid (Mg/Gm) In The Dindori MIDC Area (August 2022–July 2023)

S. N.	Tree Species	Aug 2022	Sep 2022	Oct 2022	Nov 2022	Dec 2022	Jan 2023	Feb 2023	Mar 2023	Apr 2023	May 2023	Jun 2023	Jul 2023	Average
1	*Terminalia catappa* L.	2.88	2.94	2.86	2.92	3.1	3.12	3.1	3.04	3.08	2.94	2.78	2.86	2.96
2	*Mangifera indica* L.	1.6	1.6	1.78	1.98	2.06	2.1	2.1	1.93	1.84	1.84	1.78	1.66	1.85
3	*Ficus religiosa* L.	3.66	3.45	3.68	3.64	3.48	3.88	3.74	3.94	3.86	3.98	3.86	3.78	3.74
4	*Ficus benghalensis* L.	3.76	3.74	3.88	3.82	3.98	4.22	4.2	4.18	4.22	4.36	4.08	4.12	4.04
5	*Azadirachta indica* A. Juss.	2.66	2.47	2.62	2.44	2.74	2.72	2.82	2.84	3.12	3.08	3.1	2.98	2.79
6	*Monoon longifolium* (Sonn.) B. Xue & R.M.K. Saunders	1.76	1.72	1.78	1.82	1.8	1.94	2.08	2.2	2.22	2.12	2.09	1.92	1.95
7	*Senna siamea* (Lam.) H.S. Irwin & Barneby	1.8	1.92	1.96	2.06	2.1	2.14	2.22	2.38	2.66	2.78	2.54	2.41	2.24
8	*Delonix regia* (Bojer ex Hook.) Raf.	1.76	1.8	1.82	1.93	2.08	2.12	2.32	2.42	2.24	2.26	2.14	2.06	2.07
9	*Dalbergia sissoo* Roxb. ex DC.	2.08	2.04	2	2.1	2.12	2.22	2.36	2.4	2.42	2.34	2.26	2.16	2.2
10	*Samanea saman*	3.22	3.08	3.24	3.32	3.4	3.42	3.5	3.52	3.48	3.4	3.22	3.12	3.32

	(Jacq.) Merr.													
11	*Pongamia pinnata* (L.) Pierre	1.78	1.7	1.74	1.8	1.86	1.88	1.92	1.96	2.1	2.24	2.14	2.08	1.93
12	*Eucalyptus tereticornis* Sm.	1.66	1.72	1.8	1.82	1.86	1.98	2.16	2.24	2.36	2.32	2.14	2.12	2.01
13	*Millingtonia hortensis* L.f.	1.88	1.95	1.86	1.94	2.16	2.1	2.22	2.3	2.44	2.32	2.24	2.14	2.12

Table 2 illustrates the concentration of ascorbic acid that is found in the leaves of certain plant species throughout the summer, monsoon, and winter seasons. The levels of ascorbic acid were at their highest during the summer, winter, and monsoon seasons respectively. It has been said by Conklin (2001) [22] that ascorbic acid is an important reducing agent that plays a role in the construction of cell walls, defense mechanisms, and cell division. Out of all the species that were tested, the species with the highest concentration of ascorbic acid was *Ficus benghalensis* L., which had a concentration of 4.36 mg/gm. *Mangifera indica* Sm. had the lowest value, which was 1.6 mg/gm.

Table 3. Different Tree Species' pH Concentrations In The Dindori MIDC Area (August 2022–July 2023)

S. N.	Tree Species	Aug 2022	Sep 2022	Oct 2022	Nov 2022	Dec 2022	Jan 2023	Feb 2023	Mar 2023	Apr 2023	May 2023	Jun 2023	Jul 2023	Average
1	*Terminalia catappa* L.	7.18	7.16	6.94	6.84	6.82	6.7	6.78	6.6	6.58	5.94	6.68	7.16	6.78
2	*Mangifera indica* L.	6.7	6.34	6.22	6.82	6.31	6.2	6.2	5.9	5.9	5.4	5.8	6.5	6.19
3	*Ficus religiosa* L.	7.26	7.18	7.08	7.16	7.18	7.2	7.1	7.08	6.94	6.84	7.2	7.26	7.12
4	*Ficus benghalensis* L.	7.14	7.16	7.31	7.25	7.1	7.3	7.13	7.04	6.98	6.54	7.08	7.2	7.1
5	*Azadirachta indica* A. Juss.	6.8	6.54	6.56	6.22	6.34	6.2	6.42	6.74	6.44	6	6.1	6.32	6.39

6	*Monoon longifolium* (Sonn.) B. Xue & R.M.K. Saunders	6.98	6.8	6.82	6.68	6.64	6.38	6.44	6.54	6.62	6.74	6.68	6.82	6.67
7	*Senna siamea* (Lam.) H.S. Irwin & Barneby	6.92	7.2	6.78	6.56	6.33	6.52	6.44	6.34	6.54	6.88	7.2	7.2	6.74
8	*Delonix regia* (Bojer ex Hook.) Raf.	6.34	6.66	6.51	6.22	6.34	6.1	5.98	5.68	5.74	6.1	6.32	6.3	6.19
9	*Dalbergia sissoo* Roxb. ex DC.	7.1	6.82	6.82	6.68	6.45	6.58	6.46	6.22	6.1	6.36	6.62	6.86	6.58
10	*Samanea saman* (Jacq.) Merr.	6.88	6.86	6.72	6.67	6.44	6.26	6.58	6.74	6.74	6.76	7.1	7.33	6.75
11	*Pongamia pinnata* (L.) Pierre	6.88	6.68	6.68	6.82	6.62	6.52	6.38	6.22	6.4	6.44	6.69	6.72	6.58
12	*Eucalyptus tereticornis* Sm.	6.92	6.8	6.76	6.88	6.74	6.68	6.52	6.41	6.34	6.43	6.56	6.72	6.64
13	*Millingtonia hortensis* L.f.	7.1	6.88	6.74	6.74	6.64	6.42	6.44	6.36	6.24	6.44	6.52	6.6	6.59

The leaf pH values of the selected plant species are shown throughout the year in Table 3, which may be seen here. Throughout the monsoon season, the pH of the leaves reached its highest point, went down throughout the winter, and then reached its lowest point in the summer. By increasing the pH of the cell sap, acidic pollutants have the potential to reduce the efficiency with which hexose sugar is converted into ascorbic acid. Because ascorbic acid's reducing action is greater at higher pH and lower at acidic pH,

plants with a higher leaf extract pH exhibit increased tolerance to air pollution [23]. This is because the pH of the leaf extract is higher.

Table 4. Different Tree Species'Relative Water Concentrations In The Dindori MIDC Area (August 2022–July 2023)

S. N.	Tree Species	Aug 2022	Sep 2022	Oct 2022	Nov 2022	Dec 2022	Jan 2023	Feb 2023	Mar 2023	Apr 2023	May 2023	Jun 2023	Jul 2023	Average
1	*Terminalia catappa* L.	90.12	90.1	88.74	82.68	78.58	78.34	74.66	74.84	68.28	72.1	74.12	72.66	78.76
2	*Mangifera indica* L.	80.36	80.24	80.2	80.2	76.54	74.88	78.41	76.2	76.14	74.66	78.96	80.2	78.08
3	*Ficus religiosa* L.	90.22	89.22	89.44	88.46	88.34	87.42	86.32	85.44	84.78	86.24	84.64	84.2	87.06
4	*Ficus benghalensis* L.	92.88	92.44	91.22	90.2	90.24	88.98	86.44	87.66	88.56	88.46	90.1	88.56	8964
5	*Azadirachta indica* A. Juss.	90.2	88.25	88.44	84.56	82.47	84.22	82.35	78.64	78.44	72.78	74.95	80.2	82.12
6	*Monoon longifolium* (Sonn.) B. Xue & R.M.K. Saunders	86.78	83.56	82.88	80.46	80.24	78.44	78.56	76.48	79.44	82.66	84.41	88.22	81.84
7	*Senna siamea* (Lam.) H.S. Irwin & Barneby	90.12	90.1	88.24	86.78	86.56	84.98	82.44	80.34	78.66	74.14	78.22	80.24	83.77
8	*Delonix regia* (Bojer ex Hook.) Raf.	82.48	80.58	80.16	79.22	78.66	76.42	76.33	74.14	75.66	77.23	76.41	78.22	77.95
9	*Dalbergia sissoo*	86.22	86.24	84.88	82.78	82.66	84.74	82.98	80.2	78.66	72.47	76.78	80.42	81.58

	Roxb. ex DC.													
10	*Samanea saman* (Jacq.) Merr.	90.1	88.74	90.1	89.66	88.24	86.74	85.74	83.66	82.44	85.44	89.22	88.88	87.41
11	*Pongamia pinnata* (L.) Pierre	84.22	80.36	82.44	80.78	79.44	78.64	74.66	72.44	70.88	73.44	76.22	78.6	77.67
12	*Eucalyptus tereticornis* Sm.	78.68	78.44	76.44	75.78	76.22	72.56	69.88	70.46	70.88	71.24	73.22	77.16	74.24
13	*Millingtonia hortensis* L.f.	88.82	89.34	86.78	84.22	85.74	86.34	83.48	80.44	78.74	78.22	82.74	84.66	84.12

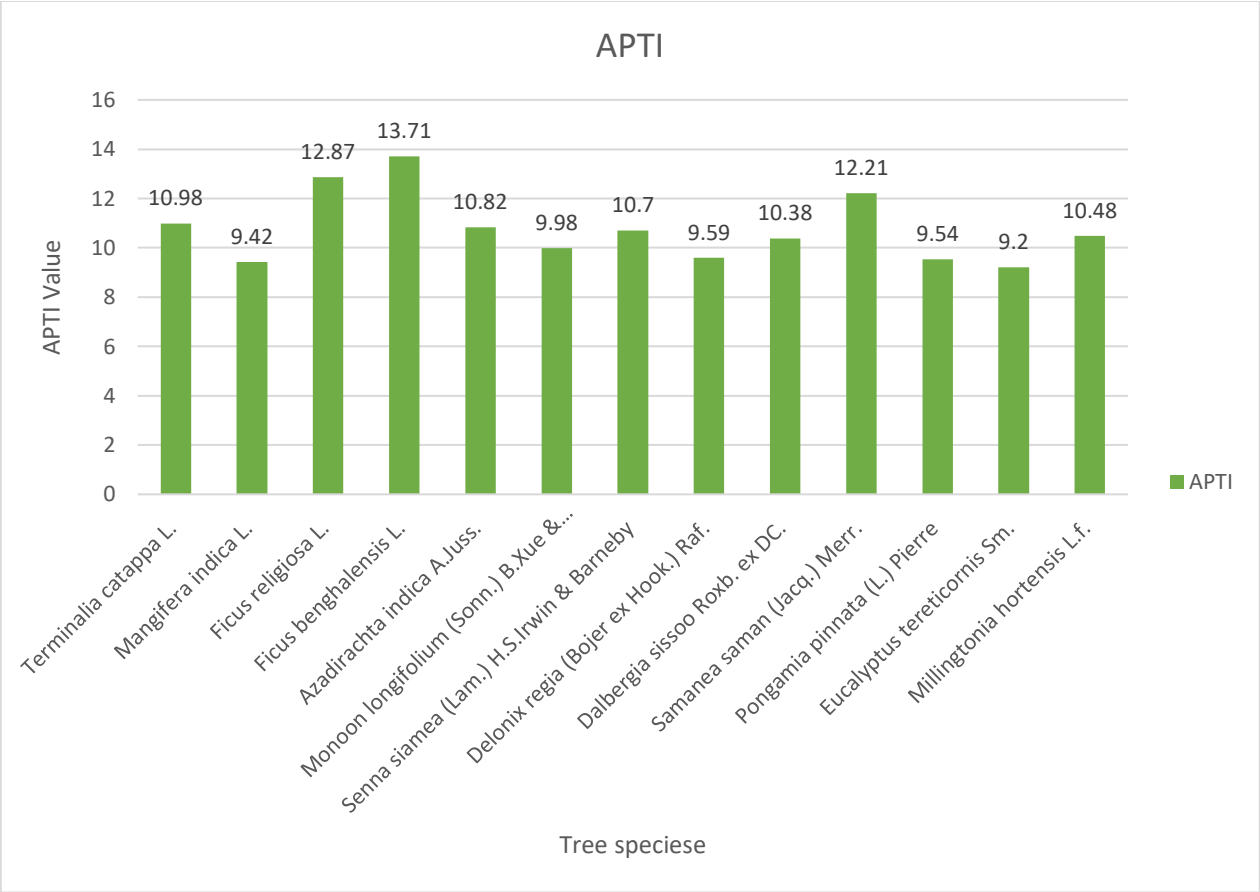
As can be seen in Table 4, the relative water content (RWC) of the plant species that were investigated reached its highest point during the monsoon season, then gradually decreased over the winter, and finally reached its lowest point during the summer. The relative water content (RWC) of a leaf is a result of its total turgidity and is connected with protoplasmic permeability. RWC is also a symbol for the relative water content of a leaf. The aging process of leaves is accelerated by increased permeability, which causes a loss of water and nutrients to occur. It is probable that plants that grown in polluted surroundings and have a higher RWC are more tolerant of the pollutants that are present in the air.

Table 5: Tolerance of Selected Tree Species to Air Pollution (APTI) in the Dindori Industrial Area, Nasik Maharashtra,

Sr. No.	Tree Species	APTI
1	*Terminalia catappa* L.	10.98
2	*Mangifera indica* L.	9.42
3	*Ficus religiosa* L.	12.87
4	*Ficus benghalensis* L.	13.71
5	*Azadirachta indica* A. Juss.	10.82
6	*Monoon longifolium* (Sonn.) B.Xue & R.M.K. Saunders	9.98
7	*Senna siamea* (Lam.) H.S. Irwin & Barneby	10.7
8	*Delonix regia* (Bojer ex Hook.) Raf.	9.59
9	*Dalbergia sissoo* Roxb. ex DC.	10.38
10	*Samanea saman* (Jacq.) Merr.	12.21
11	*Pongamia pinnata* (L.) Pierre	9.54
12	*Eucalyptus tereticornis* Sm.	9.2

13	*Millingtonia hortensis* L.f.	10.48

Figure: 1 Tolerance of Selected Tree Species to Air Pollution (APTI) in the Dindori Industrial Area, Nasik Maharashtra,



The Air Pollution Tolerance Index (APTI) data are shown in Table 5 and Fig. 1 for each plant species throughout the year. These data are presented for each plant species. Out of all the species that were tested, the two species that had the highest APTI values were *Ficus religiosa* L. (12.87) and *Ficus benghalensis* L. (13.71). On the other hand, *Eucalyptus tereticornis* Sm. got the lowest APTI score (9.2), which indicates that it is more susceptible to the effects of air pollution.

Findings

- **Chlorophyll Content:** *Eucalyptus tereticornis* has the lowest concentration (1.66 mg g^{-1} FW) while *Ficus benghalensis* has the highest (5.56 mg g^{-1} FW). As a result of the monsoon's decreased pollution load, chlorophyll levels peaked.
- **Ascorbic Acid Content:** At 4.36 mg g^{-1}, *Ficus religiosa* is at the highest, while at 1.6 mg g^{-1}, *Eucalyptus tereticornis* is at the lowest. In the summer, levels were higher, which meant that antioxidant protection was better.
- **Leaf pH:** Variegated from 5.68 for *Delonix regia* to 7.26 for *Ficus religiosa*; wood with a higher pH is more resistant to acidic contaminants.

- **Relative Water Content (RWC):** Species with a higher tolerance for water stress have better hydration maintenance, with *Ficus benghalensis* having the highest percentage and *Eucalyptus tereticornis* having the lowest.
- **APTI:** The results showed that although *Ficus religiosa, Samanea saman*, and *Ficus benghalensis* are excellent for greenbelt design due to their tolerance to pollution, *Ficus benghalensis* and *Eucalyptus tereticornis* are more susceptible. The range of values was 9.2 to 13.71.

These physiological and biochemical signs, when taken together, provide evidence that some tree species are able to adapt to situations that are contaminated with air.

CONCLUSION

This study demonstrates distinct species-specific physiological and biochemical responses of urban trees to industrial air pollution, validating their use as ecological indicators. Chlorophyll content ranged from **1.66 mg g^{-1} FW in *Eucalyptus tereticornis*** to **5.56 mg g^{-1} FW in *Ficus benghalensis***, with higher monsoon values reflecting reduced pollutant stress (Tripathi and Gautam, 2007; Rai, 2016) [24] Ascorbic acid concentration varied between **1.60 and 4.36 mg g^{-1}**, with *Ficus religiosa* showing the strongest antioxidant defense against oxidative damage (Singh and Rao, 1983; Kaur and Nagpal, 2017) [27]. Leaf pH (**5.68–7.26**) and relative water content further differentiated tolerance, as higher pH and better hydration enhanced resistance to acidic and gaseous pollutants (Agbaire and Esiefarienrhe, 2009)[28], Air Pollution Tolerance Index values ranged from **9.20 to 13.71**, classifying *Ficus religiosa*, *Samanea saman*, and *Ficus benghalensis* as tolerant species, while *Eucalyptus tereticornis* and *Delonix regia* were sensitive. These results confirm APTI as a robust indicator for species selection in pollution mitigation, particularly in industrial regions such as Dindori in Nashik district. **Policy implication:** Urban greenbelt programs should formally adopt APTI-based planting strategies to enhance air quality and ecosystem resilience.

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