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ANTICIPATED PERFORMANCE INDEX OF TREES IN INDUSTRIAL GREEN BELT

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Abstract: Air pollution is a global problem faced by the people due to its trans-boundary dispersion of pollutants over the entire world. Air gives oxygen to plants and creatures that enables them to live. Air quality decides the wellbeing status of the general population. Plants are most important species that aid to balance the ecological system of an environment in addition; they are also the prime and immobile acceptors of air pollution. Plants responses towards air pollution are assessed by air pollution tolerance index (APTI) value. The present study focuses on the determination of air pollution tolerance indices (APTI) and API of twelve common road side tree species growing along Ambernath M.I.D.C. region and from garden as control. The trees from the region can be arranged in the order of tolerance as Ficus benghalensis>Syzygiumcumini> Mangifera indica> Terminalia catappa>Azadirchta indica >Anthocephaluscadamba> Ficus religiosa > Thespesia populnea>Polyalthia longifolia >Samanea saman > Pithecellobium dulce >Peltophorumpterocarpum **.**Tolerant species serve as sink of air pollutants and thus can help in abatement of air pollutants to some extent if planted in and around industrial vicinity and along traffic islands. Based on the APTI values tolerant and moderately tolerant plants can be recommended for green belt development and air pollution attenuation.

Keywords: Air Pollution, Air Pollution Tolerance Index (APTI), Ascorbic Acid, pH, Total Chlorophyll.

Introduction

Air quality is very important aspect for the health and survival of man. Industrialisation and urbanization has played havoc on the quality of air. Today, it is very important to plant green trees or develop green belts, especially in the cities to combat air pollution. Most of the urban areas of the world have poor quality of air as result of high concentrations of air pollutants emanating from different sources viz, motor vehicle, traffic, power generation, residential heating and industry of adjoining areas (**Lopez et al., 2005**). Particulate matter is of great concern in relation to their adverse impact on human health and vegetation (**Rai et al, 2013**). The particulates and gaseous pollutants alone and in combination can cause serious setbacks to the overall physiology of plants (**Das and Prasad, 2010)**. Trees due to their perennial habit experience the exposure to a larger extent and are thereby influenced greatly by pollutant concentration. Regional impact of air pollution on local plant species is one of the major ecological issues. The adverse effect of dust settled on leaves was reported by **Chapekar (2000).** The climate condition, the physico-chemical properties of air pollutants and their residence time in the atmosphere have impact on surrounding plants (**Wagh et al., 2006).** The most obvious damage occurs in the leaves which include chlorosis, necrosis and epinasty (**Prasad and Choudhury, 1992**).

Some plants can thrive in polluted environment and can thus help in cleaning the various sources of manmade pollution both organic (petrochemical) and inorganic heavy metal toxins (**Thambavani and Sabitha, 2011**). As part of their regular functioning, trees remove significant amount of pollution from the environment, increasing the air quality and thus should be considered an integral part in aiming overall air quality (**Abida and Ramaiah, 2010**). Hence, in recent years, urban vegetation has become increasingly important not only for social reasons but also for improving urban quality **(Prajapati and Tripathi, 2008).** Vegetation works as a sink for air pollution and reduce pollution level in the atmosphere (**Hamraz et al 2014**). The dearth of precise knowledge about resistance or sensitivity of plant species to air pollution has prompted the present field study. Air pollution tolerance index (APTI) is an inherent quality of plants to encounter air pollution stress and it is a dependent on four biochemical parameters viz. leaf extract pH (P), total chlorophyll content (TC), ascorbic acid content (AA) and relative water content (RWC) Singh **and Rao, 1983**). Vegetation shows dissimilar behaviour for various pollutants and all components of tree can be used as bio-monitors (**Mingorance et al ,2007**). They are very significant in deciding and balancing the ecology; by cycling the nutrient and gases in the environment. Hence, in addition to APTI, the anticipated performance index (API), that relates to the socio-economic importance of the selected trees growing in industrial site of Ambernath M. I. D.C. was also studied.

Materials and Methods

Study area: Ambernath MIDC is part of Ambernath city, district Thane, in Maharashtra. It spreads over an area of about 15 sq meters with a record population of around 3 lakhs; located at 19^{0}18’25’’ N latitude and at 73^{0}19’26’’E longitude. The average annual temperature in Ambernath is 26.9 °C, and rainfall here averages to 3089 mm. The city industrial zones especially the Anand nagar MIDC hosts more than 150 large scale industries from textile, chemicals, edible goods, aerospace and electrical hardware.

Sampling: Forthe study twelve common tree species were selected growing along the roadside in the industrial belt of Ambernath MIDC site. Similar tree species growing in and around the RKT college campus were taken as a control. The study period was from

October 2018 to October 2019. Fully mature leaf samples of selected trees were collected in the morning hours from iso-ecological condition of light, water and soil. Leaves collected were immediately taken to the laboratory in polythene bag then washed with distilled water to get rid of dust particles, fresh weight was taken immediately and set for biochemical analysis. Various biochemical parameters such as Relative Leaf Water (RWC) content, Ascorbic acid content (AA) **(Bajaj and Kaur, 1981)** Total Chlorophyll (TCh) **(Arnon, 1979)** and pH of Leaf extract were analysed and the APTI was calculated using the formula proposed by **Singh and Rao (1983)**.

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

Where, A = Ascorbic acid (mg gm^{-1}); T = total chlorophyll (mg gm^{-1}); P = pH of the leaf extract; R = Relative water content of leaf (%)

On the basis of the resultant APTI values and some relevant biological and socioeconomic characters (plant habit, canopy structure, type of plant, laminar structure and economic values) the API for each plant species was also determined.

Statistical analysis

Pearson Correlation analysis was performed between independent variables viz. Chlorophyll, pH, RWC, ascorbic acid and dependent variable such as APTI by using XL STAT (Version 10) software. These scatter plots gives the degree of correlation between the said variables.

Results and Discussion

Air pollution tolerance index (APTI) being an inherent quality of plants is presently of prime concern particularly in industrial and non-industrial areas. The plants that were constantly exposed to the environment stress, absorb, accumulate and integrate pollutants impinging on their foliar sprays leading to variation in the leaf parameters like relative water content (RWC), total chlorophyll content (TCh), ascorbic acid (AA) and leaf extract pH content and therefore used to study the degree of tolerance of air pollution by the trees**.** Plants have been categorized into groups according to their degree of sensitivity toward and tolerance of various air pollutants on the basis of experiment and available data **(Khan and Abbasi, 2002).**

RWC is the water present in leaves relative to the full turgidity and it help to maintain the physiological balance under stress condition caused by pollution especially when the prevailing transpiration rate are high. In the present study RWC varied from 55.01% to 84.37% in the experimental leaves sample collected from the green belt region in the industrial zone. Among these samples, highest relative water content was observed in Mangifera indica (84.37%) and lowest in Peltophorumpterocarpum (55.15%) (Table 1). Though in general all experimental samples showed lower RWC than their respective control samples collected from the college campus and the latter samples appeared to be comparatively more turgid. The reduced RWC in all the experimental samples may be correlated to the effect of increased level of pollutants in the air in this MIDC region. Similar observation indicating reduction in RWC of plant species due to impact of pollutant on transpiration rate in leaves was recorded by **Swami et al** (**2004**). More over decreased RWC is also associated with protoplasmic permeability, loss of water and dissolved nutrients, and early senescence of leaves (**Agarwal and Tiwari, 1997**). Hence, maintenance of RWC by the plant may decide the relative tolerance of plants towards air pollution (**Verma, 2003**).

Ascorbic acid concentration is a strong reductant that activates many physiological and defence mechanism (**Lewin, 1976**). The leaf samples of Anthocephaluscadamba had highest ascorbic acid content (5.67 mg g^{-1}) whereas Pithecellobium dulce has least amount of ascorbic acid (2.93 mg g^{-1}). There was around 4-to-5-fold increase in the ascorbic acid content in every experimental sample compared to the respective control sample, while in Anthocephaluscadamba the increase was almost 6-fold. This response of the plants could indirectly confirm the exposure to air pollutant stress. Several studies earlier have stated that higher concentration of ascorbic acid in plants is an indicator of exposure to high concentration of SO_2, and higher tolerance of the plant. It also helps to protect the thylakoids' structure (and chlorophyll) from reactive oxygen species (ROS) formed in plants during water stress conditions (**Deepika et al, 2016**). In the present study among the twelve trees studied, higher ascorbic acid content in the leaves of few plant species may indicate the tolerance nature of the plants, while the lower ascorbic acid contents may correlate to the sensitive nature of these plants towards pollutants particularly automobile exhausts. Ascorbic acid as an anti-oxidant was found in large amount in all growing plants that are influenced greatly to adverse environmental condition like air pollution. The increased level of ascorbic acid reported in the trees under study may be in response as a defense mechanism by the respective plants to its polluted environment as suggested by **Cheng et al. (2007**).

Chlorophyll content of plant signifies its photosynthetic activity resulting into the growth and development of biomass of plant, and an index of productivity (**Raza and Murthy, 1998**). Chlorophyll content of plants varies from species to species; age of leaf and also with the pollution level as well as with other biotic and abiotic conditions **(Katiyar and Dubey, 2001).** The total chlorophyll

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content in the leaves of roadside samples was found highest in Syzygiumcumini (12.82 mg g^{-1}), least in Anthocephaluscadamba (3.08 mg g^{-1}) and all the control plant samples exhibited higher chlorophyll content with respect to the experimental samples (Table 1). The decrease in leaf chlorophyll content from the experimental samples ranged between 20% to 8%. The Ficus species appeared to be least affected among the selected samples. Also, it has been found that there is an inverse relation between the levels of pollutants and the chlorophyll content. Reports show that certain pollutants adversely affect the biochemical processes and in totality reduce the total chlorophyll content (**Allen et al., 1987**). Chlorophyll content of plants varies from the pollution status of the area i. e. higher the pollution level in the form of vehicular exhausts lower the chlorophyll content and as well varies with the tolerance as well as sensitivity of the plant species i.e., higher the sensitive nature of the plant species lowers the chlorophyll content (**Jyothi et al, 2010).**

All the leaves samples collected from polluted site exhibited pH towards acidic range, except Polyalthia longifolia (pH 7.17), which may be due to the presence of SO_2 and NO_X in the ambient air causing a change in pH of the leaf sap towards acidic side as reported by **Swami et al., (2004**). Moreover, Polyalthia longifolia chosen as a popular roadside plant appears to fit in the assumptions by earlier reports (**Kumar and Nandini ,2013**) that plants with lower pH are more susceptible while those with pH around 7 are tolerant. Though in our investigation, it appears that all the experimental tree samples with lower pH seems to be the tolerant species appropriate for urban green plantations. The change in leaf extract pH might influence the stomatal sensitivity due to air pollution. In the study samples Thespesia populnea with pH 4.1 was found to be most acidic followed by Anthocephaluscadamba (4.17) while Mangifera indica (4.23),exhibiting a clear relation to the increased ascorbic acid content, thereby suggesting to be of tolerant nature (Table 1).

The air pollution tolerance index (APTI) plays a significant role to determine resistivity and susceptibility of plant species against pollution levels. The significance of APTI in determining the tolerance along with the sensitivity of plant species were investigated by several authors **(Pathak et al., 2011).**Variation in four physiological and biochemical aspects (pH, RWC, ascorbic acid and chlorophyll content) of plant species results in variation in APTI values. Among the twelve tree leaves samples that included both broad leaved and small leaved, the broad-leaved samples have appeared to be least affected by the pollution around it. All the control samples also a specific level of inherent tolerance (Fig 1.). In the present study, **Ficus benghalensis** with highest APTI (16.27) can be predicted to be highly tolerant to automobile pollutants whereas **Peltophorumpterocarpum**was found to be least tolerant though not sensitive. Thus, it is evident from the study that plants like **Ficus benghalensis** and **Syzygiumcumini**with high APTI may act as important bio accumulators of air pollutants. The tolerance nature of the trees can be arranged in the order of higher to lowest as **Ficus benghalensis>Syzygiumcumini> Mangifera indica> Terminalia catappa>Azadirachta indica >Anthocephaluscadamba> Ficus religiosa > Thespesia populnea>Polyalthia longifolia >Samanea saman > Pithecellobium dulce >Peltophorumpterocarpum .**According to **Prasanna et al, (2005)**, plants with higher APTI being tolerant species accumulate the pollutants ,whereas plants that show APTI < 9 are classified as sensitive to air pollution. However, the trees with low APTI being sensitive may produce certain visual symptoms and act as bio indicators of air pollution **(Rai et al, 2013).**

Table 1: Air Pollution Tolerance Index (APTI) of the Plant species

Sr. No.	Botanical Name	Site	Ascorbic Acid (mg/g)	Total Chlorophyll (mg/g)	pH	Relative water (%)	APTI
1	Thespesia populnea	C	0.77±0.5	9.02±0.08	5.6±0.1	73.42±0.23	8.38
		SS	4.5± 0.2	7.27 ±0.03	4.1±0.1	65.91±0.93	11.7
2	Mangifera indica	C	1.24±0.14	7.04±0.03	5.6±0.1	87±0.26	10.31
		SS	4.57±0.15	5.46 ±0.13	4.23±0.15	84.37±1.01	12.86
3	Ficus religiosa	C	0.72±0.03	7.74±0.14	6.2±0.1	78.83±0.15	8.88
		SS	3.3±0.1	7.17 ±0.03	5.37±0.11	76.9±1.1	11.82
4	Ficus benghalensis	C	1.25±0.02	8.23±0.13	7.3±0.1	87.87±0.85	10.72
		SS	5.57±0.2	7.49 ±0.07	6.8±0.1	83.17±0.66	16.27
5	Anthocephaluscadamba	C	0.88±0.06	4.53±0.11	5.73±0.11	79.93±0.15	8.89
		SS	5.67±0.15	3.08 ±0.04	4.17±0.05	78.1±0.26	11.92
6	Polyalthia longifolia	C	0.7±0.07	5.37±0.13	7.03±0.15	75±0.15	8.37
		SS	3.8±0.1	3.96 ±0.08	7.17±0.15	71.17±0.35	11.34
7	Terminalia catappa	C	0.67±0.05	8.26±0.07	7.13±0.11	81.87±0.2	9.22
		SS	3.47±0.05	7.79 ±0.04	6.63±0.15	78.59±0.46	12.85
8	Syzygiumcumini	C	1.1±0.06	14.06±0.1	6.53±0.05	80.83±0.35	10.28
		SS	4.37±0.15	12.82 ±0.09	5.8±0.36	75.92±0.12	15.72
9	Azadirchta indica	C	1.25±0.07	6.63±0.3	6.17±0.02	78.03±0.15	9.4

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		SS	5.37±0.15	4.13 ±0.03	5.07±0.15	77.43±0.38	12.68
10	Samanea saman	C	1.11±0.01	3.75±0.08	6.47±0.05	71.53±0.30	8.29
		SS	5.13±0.15	3.13 ±0.07	4.63±0.11	69.6±0.65	10.94
11	Peltophorumpterocarpum	C	0.82±0.07	7.59±0.16	7±0.1	57.7±0.62	6.95
		SS	3.6± 0.1	6.14 ±0.04	5.53±0.25	55.01±0.12	9.7
12	Pithecellobium dulce	C	0.56±0.15	5.8±0.13	6.5±0.1	81.17±0.28	8.8
		SS	2.93±0.02	4.44 ±0.03	5.07±0.11	80.68±0.42	10.84

Considering the present scenario of urbanization and the relatively ever-increasing pollution, many researchers have attempted to study the ability of the plants to tolerate air pollutants, growing under different cultural practices from various region. **Nugrahani et al**, (2012), and Enete et **al**, (2012) studied the tolerance of ornamental plants of Indonesia and Nigeria respectively, which actually contribute to the urban green cover. Likewise,**Gharge S. and Menon G., (2012)** studied certain herb species luxuriantly growing in the Ambernath MIDC industrial area. The data reports Amaranthus spinosus as highly tolerant to air pollutant, followed by Eclipta alba, Alternanthera sessilis and Chenopodium album. Similarly, among the twelve trees in the study area growing along the roadside, ten tree species with the APTI values in the range of 10-16 can be categorized as intermediate tolerant species. Only **Ficus benghalensis** was found to be tolerant with APTI >16 and **Peltophorumpterocarpum** as close to sensitive. Moreover, the data in Fig. 1, clearly depicts the influence of the air quality on the APTI values of tree species from the study site as compared to the respective sample from the control site.

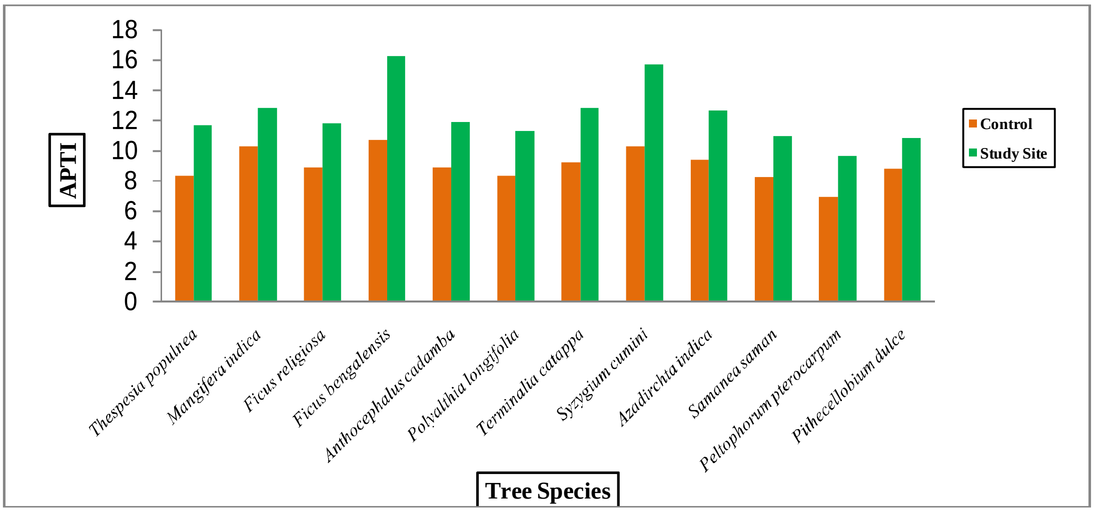

Fig 1: APTI of plant species at the control and the Study Site

The data presented in Table 2 & Fig 2, in general shows a positive correlation between the APTI and the different biochemical parameters associated with it, indicating an influential effect culminating into the tolerance index. Also, it can be noted that correlation between

Table 2: Correlation between the APTI values and biochemical parameters estimated from the leaf samples of the Study site

Biochemical Parameters	AA	Total Chlorophyll	pH	RWC	APTI
AA	1				
Total Chlorophyll	-0.197	1			
pH	-0.272	0.2955	1		
RWC	0.1983	0.0352	0.054	1	
APTI	0.417	0.636	0.342	0.588	1

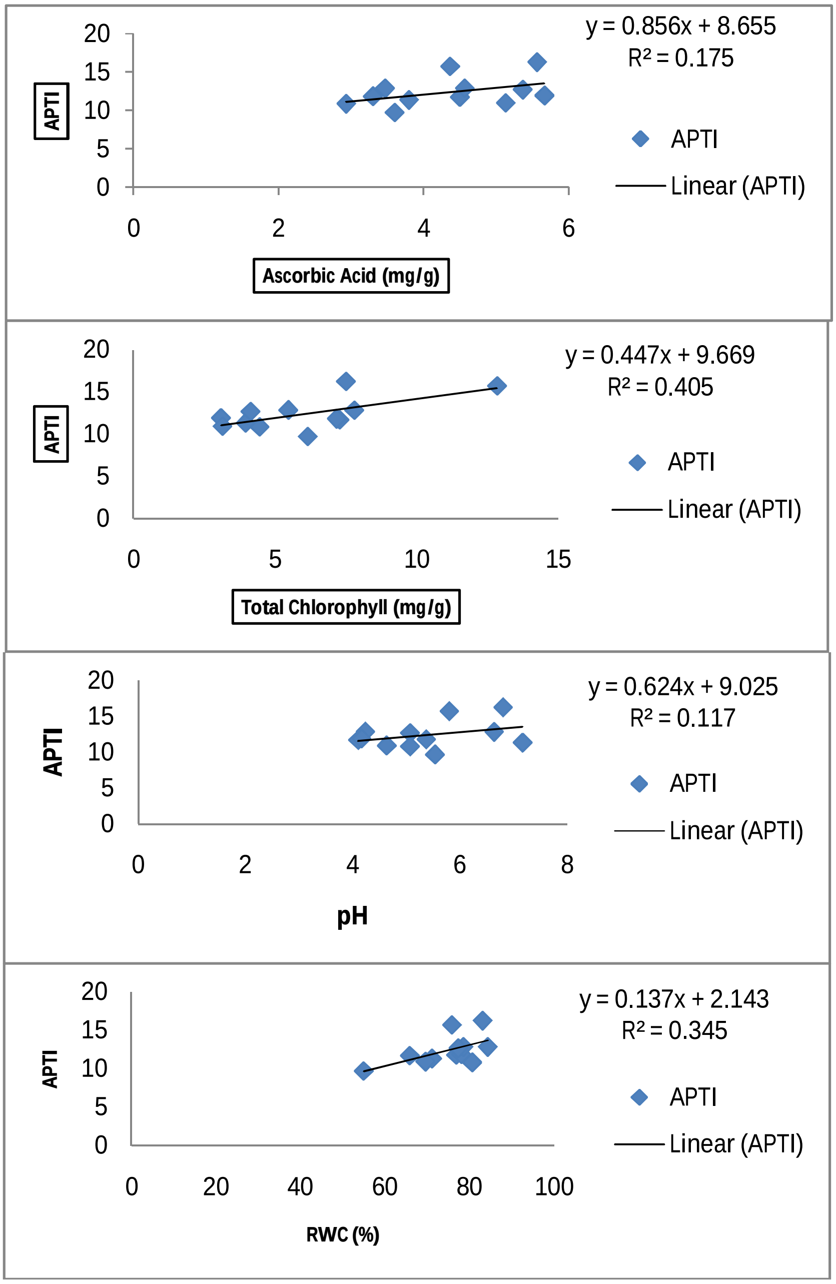

Fig 2(a-d) Scatter plot of various biochemical parameters (a.Ascorbic acid; b.TotalChl; c.RWC ;d. p H) and APTI values.

individual parameters like ascorbic acid and chlorophyll or ascorbic acid and p H were negatively related and are independent. It is observed that a significant positive correlation exists ($p< 0.05$ and $p < 0.01$) between the APTI and all the biochemical parameters. It indicates that ascorbic acid, total chlorophyll, Relative water content and pH are all very significant and thus the determining factor on which the tolerance of a tree or plant to air pollution depends. However, in trees with APTI values >16 and those categorized as highly tolerant all biochemical parameter were found to increase showing a positive correlation to APTI except Relative water content that decreased correspondingly.

As it was necessary to investigate the potential or suitability of different plants for Green Belt development, based on certain important characters, different grades (+ or -) were allotted to the plants **(Mondal et al., 2011).**

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Table 3: Anticipated Performance Index (API) Values of selected tree species

Name of Species	Mean APTI	Tree habit	Canopy structure	Tree type	Laminar size	Texture	Hardiness	Economic Imp	Total	% Scoring	API grade
Thespesia populnea	+	++	+	+	+ +	-	+	++	10	62.5	Good
Mangifera indica	++	+ +	+	+	++	+	+	+ +	12	75	Very Good
Ficus religiosa	+	+ +	-	-	+	+	+	++	8	50	Poor
Ficus benghalensis	+++	+ +	+ +	+	++	-	+	++	13	81.25	Excellent
Anthocephalus cadamba	+	+ +	+	+	+ +	+	+	++	10	62.5	Good
Polyalthia longifolia	+	+	-	+	+	+	+	+	7	43.75	Poor
Terminalia catappa	++	+ +	+	+	+ +	+	+	+	11	68.75	Good
Syzygium cumini	++	+ +	+	+	+ +	-	+	++	11	68.75	Good
Azadirachta indica	++	+ +	+	+	-	+	+	+ +	10	62.5	Good
Samanea saman	+	+ +	+	-	-	+	+	++	8	50	Poor
Peltophorumpterocarpum	+	+ +	+	+	-	+	+	+	8	50	Poor
Pithecolobium dulce	+	+ +	+	+	-	+	+	++	9	56.25	Moderate

The evaluation of API (**Table 3)** and assessment of different plants are based on their APTI values**.** The API values ofFicus bengalensis was the highest (+++) with score above 80% and therefore categorised as “Excellent”, and Mangifera indica (75% ,++) as “Very good”. While Syzygiumcumini (68%), Terminalia catappa(68%) ,Azadirachta indica (62%), Anthocephaluscadamba (62%), and Thespesia populnea (62%)are judged as “Good” category. These trees are good performer having spreading dense canopy of evergreen foliage, providing protection from pollution stress. Though,Pithecolobium dulce a very common tree showed API a little above 50, therefore categorised as “moderate”. These species have well known economic -aesthetic values, fast growing and thus recommended for extensive planting. Thus, API might be useful in the selection of appropriate species.

Conclusion: In the industrial area, development of green belt has become essential to mitigate the issues of air pollution. The composition of air pollutant in the industrial region will vary from place to place depending of the source of pollution which in turn depends on the type of industry and number of industry. Our study reveals that evaluation of APTI and API of plants is useful in making appropriate selection of tree species to be grown in the industrial green belt for optimum results. APTI determination is significant because with the rise in air pollution there is subsequent rise in hazard to the existing flora. Moreover, bio monitoring of plants is an important tool to evaluate the impact of air pollution on trees.

In the present study Ficus bengalensis, Mangifera indica, Syzygiumcumini and Terminalia catappaare found to be tolerant and thus can be used as bio monitors for vehicular pollution stress.

References

1. Abida B and Ramaiah H M. (2010). Evaluation of some tree species to absorb air pollutants in three industrial locations of South Bengaluru, India. E-Journals of Chemistry, 7(S1): S151-S156.
2. Agarwal, R. M., & Tiwari, H. S. (1997). Growth of rice under different potassium doses and low external water potentials. Journal of Potassium Research,13(1), 58–62.
3. Allen (Jnr) LH, Boote KL, Jones JW et al (1987). Response of vegetation to rising carbon dioxide photosynthesis, biomass and seed yield of soybeans. Global Biogeochemical Cycle 13:1-44.
4. Arnon DI (1949). Copper Enzymes in Isolated Chloroplasts Polyphenol Oxidase in Beta vulgaris. Plant physiol. 2 (1): 1-15

5. Bajaj KL, Kaur G (1981). Spectrophoto-metric Determination of L. Ascorbic Acid in Vegetable and Fruits. Analyst. 106: 117-120
6. Chaphekar, S.B. (2000). Green belts for industrial areas. In: Yunus, M., Singh, N., Luit, J., de Kok (Eds.), Environmental Stress: Indication, Mitigation and Ecoconservation. Kluwer Academic Publishers, pp. 431-443
7. Cheng, Fang-Yi &Burkey, Kent & Robinson, J & Booker, Fitzgerald. (2008). Leaf extracellular ascorbate in relation to O_3 tolerance of two soybean cultivars. Environmental pollution (Barking, Essex : 1987). 150. 355-62.
8. Das, S. & Prasad, P. (2010). Seasonal variation in air pollution tolerance indices and selection of plant species for industrial areas of rourkela. Indian Journal of Environmental Protection. 30. 978-988.
9. Deepika, Parag G, and Haritash A.K., (2016). Air pollution tolerance of trees in an educational institute in Delhi,International Journal of Environmental Sciences Volume 6 No.6, 979-986.
10. Enete, Ifeanyi & Ogbonna, Chidi. (2012). Evaluation of Air Pollution Tolerance Index (APTI) Of Some Selected Ornamental Shrubs in Enugu City, Nigeria. IOSR Journal of Environmental Science, Toxicology and Food Technology. 1. 22-25.
11. Gharge, S., and Menon, G. S. (2012). Air Pollution Tolerance Index (APTI) of Certain Herbs from the Site Around AmbernathMIDC.Asian J. Exp. Biol. Sci. Vol 3 (3), 543-547.
12. Hamraz H., Niaraki A. S., Omati M., Noori N. (2014). GIS-Based Air Pollution Monitoring using Static Stations and Mobile Sensor in Tehran/Iran. International Journal of Scientific Research in Environmental Sciences.2 (12):435-448.
13. Jyothi S, Jissy& D.S., Jaya. (2010). Evaluation of air pollution tolerance index of selected plant species along roadsides in Thiruvananthapuram, Kerala. Journal of environmental biology / Academy of Environmental Biology, India. 31. 379-86.
14. Katiyar, V. and Dubey, P. S. (2001): Sulfur diox-ide sensitivity on two stage of leaf develop-mentin a tropical tree species. Indian Journal of Environmental Toxicology. 11: 78-81.
15. Khan, F. I. and Abbasi, S. A. (2001). Effective design of greenbelts using mathematical models. Journal of Hazardous Materials. 81: 33–65
16. Kumar, M.; Nandini, N. (2013). Identification and Evaluation of Air Pollution Tolerance Index of Selected Avenue Tree Species of Urban Bangalore, India, Int. J. Emerg. Technol. Comput. Appl. Sci., 13: 388-390
17. Lewin, S. (1976) Vitamin C: Its Molecular biology and medical potential, Academic press, London
18. Lopez, J. &Callén, Marisol & Murillo, Ramón & Garcia, Tomas & Navarro, Maria & de la Cruz, Teresa &Mastral, A. (2005). Levels of selected metals in ambient air PM10 in an urban site of Zaragoza (Spain). Environmental research. 99. 58-67.
19. Mingorance, M.D., Valdés, B., Olivioa, S.R. Strategies of heavy metal uptake by plants growing under industrial emissions. Environment International,33: 514–520 (2007)
20. Mondal, D., Gupta, S., Datta, J.K., 2011. Anticipated performance index of some tree species considered for green belt development in Environmental Toxicology. 11: 78-81.
21. Nugrahani, P., Prasetyawati, E.T., Sugijanto and Purnobasuki, H. (2012). Ornamental shrubs as plant palettes elements and bioindicators based on air pollution tolerance index in Surabaya city,Indonesia. Asian J. Exp. Biol. Sci., 3(2): 298-302.
22. Pathak V, Tripathi B, Mishra V (2011) Evaluation of anticipated Performance Index of some tree species for green belt development to mitigate traffic generated noise. Urban for Urban Green 10:61–66.
23. Prajapati, Santoshk& Tripathi, B. (2008). Anticipated Performance Index of some tree species considered for green belt development in and around an urban area: A case study of Varanasi city, India. Journal of environmental management. 88. 1343-9.
24. Prasad D, Choudhury (1992). Effects of air pollution In:Misra, S.G.(Ed):Environmental pollution Air, Environmental Pollution and Hazards Series. Venus Publishing House, New Delhi. pp. 58- 60
25. Prasanna, R.T., U.K. Deshpande and U.Gawaid (2005) Effect of sulphur dioxide on protein and carbohydrate contents of some macrophytes. Pollu. Resea, 24, 427-430.
26. Rai, P.K., Panda, L.L.S., Chutia, B.M. and Singh, M.M. (2013). Comparative assessment of air pollution tolerance index (APTI) in the industrial (Rourkela) and non-industrial area (AIZWAL) of India. An eco-managementapproach. Afr. J. Environ. Sci. Technol., 7(10): 944-948
27. Raza S.H. and Murthy, M.S.R. (1988): Air Pollution Tolerance index of certain plants of Nacharam Industrial Area, Hyderabed, Indian J. Bot 11(1). 91-95.
28. Singh S.K and Rao, D.N. (1983). Evaluation of the plants for their tolerance to air pollution Proc. Symp on Air Pollution control held at IIT, Delhi pp 218-224.
29. Swami, A. & Bhatt, D. & Joshi, Prakash. (2004). Effect of automobile pollution on Sal (Shorearobusta) and Rohini (Mallotusphillipinensis) at Asarori, Dehradun. Himal J Environ Zool. 18. 57-61.
30. Thambavani SD and Sabitha MA. Variation in air pollution tolerance index and anticipated performance index of plants near a sugar factory: implications for landscape-plant species selection for industrial areas. Journal of research in Biology, 2011; 7: 494-502.
31. Verma, A. (2003). Attenuation of automobile generated air pollution by higher plants. Dissertation, (unpublished). Univ. of Lucknow
32. Wagh ND, Shukla PV, Tambe SB, Ingle ST (2006). Biological monitoring of roadside plants exposed to vehicular pollution in Jalgaon city. J. Environ. Biol. 27(2):419-421.

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