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A review on Air Pollution Tolerance Index (APTI) and Anticipated Performance Index (API)

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Abstract

Now a day's air pollution is one of the serious problems around the world. Plants can filter the air via-aerial elements particularly through twigs, stems, leaves, etc. Afforestation program is the best way to control the air pollution. Air pollution tolerance index(APTI) is an intrinsic quality of trees to control pollution problems, which is currently of major concern of urban localities.The trees having higher tolerance index rate are tolerant towards air pollution and can be used as a source to control air pollution, whereas the trees having less tolerance index can be used asan indicator to know the rate of air pollution.By combining biochemical and aggregate factors the Anticipated Performance Index is prepared, which is also helpful in green belt development. The present review is based on the assessment of APTI and API potential of different plants for mitigating air pollution.

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Keywords

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API,
Air pollutants,
Pollution,
Biochemical parameters.

Introduction

Due to industrialization and urbanization, air pollution has turn out to be a serious problem. Now a day's particulate matter is the big concern due to their undesirable impact on plant and animal[1]. The recognition and classification of plants into tolerant and sensitive groups is essential because the sensitive plants can use as an indicator and the tolerant as a sink for the pollutants in city and developed habitats[2].Plants have a very close relationship with nature and if any altered condition occurs in the atmosphere, it directly affects the physiology and biochemistry of plant. Vegetation works as a sink for air pollution and reduce pollution level in the atmosphere[3]. Most plants experience internal changes before showing noticeable injure to leaves when they are open to air pollutants[4]. Hence, this review was conducted to assess the biochemical changes and its role in air pollution tolerance index, a major factor that gives sensitivity, tolerance to plants.

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Air pollution tolerance index indicate the potential of vegetation to encounter air pollution[5]. Plants naturally pure the air by consuming particulate matter and smoke. Sensitive tree species are suggested as bio-indicators[6].Vegetation shows dissimilar behaviour for various pollutants and all components of tree can be used as bio-monitors[7]. They are very significant for decisive and balancing ecology by nutrient cycling and gases. Directly and indirectly air pollution can affect plants by leaves and through soil acidification[8,9]. Several researchers agree that air pollutants affect plant growth adversely[10,11].Plants preliminarily accept air pollution thus, performs like a scavenger for pollutants[12]. As the trees are being continuously exposed to the environment, hence they attract, gather and combine pollutants impinging on their leaf surface; therefore they show noticeable or slight changes depending on their sensitivity level[13]. Physiological changes take place in plants when open to air pollutants before showing visible damage to the foliage[14]. Even leaves can act as natural filters that can eradicate great number of air borne pollutants and consequently recover the quality of air in polluted atmosphere[15]. On the other hand, this function of pollution abatement can be best performed by the pollution tolerant type[16]. Thus, air pollution tolerance index (APTI) is used to choose tolerant species and helps in monitoring plant tolerance towards air pollution. So assessment of plants on the basis of their level of tolerance to air pollution is essential. Consequently, APTI based on biochemical parameter is generally employed for recognising the tolerance level of plants.

Leaf Biochemical And Physiological Parameters

The tolerance level of different plants mainly depends upon the morphological and physiological characters. Various type of biotic, abiotic and physical factors control plants life, including temperature, humidity, soil chemistry, pH, oxygen levels and salinity. Plant species with high amount of ascorbic acid are considered to be tolerant to air pollutants. Chlorophyll is known as an important stress metabolites and higher chlorophyll content in plants might favour tolerance to pollutants. The character of plants changes location wise depending upon various environmental factors, so different species exhibit different tolerability in different places. Studies showed that in the polluted sites the tree leaves turned in to smaller size and the stomata also changes.

To work out API, socio-economic importance of the plants growing alongside the roads is studied through field survey and from the available literature. In order to study socio-economic importance, characters like plant habit, canopy structure etcis considered. By combining the biological and socio-economic characters like plant habit, canopy structure, type of plant, laminar structure and economic value mentioned above and resultant APTI is worked out, The API is calculated for the selected species. Based on these characters certain grades (positive or negative) are allotted to plants and are scored according to their grades. The gradation of plant species based on APTI as well as biological parameters and socio-economic importance has been presented in Table 1 and Table 2.

Table 1: Gradation of plant species based on APTI as well as biological parameters and socio-economic importance

Grading character	Pattern of assessment	Grade allotted*
Air pollution tolerance index	8.5 to 9.0	Positive
	9.1 to 9.5	Two Positive
	9.6 to 10.0	ThreePositive
	10.1 to 10.5	Four Positive
	10.6 to 11.0	Five Positive
Tree habit	Small	Negative
	Medium	Positive

	Large	Two Positive
Canopy structure	Sparse/Irregular/Globular	Negative
	Spreading	Positive
	crown/open/semi dense	Two Positive
	Spreading dense	
Type of tree	Deciduous	Negative
	Evergreen	Positive
Laminar Characters	Small	Negative
Size	Medium	Positive
	Large	Two Positive
Texture	Smooth	Negative
	Coriaceous	Positive
Hardiness	Delineate	Negative
	Hardy	Positive
Economic value	Less than three uses	Negative
	Three of four used	Positive
	Five or more used	Two Positive

*maximum grades are 16

Table 2: Rating used for Anticipated Performance Index of plant species

Grade	score	Assessment category
0	Up to 30	Not suggestion for plantation
1	31 to 40	Very poor
2	41 to 50	Poor
3	51 to 60	Moderate
4	61 to 70	Good
5	71 to 80	Very good
6	81 to 90	Excellent
7	91 to 100	Best

Methodology

By using the parameters like chlorophyll content, leaf pH extract, relative water content and ascorbic acid content, the APTI was computed by using the following equation:

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

Where;
A is ascorbic acid (mg/g), T is total chlorophyll (mg/g)
P is leaf extract pH
R is relative water content (%)

Air Pollution Tolerance Index (APTI)

Tiwari *et al.,17* evaluated the APTI of 52 plant species collected from iron and steel industry which is 11 km away from Raigarh district of Madhya Pradesh. They found that APTI of *Acacia nilotica* was minimum (5.21) and maximum (15.02) in *Ficusglomerata*. Lakshmi *et al.,*[18] examined the APTI of twenty four plant species around industrial area of Visakhapatanam and found that out of 24 plant *Ficusreligiosa* (Peepal) show highest APTI which is 25.77 and *Casuarinaequisitifolia* (Casuarina) show lowest APTI which is 6.51. Peepal, Jujube, Amla and Indian laburnum showed intermediate response to air pollution. Other twenty plants showed APTI value less than 16, so these are under sensitive one. Sulistijorini *et al.,*[19] selected eight plant species from polluted Jagorawi highway and unpolluted site of Sindangbarang field in Indonesia. Various physiological parameters of the trees were recorded. *Lagerstroemia speciosa* was found more tolerant towards air pollution, *Pterocarpusindicus, Delonixregia, Swieteniamacrophylla* were less tolerant and *Cinnamomumburmanii* is sensitive towords air pollution.Tripathi *et al.,*[20] evaluated the APTI of selected plant species growing alongside Moradabad city and Found that *Holopteleaintegrifolia, Saracaindica* and *Pithecolobiumdulcis* having highest APTI value i.e 55.8, 52.0 and 34.8 considered as

tolerant species. *Ficusrumphii, Azadirachtaindica* and *Greweliarobusta* (35.7, 30.5, 34.3) are less tolerant. *Alstoniascholaris, Cassia simea* and *Bauhinia variegata* (21.5, 6.09, 18.22) are susceptible species.Begum *et al.,*[21] examined the air pollution tolerance index of various tree species around different manufacturing areas of Bangalore city. Seventeen plant species were selected for evaluation and out of these *Syzygiumcumini*showed highest APTI value which is 16.1, 32, and 35 in three different industrial areas and considered as tolerant species followed by *Azadirachtaindica* and *Madhucalatifolia* Roxb. Gupta *et al.,*[22] evaluated the APTI of various plant species in Burdwan town, West Bengal. Ashok-*Saracaindica*, Debdaru-*Polyanthialongifolia*, Banyan-*Ficusbenghalensis*, Dumur-*Ficushispida*, Guava-*Psidiumguajava*, Sisoo-*Dalbergiasisoo*, Mango-*Mangiferaindica*, Chattim-*Alstoniascholaris*, Mahagunii-*Swieteniamahoganii*, Asattha-*Ficusreligiosa* were selected for evaluation and found that Banyan, Mango, Mahagunii and Asoke having highest API value.Tripathi *et al.,*[23] also studied the APTI of plants commonly growing around the industrial area of Varanasi. APTI was calculated by testing various parameters and API was calculated based on resultant APTI, biological and other socio economic characteristics of plants. Out of these plants *Ficusinfectoria* and *Ficusreligiosa* considered as tolerant species. Deepalakshmi *et al.,*[24] evaluated APTI of different plant species growing around the Bangalore city. Ten commonly growing plant species were selected and fresh leaf samples of these plants were collected and analysed. *Bougainvillea spectabilis* and *Ageratum conyzoides* are considered as more susceptible type, while *Ficusreligiosa*, *Bambusabambos* and *Terminaliacatappa* with reasonable changes are regarded as tolerant type.

While *Peltophorumpterocarpum* and *Portulacaoleraceae* with are regarded as comparatively resistant species. The trees of the previous group can be efficiently used as bio indicators of vehicle exhaust pollution, whereas the resistant trees can be employed as sinks for vehicular pollutants. In a similar investigation at Durgapur, Burdwan District, West Bengal of India, it was found that the highest APTI value (176.14) was noticed at Durgapur College Campus followed by 158.68 at Durgapur Projects Limited[25]. Tanee *et al.,*[26] evaluated the APTI of various plant species growing alongside the Umuebulu Gas Flare Station of Nigeria. Ten commonly growing plant species were sleeted for analysis; these are *Mallotusoppositifolus,Pueraniap haseoloides,Vernoniaamygdalina, Cymbopogon citrates, Manihotesculenta,Telfairiaoccidentalis, Musa paradisiacal*, and *Talinumtriangulare*. The results showed that out of these ten plant species *Psidiumguajava* having highest APTI and *Ocimumgrassitisimum* have lowest air pollution tolerance index. Babu *et al.,*[27] evaluated the From two sites, where one site is polluted area of a cement industry and another site is Yogi Vemana University campus. Ten samples were collected from each sites and analysed. In the polluted site APTI values were in the range of (7.38-10.12) and in the control site is (6.44-9.6). Out of the ten sample *Aeglemarmelos* having highest APTI values and *Ziziphuszizyphus* having lowest APTI values.Wang *et al.,*[28] investigated the Leaf dust holding qualities of three tree species growing around the campus of Xi'an University of Architecture & Technology located in the south of Xi'an. S. *japonica*, P. *acerifolia* and C. *deodara* were selected and found that P. *acerifolia* having highest particulate matter holding capacity. Bakiyaraj *et al.,*[29]. Studied the air pollution tolerance index of 11 plant species growing alongside the industrial area of Neyveli town of Tamil Nadu. Out of these eleven plant species *Eucalyptus sp* having highest APTI value (6.52) and *Murryakoenigii* showed lowest (0.81). Nwadinigwe[30] evaluated the air pollution tolerance index of six plant species around the urban area of Nigeria. *Anacrdiumoccidentale, Bougainvillea spectabilisMangiferaindica, Delonixregia, Ixoracoccinea*, and *Durantaerecta* were selected and out of these six plant species *Delonixregia* gave highest APTI value followed by *Bougainvillea spectabilis, Mangiferaindica, Durantaerecta, Ixoracoccinea* and *Anacrdiumoccidentale* (5.308 to 0.909, 4.904 to 0.001, 4.577 to 0.166, 4.508 to 0.002, 3.728 to 0.004 and 3.470 to 0.001). Bora *et al.,*[31]studied the APTI of six different plant species viz., *Saracaindica*(13.71), *Azadirachtaindica* (12.98), *Shorearobusta* (12.64), *Eucalyptus spp.* (12.61), *Ficusreligiosa* (12.61) and *Tectonagrandis* (13.33). According to anticipated performance index (API) all species were tolerant i.e. *Azadirachtaindica, Ficusreligiosa, Saracaindica, Shorearobusta* and *Tectonagrandis*. Madan *et al.,*[32] determined APTI and API of Ashok (*Polyalthialongifolia*), Peepal

(*Ficusreligiosa*), Mango (*Mangiferaindica*), Neem (*Azadirachtaindica*), Jamun (*Syzygiumcumini*), Guava (*Psidiumguajava*) growing alongside Haridwar. Out of these six plant species Mango showed highest APTI value and Ashok showed lowest. On the basis of API Peepal found very good type. Dhankar *et al.,*[33] selected 15 plant species (*F. religiosa, Syzygiumcumini, F. benjamina, Mangiferaindica, A. lebbeck, P. guajava, , F.virens, F. benghalensis , A. Indica, Saracaasoca, Z. mauritiana, P. glabra, E. Oblique, A. scholaris* and *B. Variegate*) for evaluation of air pollution tolerance index around Rohtak City. Out of the 15 tree species *F.virens* and *E. Oblique* were selected for green belt development. Muhammed Aji *et al.,*[34] selected three different sites for evaluation of APTI in Maiduguri. 6 plant species were selected on the basics of their abundance. The study showed that *Mangiferaindica* having highest APTI value which is (30.02) and *Cassia angustifolia* having lowest (14.24). *Khayasenegalensis, Eucalyptus spp* and Azadiractaindica are moderate species (28.61, 24.10 and 28.23). *Akilan et al.,*[35] studied APTI values of the four selected species viz, *Tamarindusindicus* (Tamarind), *Neerium oleander*(Oleander), *Azadirachtaindica*(Neem) and *Pongamiapinnata* (Karanj). Three different study areas were selected for calculation namely Arcot (automobiles),Ranipet (Industries) and College farm (less automobile transport and industries) located in Vellore district, Tamil Nadu. Among the four selected species,higher APTI found in *Neeriumoleander* which is (11.25 20.51 18.01), *Tamarindusindicus* (10.18 16.55 17.55), *Azardictaindica* (9.73 14.31 12.72), *Pungamiapinnata* (10.79 15.55 13.07). Gholami *et al.,*[36] determined APTI of 6 tree species in Ahvaz, Iran. Plant species were selected from blank area and polluted area and analysed. Out of these six plant species Myrtus has highest APTI value (7.21) and *Prosopis* having lowest (4.57). *Ziziphus* was selected as the plant susceptible to air pollution in this study. In addition, the results of assessment of the above mentioned index showed that plants with higher APTI can be used as reducers of pollution and plants with lower APTI can be used to measure air pollution. In Indore city (MP) Patidar *et al.,*[37] studied the impact of vehicular pollution on the plants growing along the A.B road. The study was done by selecting five heavily polluted sites of the Agra-Bombay highway (NH-3). *Thevetianeriifolia, Magniferaindica, Psidiumguajava* plants were selected due to their abundance in that road. Proline and Chlorophyll content are analyzed. They found that at most of the sites chlorophyll content was decreased in the foliage of the studied vegetation as compared with the plants of reference site while proline content was increased when compared with the reference site. Results of the current study shown that chlorophyll contents in all the vegetation varied with the pollution status of the site i.e.chlorophyll content of foliage decreases in the highly polluted area. It was concluded that these parameters are highly significant in understanding the plant-environment interactions and are used for developing of bio-indicator groups. Ogunrotimi *et al.,*[38] evaluated the sensitivity and tolerance levels of the 12 tree species from 3 major roads to airpollution using APTI and results showed that the APTI of the tree species ranged between 9.2 and 12.7 the highest in case of the highest value was obtained in *Polyalthialongifolia* and the lowest value in *Psidumguajava*. It was concluded that *P. longifolia, M. indica, G. arborea, T. grandis* and *T. catappa* were the most tolerant to air pollution of all the tree species. Jyoti *et al.,*[39] studied APTI values of the five selected species i.e. *FicusReligiosa, Delonixregia, Polyalthialongifolia, Plumeria sp.* And *Azadirachtaindica* on the highly polluted roadside of Noida sector 78. For evaluation of its tolerant limit four physiological and biochemical parameters namely Relative water content, leaf extract pH, Ascorbic acid, and chlorophyll content were analyzed. The results showed that *Polyalthialongifolia* is very sensitive to pollution and *Plumeria* and *Delonixregia* are comparatively less sensitive to air pollutants. Aasawari *et al.,*[40] evaluated APTI of ten roadside tree species selected from polluted and control area in Thane city. The study shows that the control site has more APTI than the polluted site. The APTI observed minimum in *Tectonagrandis* 5.2±0.3247 and maximum in *Azadirachtaindica* 13.5±0.4404. Reduction in APTI at polluted site shows that *Alstoniascholaris* (6.6%), *Tamarindusindica* (8.8%) and *Azadirachtaindica* (10.3%) were the most tolerant tree species, while *Tectonagrandis* (47.5%), *Acacia nilotica* (27.4%) and *Cassia fistula* (20.7%) were more sensitive tree species. The results showed the order of tolerance (% difference in APTI) as *Alstoniascholar* (6.6%)> *Tamarindusindica* (8.8%)>*Azadirachtaindica* (10.3%)> *Moringapterygosperma* (11.9%)>*Mangife*

raindica(13.9%)>*Bahunia variegate*(14.3%)>*Annon asquamosa*(18.7%)>*Cassia fistula* (20.7%)>*Acacia nilotica* (27.4%)>*Tectonagrandis* (47.5%). Maysoon *et al.,*[41]evaluated the Air Pollution Tolerence Index of two plant species in Babylon provinus and The results showed the plant *Conocarpuslancifolius* can be tolerant towards air pollution in comparison with plant *Dodonaeaviscosa* that consider as sensitivity to air pollution.

Table 3: Biochemical parameters along with APTI of plant species

Author and Location	Year	Plant species (vegetation)	(Air Pollution Tolrance Index)
P. SUVARNA LAKSHMI, K. LALITHA SRAVANI, AND N. SRINIVAS INDUDTRIAL AREA OF VISAKHAPATANAM	2008	*Ficusreligiosa (Peepal), Zizypus jujube (Jujube) Phyllanthusemblica (Amla), Cassia fistula (Indian laburnum), Tamarindusindica (Tamarind), Anacardiumoccidentalis (Cashew) ,Neriumodorum (Sweet scented oleander) ,Polyalthialongifolia (Ashoka), Acacia melanoxylon (Blackwood) ,Psidium guava (Guava) Azadirachtaindica (Neem), Helianthus spp. (Sunflower), Morus alba (Mulberry), Mangiferaindica (Mango) ,Ficusbengalensis (Banyan) ,Eucalyptus spp.(Eucalyptus) Pongamiapinnata (Indian beach), Anonasquamosa (Custard apple) ,Syzygium spp. (Black plum), Artocarpus spp. (Jack fruit), Acacia arabica (Babool) ,Achrassapota (Sapota),Delonixregia (Gulmohar) Casuarinaequisitifolia (Casuarina)*	25.77, 22.32, 18.88, 18.69, 16.24, 15.69, 15.36, 15.10 14.73, 14.08, 13.55, 12.82, 11.82, 11.70, 11.34, 10.64, 10.09, 9.34, 9.07, 8.81, 8.49, 8.42, 6.51
B. K. THAKAR AND P. C. MISHRA VEDANTA ALUMINIUM LIMITED, JHARSUGUDA	2010	*TectonaGrandis , FicusGlomerataSyzigiumCumini , Eucalyptus Citriodora,DiospyrosMelanonylon ,FicusReligiosa PongamiaPinnata ,Mimusopseleng,iShorearobusta ,Ficusbengalensis, Delonixregia, Buchanialanzen, Polyalthialongifolia, Mangiferaindica, Azadirachtaindica, Bombaxceiba, Gmelinaarborea, Anthocephaluschinesis, Acacia Arabica, Sghleicheraoleosa, Buteamonosperma, Madhucaindica Aeglemarmelos , DalbergiasisooBambusa bamboos, Cuscutareflexa ,Ziziphus jujube, Artocarpusheterophy, Calotropis gigantean , Lantana camara, Tabernamontanadivaricata Annonasquamosa, Psidiumguyava , Ceasalpinia Tamarindusindica , Bogainvilleaspectabilis,Pithocolobiumdulce Anacardiumoccidentale, Ailanthus excelsa , Holarrhena,Pubescens*	20.97,19.23,19.02,18.11,23.99, 23.89,20.34,16.32,23.9224.14, 18.65,13.96,23.34,29.74,22.41, 16.89,13.32,17.9216.74,22.56, 19.92,23.71,19.31,26.92,18.32, 13.37,18.2724.85,17.89,14.26, 15.89,17.44,26.69,16.78,23.14, 27.2214.43,22.17,25.34,17.42
MOHAMMED KUDDUS, RASHMI KUMARI AND PRAMOD W. RAMTEKE ALLAHABAD CITY	2011	*Mangiferaindica, Aeglemarmelos Rosa indica, Azadirachtaindica Citrus lemon, Eucalyptus sp. Artocarpus sp*	*18.51,14.49,12.79,12.29,12.27* 11.54,8.75

DALMIA, SALEM, TAMIL NADU		*excels, Melia composite, Polyalthialongifolia*	±0.25,6.67±0.41,4.71±0.00,2.2 *25±0.30*
MOHAMMED M. AJI, ADAMU M. ADAMU AND MOHAMMED B. BORKOMA MAIDUGURI	2015	*Anacardiumoccidentale, Azadiractaindica Cassia angustifolia Eucalyptus sppKhayasenegalensis, Mangiferaindica*	29.65, 28.23, 25.12 , 24.10, 28.61, 30.21
DEEPIKA, PARAG GOUR, HARITASH A.K. DELHI TECHNOLOGICAL UNIVERSITY	2016	*Magniferaindica, Syzygiumcumini,Saracaasoca, Ailanthus altissima, Bombaxceiba, Ficusreligiosa, Dalbergiasissoo, Azadirachtaindica, Ficusvirens, Ficusbenghalensis Neolamarckiacadamba, Thevetiaperuviana, Alstoniascholaris Bauhivia variegate, Eucalyptus globules, Bougainvillea glabra, Buteamonosperma, Terminaliaarjuna, MeliaAzedarach Lagerstroemia indica, Delonixregia*	28.1,10.7,8.4,9.9,8.9,21.7,10.8, 17.9,8.8, *1*9.9,15.5,5.9,6.6,10.6,12.4,13. 0,13.4,10.113.0,9.0,12.6
MOUMITA DAS, SHARMISTHA GANGULY, SWASTIKA BANERJEE, AMBARISH MUKHERJEE BURDWAN UNIVERSITY, BURDWAN IN WESTBENGAL	2016	*Alternantherasessilis, Antigononleptopus Hook. &Arn.,Boerhaviarepens L. , Desmodiumgangeticum (L.) DC., Elephantopusscaber L.,GlobbabulbiferaRoxb., Oplismenuscompositus (L.), Ruelliatuberosa L., Tridaxprocumbens (L.) L.*	35.35, 61.20, 45.86, 51.45, 41.74,46.92,44.95,56.31,44.53
IBIRONKE OKUNLOLA, AKINOLA O. ADEPOJU AND SAMUEL O. AGELE AKURE ONDO STATE, SOUTHWEST NIGERIA	2016	*Ficusspp , Tabebuiarosea, Delonixregia, Polyalthialongifolia Raphiafarinifera, Croton variegatumDurantaerecta, Duranta golden*	6.31, 9.31 ,7.57 ,6.74 ,5.11,5.94,5.78,5.81
JYOTI KUMARI AND DR. SURINDER DESWAL NOIDA, UTTAR PRADESH	2017	*FicusReligiosa, DelonixRegia, PolyalthiaLongifolia Plumeriasp.,AzadirachtaIndica*	10 , 11, 6, 11, 9

Anticipated Performance Index (API)

Gupta *et al.,*[42] calculated the APTI and API of 10 tree species in Burdwan town, West Bengal. Out of the ten tree species Banyan (*Ficusbenghalensis*), Mango (*Mangiferaindica*), Mahagunii (*Swieteniamahoganii*), Asoke (*Saracaindica*) having excellent API value, Guava (*Psidiumguajava*) is very good, Debdaru (*Polyanthialongifolia*) and Asattha (*Ficusreligiosa*) are good, Sisoo (*Dalbergiasisoo*) is moderate, Chattim (Alstoniascholaris) and Dumur (*Ficushispida*) showed Very Poor API values. Pathak *et al.,*[43] evaluated the APTI of some plant species growing alongside Varanasi city, Uttar Pradesh 35 plant species were selected for evaluation of API and out of these species *Ficusinfectoria*, *Mangiferaindica* and *Ficusreligiosa* were classified under the 'excellent' category. Mondal *et al.,*[44] determined the Air pollution Tolerence Index(APTI) of ten plant species

collected from Burdwan town, West Bengal. High value of APTI was found in *Pisidiumguajava* which is 31.75% and lowest APTI found in *Ficushispida* which is 13.26%. The API was also calculated by considering the APTI and other parameters. On the basis of API Banyan, Mango, Mahagunii and Asoke were suitable for green belt development. Chavan *et al.,*[45] evaluated the API of different plants growing around the Aurangabad city and found that *Azadirachataindica* and *Mangiferaindica* were the tree species having good API value because of their biochemical and socioeconomic characters while *Polyalthialongifolia* and *Dalbergiasissoo* were having moderate and poor API value respectively. Esfahani *et al.,*[46] evaluated the anticipated performance index of various plant species in green belt of Isfahan, Iran. Tolerant plant species to air pollution were identified on the basis of their API values. Study showed that air pollution tolerance index in identifying resistant species to air pollution is more appropriate than anticipated performance index in semiarid areas like Isafahan. It has been noted that API is beneficial too, when it is calibrated for arid and semiarid areas. Ogunkunle *et al.,*[47]calculated API of four plant species growing alongside the University of Ilorin, by combining air pollution tolerance index and anticipated performance index. The plant species selected for study were, *Vitellariaparadoxa*, *Acacia nilotica* and *ProsopisAfricana* have API value 4 which is good, *Prosopisafricana,Acacianilotica* and *Terminaliacatappa* shown API value 3 which is moderate. So *Vitellariaparadoxa* could be used as green belt development.Field study was conducted by Kapoor *et al.,*[48] to assess the anticipated performance index of plants growing alongside the National Highway 21 revealed that comparison of the grading parameters by their summation for the API showed a variation in the plant species from a very poor to very good scale. Among the four plant species selected *Toonaciliata* with highest API was in the very good category followed by *Ficuscarica* and *Meliaazediractain* the poor and *Morusalba* under the very poor category. *Toonaciliata* was the most tolerant species among the selected plants and also this species has the high economic and aesthetic value. The study further signifies that *Toonaciliata* can be recommended for plantation in the polluted areas.The study concluded that all the biochemical, physiological, biological as well as socio-economic parameters of the plant species play an important role in determining the sensitivity and tolerance of plants to air pollution. The data related to total chlorophyll content, Ascorbic acid content, Relative water content, pH of leaf extract and APTI have been summarised in Table -3.

Based upon API, Gupta et al have identified the Arjun and Morus plant species as very good performers out of four plant species viz. Arjun, Morus, Sheesham and Ashok at Delhi[49] . Hence, these workers have suggested Arjun and Morus plants can be used for the greenbelt development purpose in the Delhi region. Their study included the dustfall deposition on the foliar in Delhi region. The APTI values of their study suggested that all the four species were sensitive and can be used as biological indicators.

Conclusion

The extensive review has focussed on the measurement and monitoring of APTI and API of plant species growing alongside the Roads and industrial areas. These are useful tools to assess the tolerance level of plant species towards air pollution. The tolerant plant species can be used as pollution sink and help in controlling and mitigating the adverse impacts from air pollution. Plants having high APTI and API value are selected for the green belt improvement and helpful in long term air pollution management in city and developed areas. On the basis of review many plant species are found to be tolerant towards air pollution and are suitable for planting around industrial area and roadsides.

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Conflict of Interest

There is no conflict of interest in the present study.

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