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CHOICE OF SELECTION OF TREE SPECIES FOR GREEN BELT DEVELOPMENT IN TARAPUR INDUSTRIAL AREA

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ABSTRACT

The current study was carried out to evaluate the diversity of tree species found in a highly industrialized areaof Tarapur, Maharashtra, India; to assess the age of the tree species based on their Diameter at Breast Height (DBH) and heightclasses, and to evaluate their suitability for green belt development.Air Pollution Tolerance Indexstudy performed during 2 dry seasons suggested thatPollution sensitive trees like *Bauhinia purpurea, Delonixregia, Nyctanthes arbor-tristis*, *Peltophorum pterocarpum* and *Psidium guajava* should be planted along residential areas as they serve as bio-indicators of pollutants. While Pollution tolerant evergreen trees like *Ficus religiosa, Manilkara zapota, Pongamia pinnata, Putranjiva roxburghii* should be planted along the roads, highways and near heavily polluting industries in order to absorb more pollutants from the ambient environment as they serve as sinks for pollution.

Keywords: Tree diversity, D.B.H, Air Pollution Tolerance Index (A.P.T.I.), pollution tolerant trees, pollution sensitive trees, green belt development.

INTRODUCTION

The benefits of trees and their uses range not only from aesthetic to economical but ecological as well and they symbolize one of the significant components of terrestrial ecosystem. A tree surface accumulates a variety of natural and anthropogenic particles from the atmosphere and hence functions as an effective sink for pollutants

[1]. Trees remove gaseous air pollution mainly by uptake via leaf stomata, though some gases are removed by the tree surface. Once inside the leaf, gases diffuse into intercellular spaces and may be absorbed by water films to form acids or react with inner-leaf surfaces [2].

Plant leaves function as a proficient gas exchange system. Their anatomical structure allows rapid diffusion of water soluble gases. These characteristics allow the plant to respire and photosynthesize along with removing pollutant from the air. [3]reported that air pollution levels are reduced when windblown particulates (PM2.5 and PM10) stick to the leaves and stems of plants. Similarly, gaseous air pollutants particularly carbon dioxide, can be dissolved or sequestered through stomata on plant leaves [4].

[5]calculated that daytime temperature reduction due to trees would decrease the dependence on air conditioning and reduce emissions of NO_x from coal fired electricity plants resulting in an estimated 10% reduction in smog precursors or a reduction of 350 tons of NO_x per day.

Thus the main objective of the current study was to evaluate the diversity of tree species in a highly industrialized area, to assess the health of the tree species and also to evaluate the tree species for their suitability for green belt development.

MATERIALS AND METHODS

1) Types of roads surveyed:

For convenience of survey, roads from two main locations were studied i.e. Industrial area and Residential area of Tarapur. Both areas were then divided into two categories:

1. Primary Roads/ Main Roads:
   Long and broad roads carrying heavy traffic that ultimately form main traffic arteries.

2. Secondary Roads:
   The primary Roads that bifurcate to form secondary roads which are less wide and ultimately branch to form capillaries of road networks.

2) Survey methodology:

Initially a survey was carried out to identify the tree species located on both sides of the roads and to record their frequency. In later visits, tree trunks were measured to record their girth and approximate height. Diameter at Breast Height (D.B.H.) was evaluated by measuring circumference of the trees at a height of about 1.3m and converting to diameter. Based on D.B.H. values, plant species were differentiated in various categories (Table 1).

3) Air Pollution Tolerance Index (APTI):

Leaf samples were collected from 30 different tree species found in Tarapur industrial area during summer and winter season (2014) (Table 3). The leaves brought to laboratory were cleaned with

distilled water to get rid of dust particles and fresh weight was taken immediately. Fresh leaf samples were then analyzed for Ascorbic acid content [6], Leaf-extract ph [7], Total chlorophyll [8] and Relative water content [9].Air Pollution Tolerance Index for plants was calculated using the formula given by Singh and Rao [7]:

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

Where, A =Ascorbic Acid (mg/g)

T =Total Chlorophyll (mg/g)

P = pH of the leaf extract

R = Relative water content of leaf (%).

RESULTS AND DISCUSSIONS

In the present study, the trees were categorized into three D.B.H. and height classes as given by [10] which provided information of their age group. D.B.H of trees is grouped as follows:

i) 5-10 cms - indicating trees < 6 years old.

ii) 10-30 cms - indicating trees between 6 to15 years old.

iii) 30 cms and above – indicating trees > 15 years of age.

The trees height classes in which trees have been classified are as follows:

i) 1.5- 5 m - Short trees.

ii) 5- 10 m - Tall trees.

iii) Above 10 m – Very tall trees.

Each tree was noted for its species, frequency, D.B.H. and approximate height. The percentages of trees present in terms of different D.B.H. and height classes were calculated from the total number of trees

along for each road studied. The above exercise was thus carried out for each individual road as well as for all the Roads together in a category.

The various parameters recorded at two categories of roads along industrial area and residential area of Tarapur is summarized in Table 1.

It wasobserved that the maximum number of old trees were present along the main roads of industrial area with 60% of the trees being very old. The number of mature trees (6-15 years) was highest along main roads and secondary roads of residential area with 55% and 54% of the trees falling in this category. Trees under the age group of 6 years were observed more at the secondary roads of industrial area with 9% of trees being in the D.B.H. group of 5-10 cms. This might be due to awareness of authorities to maintain the plantations while constructing roads.

The tallest trees were recorded at main roads of industrial area with 20% of trees being above 10 m in height. Maximum number of tall trees (57%) was again seen along main roads of industrial area. Shorter trees were noted on secondary roads and main roads of residential area with 46% and 44% of their trees belonging to 1.5-5m height class.

The older plantation along the main roads of industrial area comprises mainly of tree

species like *Ficus benghalensis, Peltophorum pterocarpum, Acacia auriculiformis, Mangifera indica* and *Polyalthia longifolia* being around 15-20 years old.

During the field survey, 75 species of trees belonging to 30 families were recorded. Dominant families of the trees were Leguminosae and Moraceae. Details of the tree species found around industrial and residential areas of Tarapur are given in Table 2. The most common trees found during the survey were *Acacia auriculiformis, Casuarina equisetifolia, Eucalyptus sps., Ficus benghalensis, Mangifera indica, Leucaena leucocephala, Polyalthia longifolia* and *Peltophorum pterocarpum*.

Table 1: D.B.H. and Height along with total number of trees along different types of roads

No	Types of roads	Running kms surveyed	Total no. of trees	D.B.H. Class in %			Height class in %		
				5-10 cms	10-30 cms	30-> cms	1.5-5m	5-10m	10m->
1	INDUSTRIAL AREA								
	Main Roads	18.3	391	6.52	38.01	60.34	22.44	57.56	20
	Secondary Roads	10.3	384	9.08	45.89	40.16	43.51	48.78	7.72
2	RESIDENTIAL AREA								
	Main Roads	10.8	644	7.81	55.22	36.97	44.42	51.62	3.96
	Secondary Roads	10.4	755	6.05	54.66	39.29	46.13	52.23	2.59

Table 2: Details of tree species found in Tarapur area

NO.	PLANT SPECIES NAME	FAMILY	SUB-FAMILY	COMMON NAME	TOTAL NUMBER OF TREES
1	*Acacia auriculiformis*Benth	Leguminosae	Mimosaceae	Australian babul	141
2	*Acacia catechu* (L.f.) Willd.	Leguminosae	Mimosaceae	Khair	11
3	*Acacia nilotica* (L.) Dilile	Leguminosae	Mimosaceae	Babul	8
4	*Albiziasaman* (Jacq.) Merr.	Leguminosae	Mimosaceae	Rain tree	54
5	*Alstoniascholaris*L. R. Br.	Apocynaceae	–	Saptaparni	7
6	*Anacardiumoccidentale* L.	Anacardiaceae	–	Kaju	1
7	*Annonasquamosa* L.	Annonaceae	–	Custard apple	3
8	*Areca catechu* L.	Arecaceae	–	Supari	8
9	*Artocarpusaltilis*(Parkinson ex. F.A. Zorn) Fosberg	Moraceae	–	Bread fruit	1
10	*Artocarpusheterophyllus* Lam.	Moraceae	–	Jackfruit	39
11	*Araucaria columnaris*(G.Forst.) Hook.	Araucariaceae	–	Christmas tree	2
12	*Azadirachta indica* A. Juss.	Meliaceae	–	Neem	60
13	*Barringtoniaasiatica*(L.) Kurz.	Lecythidaceae	–	Samudrafal	3
14	*Bauhinia acuminata*L.	Leguminosae	Fabaceae	Apta	9
15	*Bauhinia purpurea* L.	Leguminosae	Fabaceae	Kanchan	11
16	*Bombaxceiba* L.	Bombacaceae	–	Katesavar	2
17	*Borassusflabellifer* L.	Arecaceae	–	Tad	8
18	*Buteamonosperma* (Lam.) Taub.	Leguminosae	Fabaceae	Palas	2
19	*Callistemon viminalis*(Sol.ex Gaertn.) G. Don	Myrtaceae	–	Bottlebrush	1
20	*Carica papaya*L.	Caricaceae	–	Papaya	4
21	*Cascabelathevetia* L. Lippold.	Apocynaceae	–	Bitti	8

NO.	PLANT SPECIES NAME	FAMILY	SUB-FAMILY	COMMON NAME	TOTAL NUMBER OF TREES
22	*Cassia fistula* L.	Leguminosae	Caesalpiniaceae	Indian laburnum	4
23	*Casuarinaequisetifolia* L.	Casuarinaceae	–	Suru	120
24	*Ceibapentandra* L. Gaertn.	Bombacaceae	–	Savar	8
25	*Cocosnucifera* L.	Arecaceae	–	Coconut	41
26	*Cordiasebestena* L.	Boraginaceae	–	Scarlet cordia	2
27	*Couroupitaguianensis* Aubl.	Lecythidaceae	–	Cannonball	14
28	*Dalbergia latifolia* Roxb.	Leguminosae	Fabaceae	Kala shisham	2
29	*Dalbergia sissoo* DC.	Leguminosae	Fabaceae	Shisham	2
30	*Delonixregia* (Hook.) Raf	Leguminosae	Caesalpiniaceae	Gulmohar	27
31	*Erythrinavariegata* L.	Leguminosae	Fabaceae	Pangara	2
32	*Eucalyptus sps.*	Myrtaceae	–	Nilgiri	145
33	*Ficus benghalensis* L.	Moraceae	–	Vad, Banyan	103
34	*Ficusbenjamina* L.	Moraceae	–	Benjamin's fig	2
35	*Ficushispida* L.	Moraceae	–	Kala umbar	9
36	*Ficuselastica* Roxb. exHornem.	Moraceae	–	Indian Rubber tree	1
37	*Ficusracemosa* L.	Moraceae	–	Umbar	9
38	*Ficusmicrocarpa* L.f.	Moraceae	–	Chinese banyan	2
39	*Ficusreligiosa* L.	Moraceae	–	Pipal	7
40	*Gardenia jasminoides* J.Ellis	Rubiaceae	–	Anant	4
41	*Gliricidiasepium* (Jacq.) Walp.	Leguminosae	Fabaceae	Giripushpa	51
42	*Grewiatiliifolia* Vahl.	Tiliaceae	–	Dhaman	5
43	*Lagerstroemia speciosa* (L.) Pers	Lythraceae	–	Taman	13
44	*Leucaenaleucocephala* (Lam.) de Wit	Leguminosae	Mimosaceae	Safed Babul	178
45	*Mangifera indica* L.	Anacardiaceae	–	Mango	168
46	*Manilkarazapota* (L.) P. Royen	Sapotaceae	–	Chikoo	32
47	*Millingtoniahortensis* L.f.	Bignoniaceae	–	Tree jasmine	15
48	*Morindacitrifolia* L.	Rubiaceae	–	Bartondi	11
49	*Morindapubescens* J. E. Sm.	Rubiaceae	–	Noni	13
50	*Moringaoleifera* Lam.	Moringaceae	–	Shevga	18
51	*Muntingiacalabura* L.	Muntingiaceae	–	Singapore cherry	12
52	*Nyctanthes arbor-tristis* L.	Oleaceae	–	Parijatak	7
53	*Peltophorumpterocarpum* (DC.) K.Heyne	Leguminosae	Caesalpiniaceae	Copper pod tree	226
54	*Phoenix sylvestris* (L.) Roxb.	Arecaceae	–	Khajur	11
55	*Phyllanthusemblica* L.	Phyllanthaceae	–	Amla	4
56	*Pithecellobiumdulce* (Roxb.) Benth.	Leguminosae	Mimosaceae	Vilayti chinch	11
57	*Plumeriaobtusa* L.	Apocynaceae	–	Chafa	16
58	*Plumeriarubra* L.	Apocynaceae	–	LalChafa	14
59	*Polyalthia longifolia* (Sonn.) Thwaites	Annonaceae	–	False Asoka	198

NO.	PLANT SPECIES NAME	FAMILY	SUB-FAMILY	COMMON NAME	TOTAL NUMBER OF TREES
60	*Pongamiapinnata* (L.) Pierre	Leguminosae	Fabaceae	Karanj	21
61	*Psidiumguajava* L.	Myrtaceae	–	Guava	4
62	*Putranjivaroxburghii* Wall.	Putranjivaceae	–	Putranjiva	30
63	*Roystonearegia* (Kunth) O.F. Cook	Arecaceae	–	Bottle Palm	47
64	*Sennasiamea* (Lam.) H.S. Irwin &Barneby	Leguminosae	Caesalpiniaceae	Kashid	14
65	*Spathodeacampanulata* P. Beauv.	Bignoniaceae	–	Pichkari	35
66	*Streblusasper* Lour.	Moraceae	–	Kharoti	1
67	*Syzygiumcumini*(L.) Skeels	Myrtaceae	–	Jamun	13
68	*Tabernaemontanadivaricata* R.Br. ex Roem. &Schult.	Apocynaceae	–	Tagar	2
69	*Tamarindus indica* L.	Leguminosae	Caesalpiniaceae	Imli	14
70	*Tectonagrandis* L.	Verbenaceae	–	Sag	14
71	*Terminaliaarjuna* (Roxb.) Wight &Arn.	Combretaceae	–	Arjun	2
72	*Terminaliacatappa*L.f.	Combretaceae	–	Badam	54
73	*Terminaliacrenulata* Roth	Combretaceae	–	Ain	6
74	*Thespesia populnea*(L.) Sol. ex Corrêa	Malvaceae	–	Bhend	23
75	*Ziziphusjujuba* Mill.	Rhamnaceae	–	GhatBor	4

Table 3: Air pollution tolerance index of trees from industrial area of Tarapurin summer and winter season

No	Plant species name	Ascorbic acid content (mg/g)		Total chlorophyll content (mg/g)		Leaf extractpH		Relative water content (%)		APTI	
		S	W	S	W	S	W	S	W	S	W
1	*Acacia auriculiformis*	0.93	0.34	0.63	0.15	6.82	6.05	83.66	86.36	9.06	8.88
2	*Albiziasaman*	0.54	0.41	0.92	0.56	6.34	6.52	58.33	75.78	6.22	7.86
3	*Alstoniascholaris*	0.70	1.05	0.76	0.79	5.93	5.95	80.23	83.99	8.49	9.11
4	*Annonasquamosa*	0.50	0.12	0.46	0.33	6.04	5.02	72.73	74.14	7.59	7.49
5	*Artocarpusheterophyllus*	0.60	0.47	0.53	0.37	6.63	6.53	66.67	76.76	7.10	8.00
6	*Azadirachta indica*	1.40	1.37	0.37	0.44	6.30	6.11	75.37	71.75	8.47	8.10
7	*Bauhinia purpurea*	0.35	0.59	0.40	0.37	6.63	3.00	61.78	71.71	6.43	7.59
8	*Buteamonosperma*	0.67	0.60	0.51	0.33	6.61	6.23	80.25	77.63	8.50	8.18
9	*Cassia fistula*	1.15	1.95	0.68	0.65	6.47	7.10	76.25	80.74	8.45	9.47
10	*Delonixregia*	0.31	0.11	0.57	0.23	6.73	6.92	64.00	84.11	6.63	8.48
11	*Ficus benghalensis*	0.16	1.00	0.14	0.58	6.82	5.54	92.59	83.32	9.37	9.07
12	*Ficushispida*	0.14	0.83	0.65	0.44	6.39	5.11	87.69	92.46	8.87	9.81
13	*Ficusracemosa*	0.76	1.18	0.38	0.36	5.86	5.23	95.56	90.18	10.03	9.75
14	*Ficusreligiosa*	0.22	0.80	0.70	0.68	6.52	5.24	87.03	73.38	8.86	7.91
15	*Gardenia jasminoides*	0.65	0.56	0.76	0.10	6.36	6.17	72.32	80.02	7.70	8.36
16	*Gliricidiasepium*	0.66	1.15	0.39	0.27	6.33	6.12	52.61	76.89	5.71	8.45
17	*Lagerstroemia speciosa*	0.15	1.78	0.33	0.28	5.49	5.68	70.25	72.51	7.11	8.31
18	*Mangifera indica*	2.49	0.49	0.52	0.50	6.69	6.25	92.83	86.93	11.08	9.04
19	*Morindacitrifolia*	1.29	1.31	0.81	0.59	6.35	6.27	81.31	85.74	9.06	9.48
20	*Morindapubescens*	1.86	1.07	0.68	0.59	6.40	5.53	43.37	77.26	5.65	8.47
21	*Nyctanthes arbor-tristis*	0.60	0.68	0.47	0.53	6.40	6.35	64.43	64.07	6.86	6.88
22	*Peltophorumpterocarpum*	0.04	0.61	0.71	0.69	6.49	6.09	65.22	69.58	6.55	7.40
23	*Plumeriaobtusa*	0.35	0.84	0.71	0.45	5.99	5.79	81.41	85.83	8.38	9.12
24	*Polyalthia longifolia*	0.27	0.12	0.44	0.40	6.75	6.60	90.98	88.39	9.29	8.93
25	*Pongamiapinnata*	1.32	1.85	0.83	0.33	6.98	6.86	83.53	76.48	9.38	9.00
26	*Psidiumguajava*	1.56	1.55	0.30	0.29	6.59	6.3	57.76	61.19	6.85	7.19
27	*Putranjivaroxburghii*	8.21	8.48	0.48	0.57	6.34	6.15	90.06	93.88	14.61	15.24
28	*Sennasiamea*	0.42	0.86	0.69	0.60	5.85	5.45	76.22	80.87	7.89	8.64

No	Plant species name	Ascorbic acid content (mg/g)		Total chlorophyll content (mg/g)		Leaf extractpH		Relative water content (%)		APTI	
		S	W	S	W	S	W	S	W	S	W
29	*Syzygiumcumini*	0.38	0.51	0.44	0.23	6.33	6.13	66.06	89.84	6.86	9.32
30	**Tamarindus indica**	0.08	0.80	0.37	0.39	3.66	3.60	79.79	83.49	8.01	8.67

S = summer season, W = winter season, APTI = Air Pollution Tolerance Index
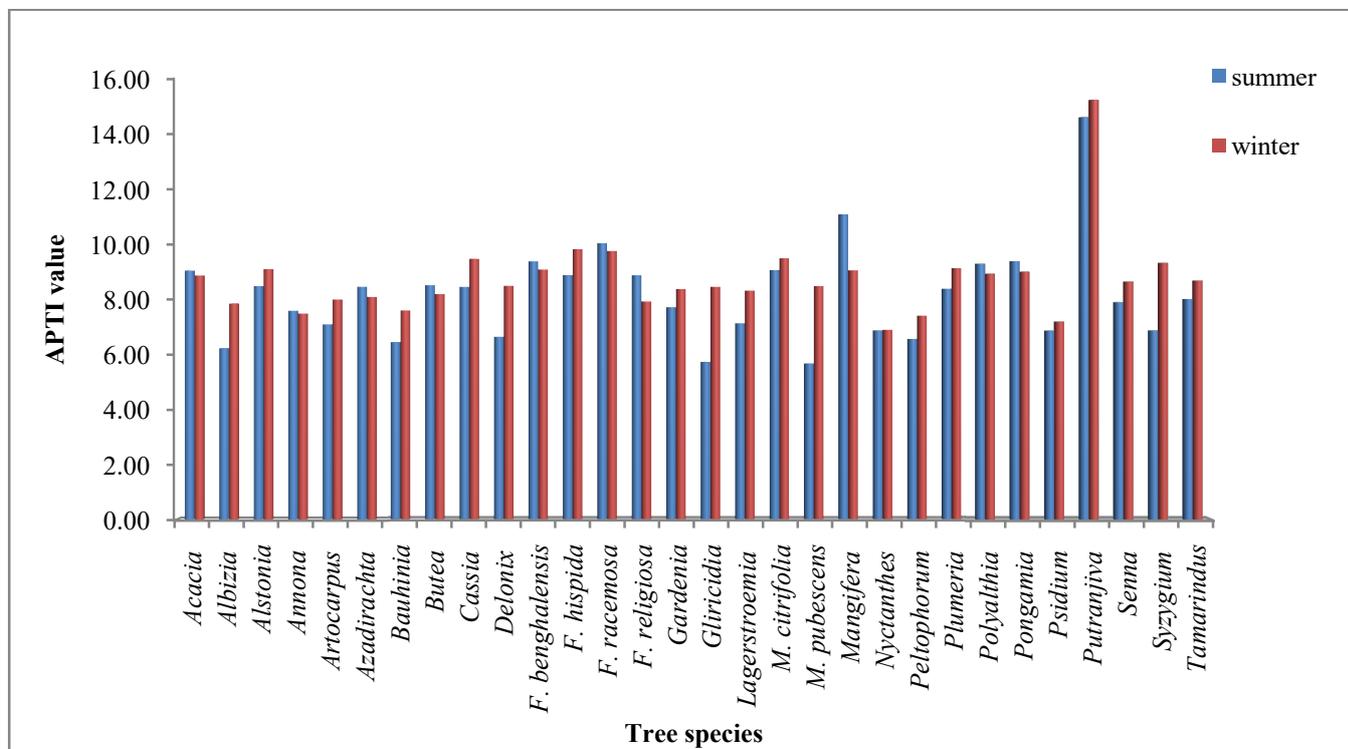
Fig. 1: A.P.T.I of 30 plant species from Tarapur industrial area during 2 dry seasons.

CONCLUSIONS

From the current study it can be concluded that the approximate age of the trees can be judged by measuring their diameters at breast height (D.B.H). A large number of trees have been planted during the last few decades which are indicated by the D.B.H. values recorded in the survey. This might possibly be due to the awareness created by various organizations and authorities to beautify roads. This explains the most recent plantations along the secondary roads of the industrial area.

The total number of trees present along the roads of residential area was more as compared to those present along the roads of industrial area (Table 1). In the residential areas, trees have been planted with the aim of beautifying the locality. Moreover, sufficient protection and care of the trees by local residents leads to better longevity of the tree species.

However in industrial areas much care is not taken regarding the roadside vegetation. Individual industries have planted some trees along their vicinity majority of which are *Polyalthia longifolia* species but many

roads have bare patches where plantation is needed. In areas having scattered tree canopies or less plantation, solar radiations can reach and heat ground surfaces thereby increasing air temperatures however a tree shade can reduce the air temperature and also improve air quality as emission and mixing of many pollutants is temperature dependent [11].

Frequently occurring tree species found during the survey were *Peltophorum pterocarpum, Polyalthia longifolia, Leucaena leucocephala, Mangifera indica, Eucalyptus sps., Acacia auriculiformis, Casuarina equisetifolia* and *Ficus benghalensis* (Table 2).

Air pollution tolerance index (APTI) study carried out during winter and summer season suggests that trees like *Ficus benghalensis, Ficushispida, Mangifera indica, Morindacitri folia,* and *Putranjiva roxburghii*are pollution tolerant while trees like *Bauhinia purpurea, Morinda pubescens, Nyctanthes arbor-tristis, Peltophorum pterocarpum, and Psidium guajava* are pollution sensitive.

Since there are no ecological parks and gardens in the Tarapur industrial area it becomes essential to create more green patches or belts along the roads of industrial region in order to combat air pollution since trees serves as major sinks.

The selection of tree species for green belt development is based on the regional extent of the pollution load together with soil quality, rainfall, temperature and human interactions. In any green belt development, monoculture is not advisable due to its climatic factor and other environmental limitations.

Trees also act as noise absorbers and can deflect the noise upward. Studies conducted by [12] have suggested *Azadirachta indica* A. Juss. and *Putranjiva roxburghii* Wall. to be the best sound absorbers and can be planted near residential, industries and along roadsides as these trees have the capacity to reduce noise up to 5-10dB.

From the above tree survey and from ecological point of view it is very essential to plant trees which will help in indicating and mitigating air pollution related problems. Pollution sensitive species like *Bauhinia purpurea, Delonixregia, Nyctanthes arbor-tristis*, *Peltophorum pterocarpum* and *Psidium guajava* should be planted around the residential areas and commercial complexes in order to monitor air pollution levels as these plants serve as bio-indicators of pollutants. Also these tree species have dense canopies and beautiful flowers which increase their aesthetic value.

Pollution tolerant evergreen trees with thick foliage, attractive flowers, leaves with

larger surface area and dense canopies like *Ficus religiosa, Manilkara zapota, Pongamia pinnata, Putranjiva roxburghii* along with moderately tolerant tree species like *Alstonia scholaris, Azadirachta indica, Buteamono sperma, Ficus religiosa, Gardenia jasminoides, Lagerstroemia speciosa, Plumeria obtusa, Sennasiamea, Syzygiumcumini* and *Tamarindus indica* should be planted along the roads, highways and near heavily polluting industries so that they can absorb more pollutants and help in cleaning the ambient environment.

Air Pollution may be caused by point sources such as cities, industrial areas, factories or by linear sources such as highways. Vegetation buffers can help minimize the buildup of pollution levels in urban areas by acting as pollution sinks. Vegetation belts can be used as a visual partition and partial noise barrier next to hospitals, institutions, school playgrounds, garden areas and residential estates close to main road networks.

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