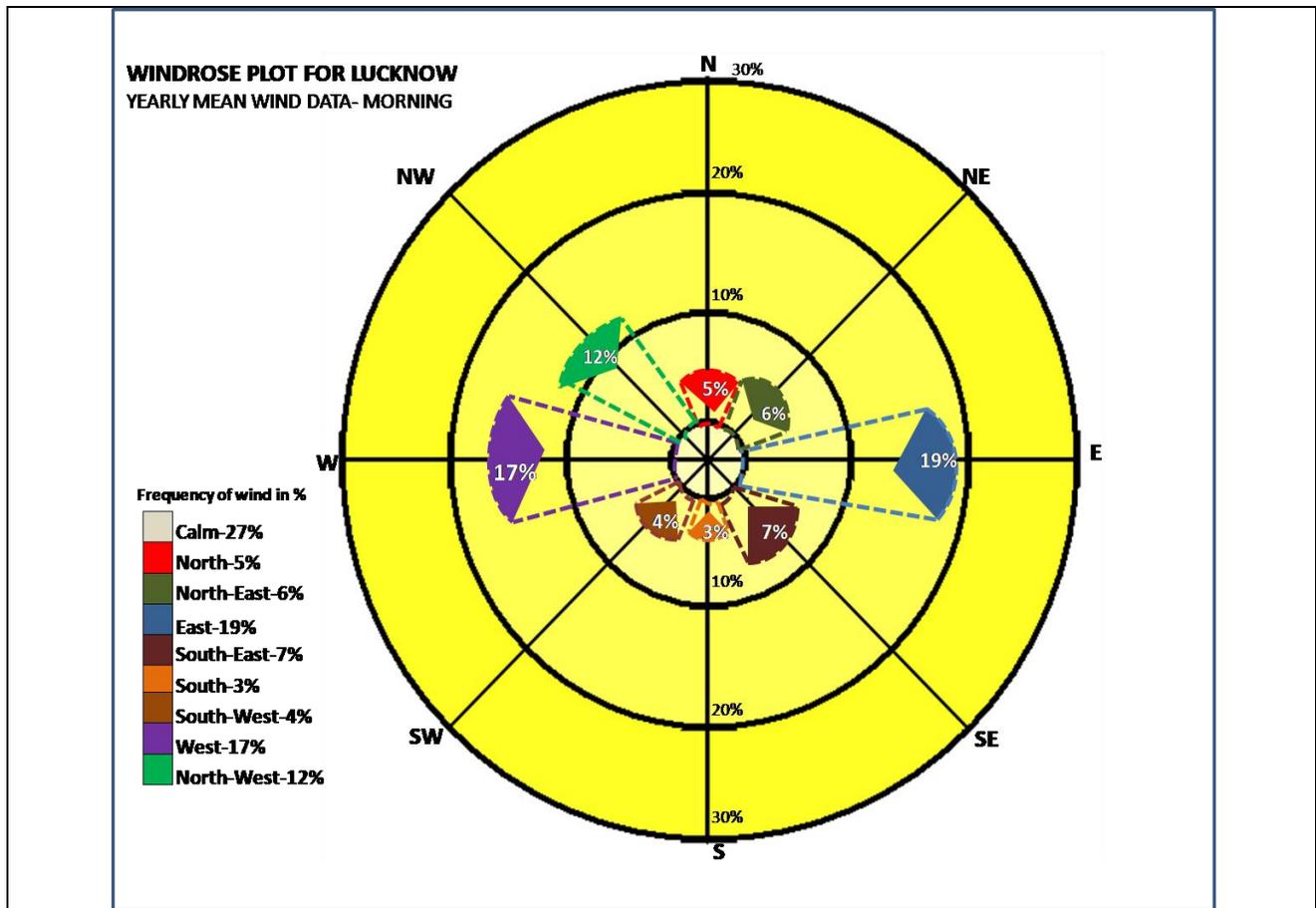


Report on Proposed plantation scheme around Lucknow

With recent eye opening report released by Greenpeace (NGO) ranking Lucknow at the 9th position amongst the top 10 most polluted cities in the world are in India.

To improve the decreasing air quality of Lucknow and nearby cities a much desired plantation scheme should to be implemented to curb the increasing Air Pollution Index and various health hazards especially respiratory diseases in elderly and children. Keeping in view the various aspects of wind i.e. wind direction, wind speed, frequency which are the key factors in circulating the Particulate matter, dust particles and other pollutants.

As per the wind rose diagram showing wind flowing patterns of Lucknow on the basis of the average of last 30 years Meteorological (met) data. (Reference Government of India, Ministry of Earth Sciences, India Meteorological Department, Meteorological Centre, Lucknow)



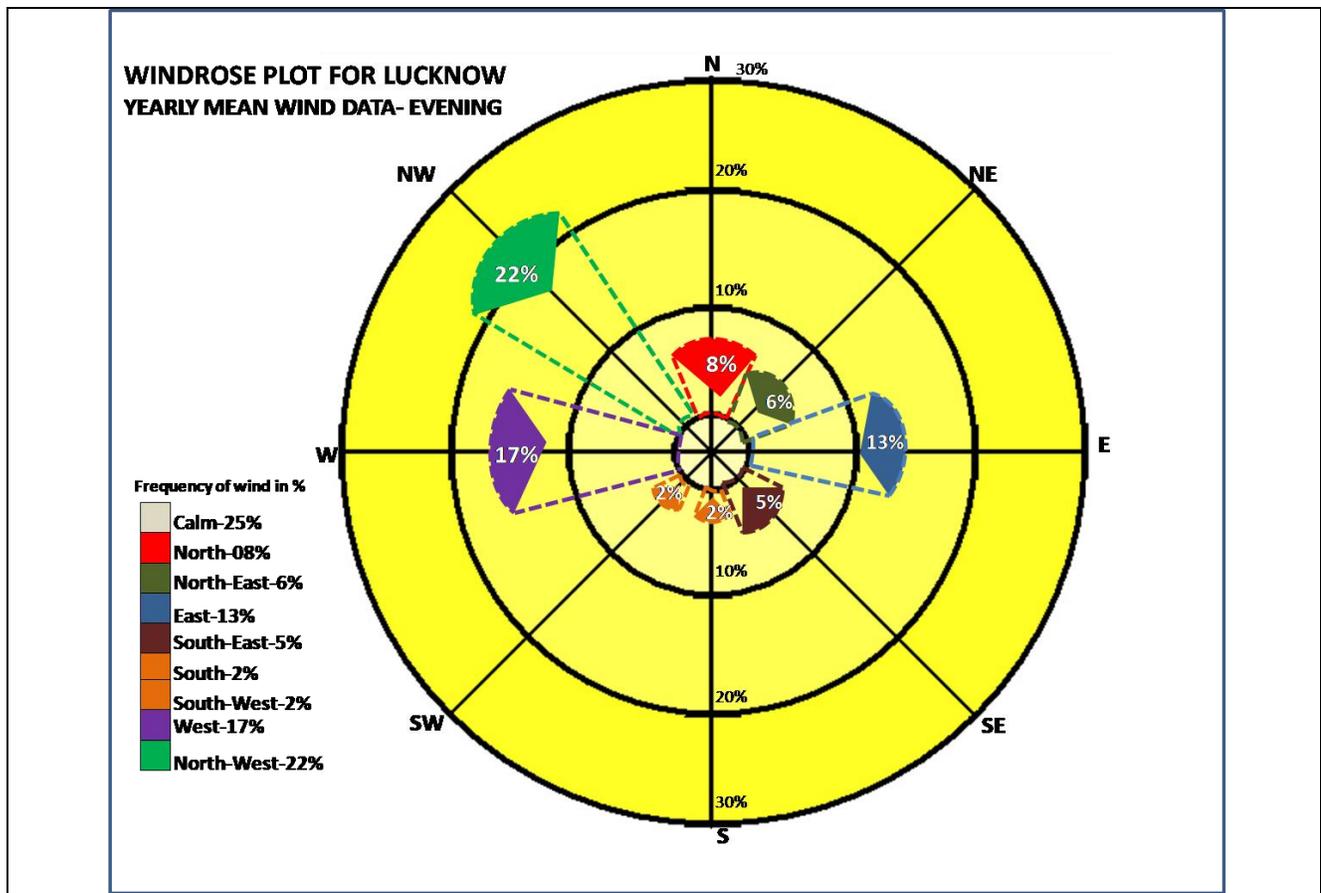


Fig 1. Shows yearly average wind blow pattern during Morning & Evening time

According to the windrose diagram plotted on the averaged data of wind's frequency in particular direction of last years at two different hours monitored in a day, the prominent direction in which wind has the maximum frequency is East direction during day time. Similarly during evening time the maximum frequency of wind is in North-west direction. Hence, heavy plantation is proposed towards the direction which has the high wind frequency.

On the basis of Windrose diagram for the Lucknow district, places located on the outskirts and within the Lucknow district in the prominent wind directions of Wind which are towards East, South East, West and North-west direction as these directions will be categorized as Upwind and Downwind directions of wind.

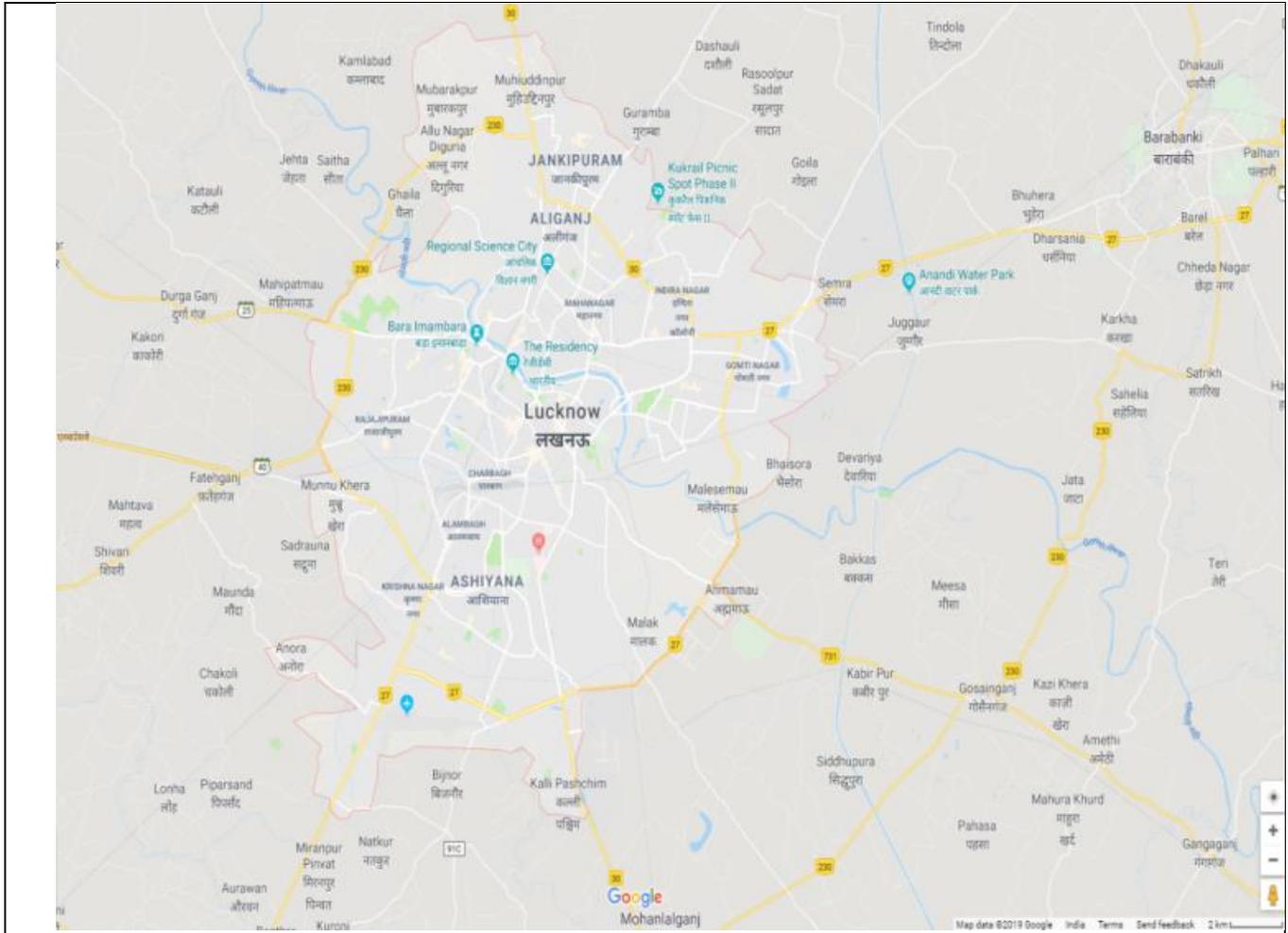


Fig 2: Lucknow district map

Other actions which can be taken in account to curb the emission of dust and other particulate matter in the district:

- Proposal for speed up the process of developing green belt around the Construction sites of townships and Buildings being constructed towards prominent downwind direction(i.e along Amar Shaheed Path and Bharat Ratna Atal Bihari Vajpayee Ekana Stadium) of wind as they have already obtained EC from SEAC/SEIAA and to also produce the 6month Compliance report.
- Development of green belt around the existing brick kiln sites and other polluting sources located within the city.
- Proposal for developing wind break along the Bhainsora Road and Gomti Nagar Sewage Treatment Plant.
- Other places which found suitable for proposing plantation- Shahpur, Chinhat (Towards East direction) and Sindhu Nagar, Krishnanagar (towards West direction).
- Plantation of Trees on Abandoned Sanitary Landfill Sites may also be done. Like Ghaila Dumping site and other abandoned sites of Brick Kiln

Table 1: Sites identified for proposing Plantation towards East and West directions

TOWARDS WEST DIRECTION				TOWARDS EAST DIRECTION			
SR. NOS.	IDENTIFIED SITE	COORDINATES	AREA (IN Hectares)	SR. NOS.	IDENTIFIED SITE	COORDINATES	AREA (IN Hectares)
1.	Ghaila, Along the River Gomti	26°54'11.26"N 80°52'50.27"E	(37.0+22.0) Total= 59.0	1.	Radio Tower, Chinhat	26°52'51.23"N 81° 2'38.86"E	11.5
2.	Ghaila Dump site, Hardoi Road	26°53'54.81"N 80°52'21.85"E	24.0	2.	Shahpur Abandoned site	26°52'26.98"N 81° 3'19.33"E	67.2
3.	Moosa Bagh	26°53'6.29"N 80°52'23.19"E	20.6	3.	Uttardhona	26°53'19.81"N 81° 3'42.10"E	8.51
4.	Vasant kunj	26°53'3.79"N 80°52'1.99"E	4.95	4.	Gomti Nagar, sewage Treatment Plant	26°50'20.88"N 81° 2'37.81"E	34.6
5.	Vasant Kunj, Near Dubagga Cemetry	26°52'47.79"N 80°51'30.28"E	18.6	5.	Bharat Ratna Atal Bihari Vajpayee Ekana Stadium,	26°48'54.52"N 81° 1'26.24"E	29.2

					Mastemau		
6.	Dubagga, SH-25	26°52'44.83"N 80°51'10.81"E	3.76	6.	Malesamau	26°49'24.65"N 81° 0'22.74"E	5.59
7.	Abandoned Brick kiln site-4	26°52'11.24"N 80°52'5.58"E	--	7.	Ujariyaon	26°49'37.98"N 80°59'50.27"E	25
8.	Sarosa Bharosa, Near Haider Canal	26°49'54.00"N 80°50'47.31"E	8.86	8.	Arjun ganj	26°48'50.07"N 80°59'4.81"E	50.6
9.	Near Temple, Deputy Khera Ring Road	26°49'47.40"N 80°51'15.78"E	2.87	9.	Roberts Line, Malak	26°47'45.07"N 80°58'56.25"E	58.2
10.	Near Farmer Lake	26°56'37.41"N 80°53'47.06"E	16.9				
11.	Narharpur	26°56'38.08"N 80°53'33.78"E	10.3				
12.	Sadhupur	26°57'8.87"N 80°54'32.11"E	4.42				

Abandoned Brick Kiln sites identified proposed for carrying out plantation on the following sites:

Sr. Nos.	Sites	Coordinates
1.	Abandoned Brick kiln site-1	26°50'24.65"N 80°51'34.06"E
2.	Abandoned Brick kiln site-2	26°51'25.63"N 80°51'50.54"E
3.	Abandoned Brick kiln site-3	26°51'50.79"N 80°51'48.66"E
4.	Abandoned Brick kiln site-4	26°52'11.24"N 80°52'5.58"E
5.	Abandoned Brick kiln site-5	26°51'59.32"N 80°51'54.23"E

Table 2: Position of Active And Closed MSW Dumping sites

Site no.	Site name	Dumping starts from	Tot Area in sq.m	Position of site
1	Dubagga, Kadimi Kbristan	2007	61420.0803	Active
2	Jehta-Mor Bandha	2007	23660.5909, 17843.6384	Active
3	Yadav Chowraha	2007	0359.7415, 580.5386, 3559.5252	Closed
4	Pulton Chawni	2000	8498.7929	Closed
5	Aliganj Sec-Q	2000	100441.9699	Closed
6	Near Aliganj Sec-Q	2000	58329.5822	Closed
7	RR Bhawan	2010	91466.5592, 8459.2445	Active
8	Near Race course Maidan	2009	63768.1939	Closed
9	Near Telibagh	2007	3112.4341	Closed
10	Telibagh Main Bhattha Maidan	2007	46904.1049	Active
11	Rashmi Khand, Near Kansiram Smriti		37741.0768	Closed
12	Near Nahar Chowraha	2007	16667.2014	Closed
13	Ramdas Khera	2006	23468.9528	Closed
14	Chunnu Khera Village	2006	6174.3185	Closed
15	Hansa Khera	2007	1697.0575	Closed
16	Near Budheshvr Chowraha	2006	21051.5585	Closed
17	Bohar Village, Near Alamngr Rlyline	2008	2729.3947	Closed
18	Moti Jheel in Aishbag	-	45061.3717	Closed
19	Budha Park	-	40552.9199	Closed
21	Hathi Park		13566.9459	Closed
22	Daliganj pul, Mankameshwar Mandir Marg		5194.4264	Active
23	Tile Wali Masjid	2007	5780.7858	Active
24	Gandhi Setu	2007	38535.7156	Closed

As plants are universal sink for air pollutants, they trap the carbon dioxide and store it within them as reserve food material. Plants being the initial acceptors of air pollutants act as a scavenger to the pollutants. Leaves provide surface area for impingement, absorption and adsorption of air pollutants as well settlement for dust particles in the atmosphere equally. Few plants are sensitive to certain air pollutants while others are tolerant. The plants sensitive to pollutants act as pollution indicators while the plants tolerant to pollutants act as sink. While selecting the species for pollution control the following are the important characteristics that should be considered. Plants should be evergreen, large leaved, rough bark, indigenous, ecologically compatible, low water requirement, minimum care, high absorption of pollutants, resistant pollutants, agro-climatic suitability, height and spread, canopy architecture, growth rate and habit (straight undivided trunk), aesthetic effect (foliage, conspicuous and attractive flower colour), pollution tolerance and dust scavenging capacity. Hence, plantation needs to be done on haul routes to curb air pollution in respect to dust emission.

Selection of Plants for Greenbelts:

The main limitation for plants to function as scavenger of pollutants are- Plants interaction to air pollutants, sensitivity to pollutants, climatic conditions and soil characteristics. While making choice of plants species for plantation in green belts, due consideration has to be given to the natural factor of bio-climate. Character of plants mainly considered for affecting absorption of pollutant gases and removal of dust particle are as follows.

Major Pollutants	Varieties of Trees	Varieties of Bushes
Particulate Matter	<i>Cassia siamea</i> (Kassod tree), Siris, Chitwan, Kadamb, Neem, Sheesham, Mahua, Amaltas, Ficus (Peepal and Banyan)	Kadi Patta, Croton, Tecoma stans, Cassia glauca, Dhak
Sulphur oxides	Siris, Arroo, Chitwan, Kadamb, Neem, Bamboo, Mahuli, Semal, Mahua, Tamarind, Ficus	Amla, Dhak, Subabool,
Nitrogen oxides	Chilbil, <i>Mangifera indica</i> (aam), Siris, Mahua, Jamun, Neem, Sheesham	Mahuli, Subabool, Dhak,

For absorption of gases:

- Tolerance towards pollutants in question, at concentration, that are not too high to be instantaneously lethal
- Longer duration of foliage
- Freely exposed foliage
- Adequate height of crown
- Openness of foliage in canopy
- Big leaves (long and broad laminar surface)
- Large number of stomatal apertures

For Removal of Suspended Particular matter:

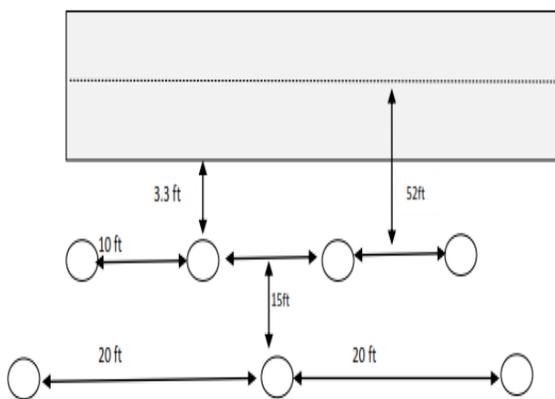
- Height and spread of crown.
- Leaves supported on firm petiole
- Abundance of surface on bark and foliage
- Roughness of bark
- Abundance of axillaries hairs
- Hairs or scales on laminar surface
- Protected Stomata

Selection of Plants for Greenbelts:

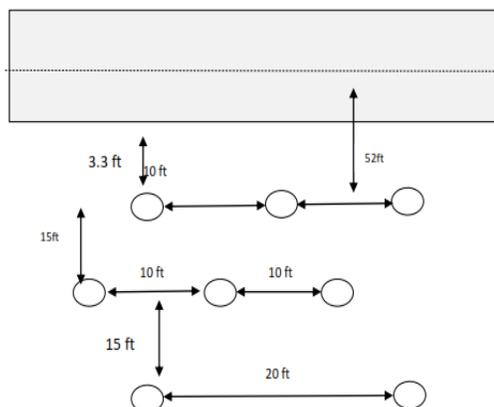
The main limitation for plants to function as scavenger of pollutants are, plant's interaction to air pollutants, sensitivity to pollutants, climatic conditions and soil characteristics. While making choice of plants species for plantation in green belts, due consideration has to be given to the natural factor of bio-climate. Character of plants mainly considered for affecting absorption of pollutant gases and removal of dust particle are as follows.

a. **Plantation pattern:**

- The first row along the highways will be of small to medium size ornamental trees
- Subsequent rows depending on the availability of width will comprise of ornamental and/or shade bearing species of medium height more than those in the first row.
- In rural sections the last row shall always be shade bearing tall trees.
- Plantation shall be done in a staggered (zigzag) manner.



(Option 1) Two-row Plantation



(Option 2) Three-row Plantation

Plantation pattern

Specification	I row	II row	III row
Spacing between plant to plant	10 ft	10 ft	20 ft
Canopy Shape & Size	Cylindrical/oblong with small CSA	Round/oblong with medium CSA	Spreading with medium CSA
Spacing between rows	-	15 ft	15 ft
Size of the pits	60 X 60 X 60 cm	60 X 60 X 60 cm	60 X 60 X 60 cm
Height of the plant	1.5 m to 2 m	More than 2m	More than 3m

To develop a plantation matrix various characteristics of plant species are taken into considerations like tolerance factor, ecologically compatible, growth rate of plant species, canopy surface area, leaf area, stomatal index,

canopy shape, flowering seasonality and utility etc. and score obtained by varieties of species of trees and bushes naturally found in that region. The species which scored high are preferred over the species scored less for the plantation to curb air pollution.

Matrix for plant selection

S.No.	Characteristic	Score	Remarks
1.	Tolerance/stressed	1/0	Any species which have shown tolerance for primary pollutants of vehicular emission will be rated tolerant and given a fixed score of 1 mark and sensitive species are given 0 mark.
2.	Evergreen	1/0.5/0	Evergreen tree/shrubs have been given 1 marks, semi deciduous have been given 0.5 marks and deciduous have got 0 mark.
3.	Growth rate	1/0.5/0	Growth rate of trees/ shrubs have been classified in to three categories. Fast- 1 mark for the trees which grow in a very short span of time. Quick 0.5 mark for the trees which grow in a very short span of time. Slow-0 mark for the trees which grow in a very short span of time.
4.	Canopy surface	1	Trees/ shrubs with highest canopy surface have been given 1 mark and others have been rated relative to the tree /shrubs with highest CS.
5.	Leaf area	1	Trees/ shrubs with highest leaf area have been given 1 mark and others have been rated relative to the tree /shrubs with highest LA.
6.	Stomatal index.	1	Trees/ shrubs with highest stomatal index have been given 1 mark and others have been rated relative to the tree /shrubs with highest SI.
7.	Canopy shape- Spreading/Round /oblong/Flat crown/Conical	1/0.75/0.5/0.25/0	Spreading-1 mark Round -0.75 mark Oblong-0.5 mark Flat crown-0.25 mark Conical-0 mark
8.	Flowering seasonality	0.5	Tree/shrubs having the round year flowering season have been given 0.5 marks and others have been rated relative to them.
9.	Utility	1	Trees with highest recorded uses have been given 1 mark and others have been rated relative to the tree /shrubs with highest uses.
10.	Total	8.5	

Recommended Species for Various Soil Types:

Selection of suitable plant species for the plantation downwind direction to curb the dust emitted in the city and upwind direction to ensure the entry of filtered wind into the city is the key of successful plantation programme. Given below are the few species suitable for plantation according the soil types found in that region.

Suitable species for different soil types.

Soil Type	Suitable Species
Clay Soil	<i>Azadirachata indica</i> , <i>Pongamia pinnata</i> , <i>Swietenia mahagoni</i> , <i>Pterocarpus marsupium</i> , <i>Terminalia tomentosa</i> , <i>Melia dubia</i> , <i>Delbergia latifolia</i> , <i>Delbergia sissoo</i>
Red soil with 10 ft minimum soil depth	<i>Swietenia mahagoni</i> , <i>Pterocarpus marsupium</i> , <i>Terminalia tomentosa</i> , <i>Melia dubia</i> , <i>Delbergia latifolia</i> , <i>Azadirachata indica</i> , <i>Pongamia pinnata</i> , <i>Ailanthus exceisa</i>
Red soil with 5 ft minimum soil depth	<i>Tectona grandis</i> , <i>Swietenia mahagoni</i> , <i>Santalum album</i> , <i>Pterocarpus marsupium</i> , <i>Delbergia latifolia</i> , <i>Azadirachata indica</i> , <i>Melia dubia</i> , <i>Ailanthus exceisa</i>
Alluvial soil	<i>Tectona grandis</i> , <i>Swietenia mahagoni</i> , <i>Pterocarpus marsupium</i> , , <i>Melia dubia</i> , <i>Delbergia latifolia</i> , <i>Neolamarckia cadamba</i> , <i>Pongamia pinnata</i>
Uncultivable soil	<i>Azadirachata indica</i> , <i>Albezia lebbeck</i> , <i>Delbergia sissoo</i> , <i>Ailanthus exceisa</i> , <i>Pterocarpus santanalius</i>
	<i>Terminalia arjuna</i> , <i>Casurina junghuniana</i> , <i>Pongamia pinnata</i>

Plants experience physiological changes before getting damaged when the leaves are exposed to air pollutants. The tolerant species are preferred over the sensitive species for plantation. To analyze the species, various variables are used like Air Pollution Tolerance Index (APTI) which is based on biochemical parameters, Anticipated Performance Index (API) which is based on biological and socio-economic aspect of a plant. The carbon trapping and dust accumulating potential also varies from species to species.

APTI score of different trees and their efficacy in Pollution control.

S.Nos.	Botanical Name	Family	Common Name	APTI	Effective in Control
1.	<i>Cassia siamea</i>	Caesalpinioideae	Kassod tree	10.41	Dust
2.	<i>Albizia lebbeck</i>	Fabaceae	Siris tree	15.9	Air pollution
3.	<i>Alstonia scholaris</i>	Apocynaceae	Chitwan tree (Blackboard tree)	6.6	Dust
4.	<i>Neolamarckia cadamba</i>	Rubiaceae	Kadamb tree (Burflower tree)	15.5	Dust
5.	<i>Azadirachta indica</i>	Meliaceae	Neem tree	18.73	Dust, air pollution and Noise pollution

6.	<i>Dalbergia sissoo</i>	Papilionaceae	Sheesham	16.59	Air pollution Noise pollution
7.	<i>Madhuca indica</i>	Sapotaceae	Mahua	22.57	Air pollution
8.	<i>Mangifera indica</i>	Anacardiaceae	Mango	20.80	Air pollution
9.	<i>Bougainvillea spectabilis</i>	Nyctaginaceae	Booganbel	20.32	Air pollution
10.	<i>Nerium indicum</i>	Apocynaceae	Kaner	18.94	Air pollution
11.	<i>Ficus benghalensis</i>	Moraceae	Banyan	15.92	Air pollution, noise pollution
12.	<i>Ficus religiosa</i>	Moraceae	Peepal	12.41	Air pollution, noise pollution