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ESTABLISHMENT OF GREENBELT AROUND KOCHI (COCHIN) REFINERIES LIMITED, AMBALAMUGAL

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[Final Report of the Research Project KFRI 158/92]

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ABSTRACT OF PROJECT PROPOSAL

1.	Project Number	:	158/92
2.	Title of the project	:	Establishment of greenbelt around Cochin Refineries Limited.
3.	Objectives	:	1. To prepare a plan for the establishment of greenbelt around the Cochin Refineries Limited (CRL) in order to change the ecological conditions around there and thereby controlling pollution and improving the environment. 2. To monitor the growth and pollution attenuation capacity of the species planted.
4.	Date of commencement	:	July 1992
5.	Scheduled date of completion	:	June 1997
6.	Funding agency	:	Cochin Refineries Limited
7.	Project team		
	Principal Investigator	:	K. C. Chacko
	Investigators	:	R. C. Pandalai S. Sankar
	Project Fellows/ Research Fellows/Other Staff	:	P. K. Chandrasekhara Pillai Saju Abraham
8.	Study area	:	
9.	Duration of study	:	5 years

ABSTRACT

The Kerala Forest Research Institute established a green belt plantation in the campus of Kochi Refineries Ltd. (ersthwhile Cochin Refineries Ltd.) Ambalamugal at in the Ernakulam District of Kerala State during 1992-1997, over an area of 8.11 ha using 106 tree, bamboo and rattan species. Growth, overall health, diseases and disorders, pest incidences as well as first flowering and fruiting were recorded. Health scoring of 23 older trees in the campus was also carried out. Most of the planted species grew well and appeared healthy. A few species, which normally grow slow, recorded remarkably higher mean annual height increment at the fourth year after planting; they include *Azadirachta indica* (mean annual height increment of 0.99 m), *Hopea parviflora* (1.03 m), *Mimusops elengi* (0.70 m), *Pterocarpus marsupium* (1.15 m), *Xylia xylocarpa* (0.87 m) and *Calamus hookerianus* (0.56 m). Of the 23 older trees observed, coconut (*Cocos nucifera*) alone was unhealthy, probably due to pollution or root wilt. Although it is difficult to identify the effect of soil characteristics and pollution separately on plant growth, the study suggests that a large number of tree species and a few bamboo and rattan species are tolerant to air pollution in and around KRL and can be used for greening up similar industrially polluted areas to mitigate air pollution.

1. INTRODUCTION

Kochi Refineries Limited (KRL) [erstwhile Cochin Refineries Ltd (CRL)], is a Public Limited Company set up by the Government of India, in collaboration with Phillips Co. of USA in 1963. KRL's output spans over a wide range of petroleum products and a few petrochemicals that are important to Indian economy. They include liquid petroleum gas (LPG) and kerosene for household, petrol and diesel for automobiles, naphtha for fertilizers, furnace oil for industries, aviation turbine fuel (ATF) for air-crafts, benzene for pharmaceuticals, pesticides, dyestuffs and nylon, and toluene for paints and pesticides. Technological collaborations led to the development of new processes and products, and opened up a versatile range of output for the refinery. Easy availability of such products further resulted in the establishment of satellite industries, transforming Kochi into a fast-growing industrial hub of South India. KRL is located at Ambalamugal in the Ernakulam District of Kerala State.

As in most industrial areas, air pollution is a matter of serious concern in the KRL complex also. The major pollutants are Carbon monoxide, Sulphur dioxide, Hydrogen sulphide, Oxides of nitrogen and Hydrocarbons. Although the emission levels of these pollutants can be limited to certain levels, it is not possible to completely prevent their entry into atmosphere. These pollutants in turn cause health hazards to various living organisms including the humans.

Air pollutants may be eliminated from the atmosphere by a variety of mechanisms. The primary natural processes of cleaning the environment are precipitation, chemical reaction, dry deposition (sedimentation) and absorption. The plant communities such as forests, tree plantations or green belts play an important role in mitigating atmospheric pollution by filtering or absorbing the air pollutants. There are substantial evidences that trees remove gaseous contaminants from the atmosphere justifying the importance of tree planting in the form of green belts in and around industrial areas. Plant uptake increases as the solubility of the pollutant in water increases. Hydrogen fluoride, Sulphur dioxide, Nitrogen dioxide and Ozone, which are soluble and reactive are readily absorbed pollutants. Nitric oxide and Carbon monoxide, which are very insoluble, are absorbed relatively slowly or not at all by vegetation (Pokhriyal and Nautiyal, 1991; Pokhriyal and Subba Rao, 1986).

Air pollutants induce adverse metabolic changes and injuries in plant cells. Chronic injury, characterised by chlorosis and early leaf senescence, follows absorption of sublethal amounts of gaseous air pollutants. Rapid absorption of pollutants by leaves causes collapse of leaf cells and necrosis. Growth reduction by pollutants has been shown by measurements of height growth, leaf growth, xylem increment, dry weight increment of roots, stems and leaves, relative growth rate, and reproductive growth (Kozlowski and Constantinidou, 1986a).

Responses of woody plants to pollution vary appreciably with species and genetic materials, pollutant dosage, types and combinations of pollutants, response parameters, developmental stages of plants, environmental factors, diseases and insects. Gymnosperms are generally more sensitive than angiosperms to air pollution but pollution resistance within each of these groups varies greatly. Differences among woody plants in pollution resistance result largely from variations in capacity for avoidance of pollutant uptake or intolerance of toxic effect. Pollution resistance mechanisms sometimes also involve the capacity for metabolising pollutants to less toxic substance and dilution of pollutants by rapid redistribution within plants (Kozlowski and Constantinidou, 1986b).

A survey of vegetation in the industrial area of Banagar, Hyderabad by Madhavavendra *et al.* (1990) revealed 34 plants as resistant, 12 as susceptible and 3 as very susceptible to pollution in terms of defoliation, leaf chlorosis, necrosis, bronzing and withering. According to them, flowering and fruiting was very much reduced in six species. Agarwal and Tiwari (1997), based on Air Pollution Tolerance Index (APTI), proposed *Albizia lebbeck, Ficus gibbosa, Terminalia arjuna, Madhuca latifolia, Pithecellobium dulce, Acacia catechu, Terminalia tomentosa* and *Eucalyptus globulus* as more tolerant to pollution than *Aegle marmelos*, *Annona squamosa* and *Tectona grandis*. Studies on the scavenging potentials of seedlings of seven common tree species showed that species such as *Mangifera indica*, *Cassia siamea, Eucalyptus* spp. and *Azadirachta indica* had a greater potential for scavenging SO_2 and NO_2 than *Syzygium cumini, Ficus religiosa* and *Dalbergia sisoo* (Reddy and Dubey, 2000).

The National Botanical Research Institute, Lucknow, in collaboration with Indian Toxicological Research Institute, Lucknow, has extensively surveyed seven industrially polluted areas in the Uttar Pradesh and identified a number of pollution tolerant species in air-polluted areas (Pokhriyal and Nautiyal, 1991). Bhattacharya (1994) also listed out a number of tree species tolerant to different air pollutants.

Species such as *Leucaena leucocephala, Albizia falcataria, Caesalpinea pulcherrima, Aleurites molucanna, Spathodea campanulata* and *Gmelina arborea* are reported to have ability to absorb Nitrogen dioxide and Sulphur dioxide. *Mangifera indica* and Alpine fig absorb chlorine; Almond and Mulberry absorb Sulphur dioxide and *Ficus elastica* and Fan palm absorb Hydrogen fluoride (Anon, 1984).

Among temperate crops, species such as *Abies amabilis*, *Abies concolor, Acer platanoides, Acer saccharinum, Acer saccharum, Chamaecyparis lawsoniana, Crataegus douglasii, Ginkgo biloba, Ilex aquilifolium, Juniperus occidentalis, Juniperus osteosperma, Juniperus scopulorum, Ligustrum vulgare, Picea pungens, Pinus edulis, Pinus flexilis, Platanus acerifolia, Platanus hispanica, Populus canadensis, Quercus gambelii, Quercus palustris, Quercus petraea, Quercus robur, Quercus rubra, Rhus glabra, Thuja occidentalis, Thuja plicata,* and *Tilia cordata* are tolerant to SO_2 (Kozlowski and Constantinidou, 1986b).

Table 1 provides a list of 155 pollution-tolerant species. Cultivation of such pollution tolerant species will help in reducing injury caused to the environment by air pollutants.

Table 1. Pollutant tolerant/resistant species reported in literature

Sl. No.	Species	Pollutant								
		SO_2	Fluorides	Chlorides	MIC gas	Smoke and dust particulates	Combined gaseous pollutants (emissions of oxides of sulphur, nitrogen and carbon from petro-chemical and thermal power plants)	Pollutants from Thermal and fertilizer plants, brick kilns and loco shed	Oxides of sulphur, nitrogen and particulates	Ozone
1.	*Abies amabilis*	*								
2.	*Abies balsamea*									*
3.	*Abies concolor*	*								*
4.	*Acacia nilotica*					*	*	*	*	
5.	*Acer grandidentatum*									*
6.	*Acer platanoides*	*								*
7.	*Acer rubrum*									*
8.	*Acer saccharinum*	*								
9.	*Acer saccharum*	*								*
10.	*Aegle marmelos*						*	*		

Sl. No.	Species	Pollutant								
		SO_2	Fluorides	Chlorides	MIC gas	Smoke and dust particulates	Combined gaseous pollutants (emissions of oxides of sulphur, nitrogen and carbon from petro-chemical and thermal power plants)	Pollutants from Thermal and fertilizer plants, brick kilns and loco shed	Oxides of sulphur, nitrogen and particulates	Ozone
11.	*Ailanthus altissima*		*							
12.	*Ailanthus excelsa*	*	*	*			*	*		
13.	*Albizia falcataria*								*	
14.	*Albizia lebbeck*					*	*	*		
15.	*Aleurites molucanna*								*	
16.	*Alnus* spp.		*							
17.	*Alstonia macrophylla*						*	*		
18.	*Alstonia scholaris*						*	*		
19.	*Althaea officinalis*	*	*	*						
20.	*Anthocephalus cadamba*						*	*		
21.	*Artocarpus heterophyllus*						*	*		
22.	*Azadirachta indica*	*					*	*		
23.	*Berberis thunbergii*		*							
24.	*Betula nigra*		*							
25.	*Betula papyrifera*		*							
26.	*Betula pendula*		*							*
27.	*Betula pendula dalecarlica*		*							
28.	*Betula verucosa*	*								
29.	*Butea frondosa*							*		
30.	*Butea monosperma*						*			
31.	*Callistemon viminalis*				*					
32.	*Carpinus betula*	*								
33.	*Caesalpinia pulcherrima*								*	
34.	*Cassia siamia*				*					
35.	*Casuarina eqisetifolia*						*	*		
36.	*Cerdrus deodara*	*	*	*						
37.	*Chamaecyparis lawsoniana*	*								
38.	*Chamaecyparis* spp.		*							
39.	*Citrus medica*						*	*		
40.	*Cordia obliqua*					*				
41.	*Coffea arabica*		*							
42.	*Cornus florida*		*							*
43.	*Cornus stolonifera*		*							

Sl. No.	Species	Pollutant								
		SO_2	Fluorides	Chlorides	MIC gas	Smoke and dust particulates	Combined gaseous pollutants (emissions of oxides of sulphur, nitrogen and carbon from petro-chemical and thermal power plants)	Pollutants from Thermal and fertilizer plants, brick kilns and loco shed	Oxides of sulphur, nitrogen and particulates	Ozone
44.	*Crataegus douglasii*	*								
45.	*Dalbergia sissoo*					*	*	*		
46.	*Delonix regia*						*	*	*	
47.	*Diospyros melanoxylon*						*	*		
48.	*Diospyros virginiana*	*	*	*						
49.	*Dracaena* spp.				*					
50.	*Eleagnus angustifolia*		*							
51.	*Eucalyptus citriodora*						*	*		
52.	*Eugenia jambos*	*								
53.	*Euonymus alatus*		*							
54.	*Euonymus fortunei*		*							
55.	*Fagus sylvatica*	*								*
56.	*Ficus benghalensis*				*	*	*	*		
57.	*Ficus carica*			*						
58.	*Ficus elastica*		*							
59.	*Ficus infectoria*						*	*		
60.	*Ficus religiosa*						*	*	*	
61.	*Ginkgo biloba*	*								
62.	*Gleditsia triacanthos* var.		*							
63.	*Gleditsia tricanthos*	*	*	*						
64.	*Gmelina arborea*								*	
65.	*Holoptelia integrifolia*						*	*		
66.	*Ilex aquilifolium*	*								
67.	*Ilex opaca*									*
68.	*Juglans nigra*									*
69.	*Juniperus chinensis*		*							
70.	*Juniperus horizontalis*		*							
71.	*Juniperus occidentalis*	*								*
72.	*Juniperus osteosperma*	*								
73.	*Juniperus scopulorum*	*								
74.	*Juniperus virginiana*		*							
75.	*Lagerstroemia indica*						*			
76.	*Lagerstroemia* spp.							*		

Sl. No.	Species	Pollutant								
		SO_2	Fluorides	Chlorides	MIC gas	Smoke and dust particulates	Combined gaseous pollutants (emissions of oxides of sulphur, nitrogen and carbon from petro-chemical and thermal power plants)	Pollutants from Thermal and fertilizer plants, brick kilns and loco shed	Oxides of sulphur, nitrogen and particulates	Ozone
77.	*Leucaena leucocephala*								*	
78.	*Leucaena macrophylla*						*	*		
79.	*Ligustrum vulgare*	*								
80.	*Liquidambar styraciflua*		*							
81.	*Liriodendron tulipifera*		*							
82.	*Madhuca indica*						*	*		
83.	*Mangifera indica*			*	*					
84.	*Mimusops elengi*						*	*		
85.	*Moringa oleifera*						*	*	*	
86.	*Nyssa sylvatica*									*
87.	*Paulownia spp.*	*	*	*						
88.	*Persea americana*									*
89.	*Phoenix* spp.				*					
90.	*Phyllanthus distichus*						*	*		
91.	*Phyllanthus emblica*							*		
92.	*Picea abies*									*
93.	*Picea engelmannii*	*	*							
94.	*Picea glauca*		*	*						*
95.	*Picea mariana*		*							
96.	*Picea nidiformis*		*							
97.	*Picea pungens*	*								*
98.	*Pinus edulis*	*								
99.	*Pinus flexilis*	*								
100.	*Pinus resinosa*									*
101.	*Pinus sabiniana*									*
102.	*Pithecellobium dulce*						*	*		
103.	*Platanus acerifolia*	*	*							
104.	*Platanus hispanica*	*								
105.	*Platanus occidentalis*		*							
106.	*Polyalthia longifolia*				*		*	*	*	
107.	*Populus alba*		*							
108.	*Populus balsamifera*	*	*							
109.	*Populus canadensis*	*	*							

Sl. No.	Species	Pollutant								
		SO_2	Fluorides	Chlorides	MIC gas	Smoke and dust particulates	Combined gaseous pollutants (emissions of oxides of sulphur, nitrogen and carbon from petro-chemical and thermal power plants)	Pollutants from Thermal and fertilizer plants, brick kilns and loco shed	Oxides of sulphur, nitrogen and particulates	Ozone
110.	*Populus nigra*		*							
111.	*Populus trichocarpa*		*							
112.	*Prosopis juliflora*	*				*	*	*	*	
113.	*Prunus armeniaca*		*							
114.	*Prunus* spp.	*								
115.	*Pseudotsuga menziesii*									*
116.	*Psidium guajava*						*	*		
117.	*Punica granatum*					*				
118.	*Pyrus communis*		*							*
119.	*Quercus gambelii*	*								
120.	*Quercus imbricaria*									*
121.	*Quercus macrocarpa*									*
122.	*Quercus palustris*	*								
123.	*Quercus petraea*	*								
124.	*Quercus robur*	*								*
125.	*Quercus rubra*	*		*						*
126.	*Quercus* spp.		*							
127.	*Rhus glabra*	*								
128.	*Ribes* spp.		*							
129.	*Robinia pseudoacacia*		*							*
130.	*Rubus* spp.		*							
131.	*Salix babylonica*		*							
132.	*Salix caprea*		*							
133.	*Salix pentandra*		*							
134.	*Sambucus* spp.		*							
135.	*Sequoia sempervirens*									*
136.	*Sequoiadendron giganteum*									*
137.	*Spathodea campanulata*								*	
138.	*Spondias mangifera*						*	*		
139.	*Syzygium cumini*				*		*	*		
140.	*Tamarindus indica*						*	*		
141.	*Tecoma stans*					*				
142.	*Tecomella undulata*					*				

Sl. No.	Species	Pollutant								
		SO_2	Fluorides	Chlorides	MIC gas	Smoke and dust particulates	Combined gaseous pollutants (emissions of oxides of sulphur, nitrogen and carbon from petro-chemical and thermal power plants)	Pollutants from Thermal and fertilizer plants, brick kilns and loco shed	Oxides of sulphur, nitrogen and particulates	Ozone
143.	*Thevetia nerifolia*			*						
144.	*Thuja occidentalis*	*								*
145.	*Thuja plicata*	*	*							
146.	*Thuja* spp.			*						
147.	*Tilia americana*		*							*
148.	*Tilia cordata*	*								*
149.	*Tsuga canadensis*		*							*
150.	*Ulmus americana*		*							
151.	*Ulmus parviflora*	*	*	*						
152.	*Ulmus pumila*		*							
153.	*Viburnum dentatum*		*							
154.	*Viburnum prunifolium*		*							
155.	*Zizyphus mauritiana*					*	*	*		
Source		*Bhatacharya (1994), Kozlowski &Constantinidou (1986b)*		Bhatacharya (1994)				Pokriyal & Nautiyal (1991)	Madhavendra (1990), Anon (1984)	Kozlowski & Constantinidou (1986b)

The KRL authorities showed interest in launching a green belt planting programme in their factory area and entrusted the job to the Kerala Forest Research Institute (KFRI) to develop a proposal and implement the same within a period of five years.

2. MATERIALS AND METHODS

2.1. STUDY SITE

KRL is located at Ambalamugal, 15 km away from Kochi in Kerala. This industrial zone lies at 9°57'N latitude and 76°23'E longitude. The site is 32.5 m above mean sea level and receives an annual average rainfall of 2800 mm with 85% of the rains within 6 months from June to November. The soil is mostly lateritic. Site characteristics (Table 2) indicate that the soil is acidic with low organic carbon and Nitrogen contents. The main pollutants in and around this industrial area are CO, SO_2, H_2S, oxides of nitrogen, Hydrocarbon, etc.

Table 2. Site characteristics of KRL area

Site No.	Location	Gravel Sand Silt+Clay ..... %			pH	Organic carbon (%)	Nitro-gen (%)
1.	KRL factory boundary on Thrippunithura-Mattakuzhy road	41	75	25	5.9	0.9	0.09
2.	KRL factory boundary facing Chithrapuzha	32	72	28	4.4	1.0	0.10
3.	Near ARU site	31	73	24	4.1	2.4	0.24
4.	Wagon loading rack site	39	80	20	4.4	0.9	0.09
5.	NW boundary facing FACT	22	73	27	4.4	1.7	0.17
6.	KRL factory boundary on Housing Colony side (around the fire pond)	31	74	26	4.0	2.0	0.20
7.	KRL Housing Colony	46	71	29	3.8	1.6	0.16

Bulk density of soil = 1.7 g cm^2

2.2. IMPLEMENTATION

After a reconnaissance survey of the proposed planting areas, a proposal for planting 33 species was submitted to the KRL (Chand Basha *et al.*, 1992) and the list was sent by them to the Ministry of Environment and Forests for approval. Based on the suggestions from the Ministry and the Expert Committee, the list of species was further modified and expanded to include a number of indigenous evergreen species.

The green belt planting was done during 1992-94 using polypotted seedlings raised in the nursery specially established for the purpose (Figs. 1 & 2) inside the KRL campus. The planted area was demarcated and surveyed to ascertain the area of plantation established. The entire green belt area was maintained by casualty replacements, regular weeding, soil working, mulching and fertilisation using farmyard manure and chemical

fertilizers. Branches of trees up to about two metre height were pruned to facilitate distant vision as per security guidelines. The plants susceptible to wind damage were provided with support.

Fig. 1. Nursery for the development of greenbelt in KRL – a general view

Fig.2. Nursery at KRL showing taller seedlings for out planting

2.3. MONITORING

The plants were measured for height and girth at breast height. Visual scoring was also done on general health on a 1-3 (poor-good) scale, disease and pest problems on a 0-3 (nil-high) scale at periodic intervals. Incidence of initial flowering and fruiting was also recorded. The data were tabulated to arrive at mean figures for each species.

3. RESULTS AND DISCUSSION

3.1. EXTENT OF GREENBELT PLANTATION

In all 106 species were planted over an area of 8.11 ha. The sketch of the area showing location of greenbelt plantations established under the project is given in Fig. 3. Photographs of greenbelt plantation are given in Figures 4 to 11.

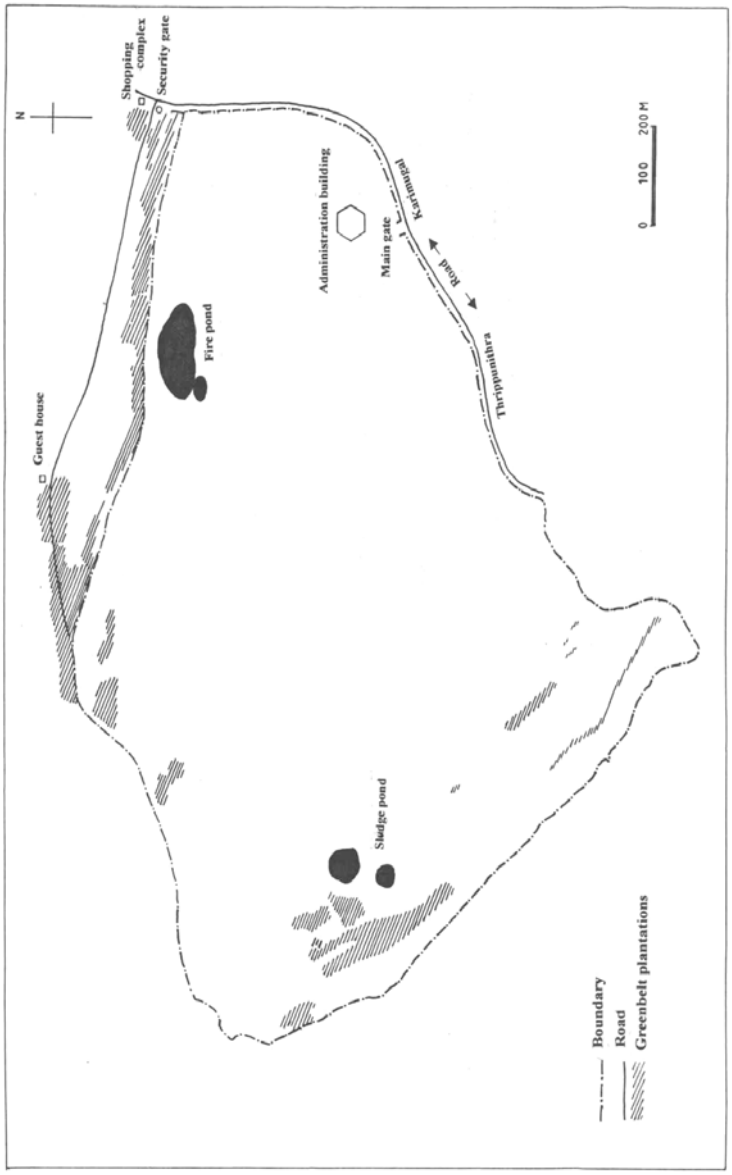

Fig. 3. Sketch of the KRL campus showing the Greenbelt plantations established by KFRI

Fig. 4. Thirty-six months old greenbelt plantation in Wagon Loading area

Fig. 5. Thirty-six months old greenbelt plantation in Old Scrap Yard area

Fig. 6. Thirty-six months old *Dalbergia sissoo* growing along the ARU wall side area

Fig. 7. Thirty-six months old greenbelt plantation in ARU area

Fig. 9. Forty-eight months old greenbelt plantation. A healthy *Mimusops elengi* is prominently seen in the Shopping Complex area of KRL

Fig. 10. Forty-eight months old *Delonix regia* established in Guest House area

Fig. 11. Forty-eight months old greenbelt plantation on the right side of the Flare gate area

3.2. HEIGHT AND DIAMETER GROWTH

Mean height and diameter of trees at 18, 27, 36 and 48 months after planting are provided in Table 3. Most of the trees, except *Aglaia barberi, Citrus* species, *Calospermum sapota, Caryota urens, Cinnamomum zeylanicum, Eugenia uniflora, Garcinia gummi-gutta, Hardwickia binata, Hopea ponga, Melaleuca leucadendron, Polyalthia longifolia, Polyalthia fragrans, Santalum album* and *Terminalia arjuna,* have recorded more than average growth. Those plants, which recorded slow growth, were species with characteristic slow growth and hence the slow growth cannot be attributed to pollution in the area.

Some of the plants, which normally grow at slow to moderate rate, recorded remarkably good growth and it is not easy to determine whether site, management or pollution contributed to this. They include *Azadirachta indica* (mean annual height increment of 0.99 m), *Hopea parviflora* (1.03 m), *Mimusops elengi* (0.70 m), *Pterocarpus marsupium* (1.15 m), *Xylia xylocarpa* (0.87 m) and *Calamus hookerianus* (0.56 m).

Table. 3. Mean height and diameter (at breast height of 1.37m) of 106 species planted in the green belt plantation during 48 months after planting.

Sl. No.	Species	Mean height and diameter at 1.37 m								Mean annual increment in height and diameter at breast height				Remarks
		Months after planting								Months after planting				
		18 month		27 month		36 month		48 month		36 month		48 month		
		Dia (cm)	Ht (m)	Dia (cm)	Ht (m)	Dia (cm)	Ht (m)	Dia (cm)	Ht (m)	Dia (cm)	Ht (m)	Dia (cm)	Ht (m)	
1.	*Acacia mangium*	4.1	2.89	7.0	5.55	10.7	6.42	12.8	8.83	3.5	2.12****	3.2	2.16****	
2.	*Acacia nilotica*	1.0	0.96	5.7	2.83	7.2	4.93	--	--	2.4	1.63***	--	--	irr
3.	*Achras sapota*	--	0.50	--	0.49	--	--	--	--	--	--	--	--	
4.	*Acrocarpus fraxinifolius*	3.5	3.01	4.4	3.31	6.1	3.91	--	--	2.0	1.29***	--	--	
5.	*Adenanthera pavonina*	3.0	2.35	5.1	3.65	6.2	4.42	8.0	5.09	2.1	1.46***	2.0	1.25***	
6.	*Aegle marmelos*	.5	0.82	2.4	1.12	2.6	2.15	--	--	.9	0.71**	--	--	irr
7.	*Aglaia barberi*	--	0.95	--	1.16	--	1.36	--	--	--	0.45*	--	--	
8.	*Ailanthus excelsa*	4.4	1.88	--	--	--	--	7.6	5.01	--	--	1.9	1.23***	
9.	*Ailanthus triphysa*	1.3	0.97	4.3	2.00	4.8	3.06	5.2	3.78	1.6	1.01**	1.3	0.93**	
10.	*Albizia lebbeck*	2.0	2.32	2.8	3.08	4.1	3.88	5.6	4.79	1.4	1.28***	1.4	1.18**	
11.	*Albizia odoratissima*	2.6	2.65	4.3	3.64	7.6	6.22	--	--	2.5	2.06****	--	--	
12.	*Alstonia scholaris*	4.4	1.76	4.9	2.09	5.6	2.90	10.0	4.93	1.8	0.96**	2.4	1.21***	
13.	*Anacardium occidentale*	2.9	2.21	4.3	3.15	5.7	4.01	7.6	4.55	1.9	1.33***	1.9	1.12**	
14.	*Anogeissus latifolia*	--	1.35	--	1.71	1.2	2.40	--	--	0.4	0.79**	--	--	
15.	*Annona squamosa*	1.7	1.12	2.0	1.81	2.4	2.22	3.1	2.48	.8	0.74**	.8	0.61**	
16.	*Artocarpus heterophyllus*	2.4	2.15	4.1	3.13	5.3	4.12	6.8	4.99	1.8	1.36***	1.7	1.23***	
17.	*Artocarpus hirsutus*	2.2	2.07	3.0	2.34	4.3	3.32	4.8	4.52	1.4	1.10**	1.2	1.07**	
18.	*Aphanamixis polystachya*	.6	0.66	2.4	1.19	3.8	2.54	--	--	1.2	0.84**	--	--	

Sl. No.	Species	Mean height and diameter at 1.37 m								Mean annual increment in height and diameter at breast height				Remarks
		Months after planting								Months after planting				
		18 month		27 month		36 month		48 month		36 month		48 month		
		Dia (cm)	Ht (m)	Dia (cm)	Ht (m)	Dia (cm)	Ht (m)	Dia (cm)	Ht (m)	Dia (cm)	Ht (m)	Dia (cm)	Ht (m)	
19.	*Azadirachta indica*	2.7	2.52	4.6	3.26	6.3	3.72	7.3	4.02	2.1	1.23***	1.8	0.99**	
20.	*Bambusa arundinacea*	1.3	3.19	--	--	--	--	3.7	6.77	--	--	.9	1.66***	
21.	*Bambusa vulgaris*	3.3	4.53	4.4	6.41	5.4	7.75	6.3	7.83	1.8	2.56****	1.5	1.92****	
22.	*Bauhinia purpurea*	3.6	3.28	4.6	4.01	6.9	4.64	7.6	5.02	2.3	1.54***	1.9	1.23***	
23.	*Bischofia javanica*	--	--	--	--	--	--	--	--	--	--	--	--	
24.	*Caesalpinia coriaria*	2.4	1.82	2.9	2.34	3.1	3.28	3.9	--	1.0	1.09**	1.0	--	
25.	*Caesalpinia sappan*	2.1	1.76	3.3	2.58	4.3	3.08	4.4	4.23	1.4	1.02**	1.1	1.04**	
26.	*Calamus hookerianus*	--	0.45	--	--	--	--	4.9	2.26	--	--	1.2	0.56*	Irr
27.	*Calamus thwaitesii*	--	--	--	--	--	--	--	0.87	--	--	--	0.21*	
28.	*Calospermum sapota*	1.9	--	--	1.27	2.1	1.59	--	--	.7	0.53*	--	--	
29.	*Carallia brachiata*	1.7	1.52	2.0	2.10	3.2	2.62	--	2.93	1.0	0.86**	--	0.72**	irr
30.	*Caryota urens*	--	--	--	--	--	1.10	--	--	--	0.36*	--	--	
31.	*Cassia fistula*	2.3	2.02	--	--	--	--	4.1	3.21	--	--	1.0	0.79**	irr
32.	*Cassia marginata*	1.5	1.55	2.7	2.15	3.5	3.64	5.2	5.23	1.2	1.20***	1.3	1.28***	
33.	*Cassia siamea*	2.9	2.84	5.4	3.29	7.4	4.71	8.2	6.01	2.5	1.56***	2.0	1.48***	
34.	*Castanospermum australe*	1.9	1.49	2.4	2.03	2.9	2.59	--	2.98	1.0	0.86**	--	0.73**	
35.	*Casuarina equisetifolia*	4.4	4.31	5.7	6.02	7.9	7.00	--	--	2.6	2.31****	--	--	
36.	*Ceiba pentandra*	5.0	3.06	--	--	--	--	9.8	5.55	--	--	2.4	1.36***	
37.	*Chrysophyllum cainito*	--	1.34	1.7	2.01	3.0	2.36	--	2.80	1.0	0.78**	--	0.69**	irr
38.	*Cinnamomum zeylanicum*	1.4	0.68	--	1.03	2.1	1.66	3.2	1.75	.7	0.55*	.8	0.43*	
39.	*Citrus* spp.	--	0.58	--	0.82	1.8	0.96	--	--	.6	0.32*	--	--	
40.	*Dalbergia lanceolaria*	2.9	2.71	5.8	4.65	7.7	5.94	10.0	--	2.6	1.96****	2.5	--	
41.	*Dalbergia sissoo*	1.8	2.19	3.2	3.90	5.4	5.24	--	6.43	1.8	1.74	--	1.52	--
42.	*Delonix regia*	5.5	3.56	8.3	5.07	11.2	6.58	13.2	7.84	3.7	2.18****	3.2	1.92****	
43.	*Diospyros buxifolia*	--	--	1.5	2.01	2.3	2.90	--	--	.7	0.96**	--	--	irr
44.	*Dysoxylum malabaricum*	--	--	--	--	--	--	--	--	--	--	--	--	
45.	*Elaeocarpus ganitrus*	2.0	1.58	2.8	2.00	3.2	2.89	--	--	1.1	0.96**	--	--	irr
46.	*Enterolobium cyclocarpum*	3.6	3.00	7.6	4.48	10.5	5.06	11.5	5.30	3.5	1.68***	2.7	1.30***	
47.	*Eugenia uniflora*	--	--	--	1.28	--	1.52	--	--	--	0.51*	--	--	
48.	*Ficus benghalensis*	3.5	2.58	5.4	3.23	7.1	3.97	--	--	2.3	1.31***	--	--	irr
49.	*Ficus dalhousiae*	2.6	2.07	3.5	2.77	5.8	3.56	--	--	1.9	1.18**	--	--	irr
50.	*Ficus religiosa*	2.7	2.94	4.5	4.02	5.5	5.03	--	--	1.8	1.67***	--	--	irr
51.	*Garcinia gummi-gutta*	1.1	0.40	--	0.72	--	0.82	--	0.90	--	0.27*	--	0.22*	
52.	*Gmelina arborea*	3.3	2.47	--	--	--	--	6.5	4.67	--	--	1.6	1.15**	
53.	*Grewia tiliifolia*	--	0.85	2.8	2.65	4.5	3.37	--	--	1.5	1.12**	--	--	irr
54.	*Haldina cordifolia*	--	1.07	3.7	1.86	--	2.00	--	--	--	0.66**	--	--	
55.	*Hardwickia binata*	--	0.90	--	1.48	--	1.72	--	--	--	0.57*	--	--	
56.	*Holigarna arnottiana*	5.2	2.55	10.2	4.20	16.6	6.25	--	--	5.5	2.07****	--	--	irr
57.	*Holoptelia integrifolia*	1.8	1.60	3.1	2.74	4.6	--	7.3	5.45	1.5	--	1.8	1.34***	
58.	*Hopea parviflora*	1.6	1.40	2.8	2.08	4.6	2.30	--	4.18	1.5	0.76**	--	1.03**	irr
59.	*Hopea ponga*	--	0.70	--	1.38	--	1.70	--	--	--	0.56*	--	--	
60.	*Hydnocarpus pentandra*	--	1.21	2.1	1.73	2.6	2.65	3.5	2.74	.9	0.88**	.8	0.67**	

Sl. No.	Species	Mean height and diameter at 1.37 m								Mean annual increment in height and diameter at breast height				Remarks
		Months after planting								Months after planting				
		18 month		27 month		36 month		48 month		36 month		48 month		
		Dia (cm)	Ht (m)	Dia (cm)	Ht (m)	Dia (cm)	Ht (m)	Dia (cm)	Ht (m)	Dia (cm)	Ht (m)	Dia (cm)	Ht (m)	
61.	*Jacaranda mimosifolia*	3.3	2.86	3.8	3.48	4.8	4.13	6.4	5.38	1.6	1.37***	1.6	1.32***	
62.	*Lagerstroemia reginae*	2.6	2.00	3.8	2.49	5.3	3.19	6.3	3.77	1.8	1.06**	1.6	0.93**	irr
63.	*Lepisanthes tetraphylla*	--	1.35	--	--	--	--	--	--	--	--	--	--	
64.	*Leucaena leucocephala*	3.1	2.44	3.8	3.03	4.5	4.48	13.2	10.42	1.5	1.48***	3.2	2.56****	
65.	*Litchi chinensis*	--	--	--	--	--	--	--	--	--	--	--	--	
66.	*Litsea coriacea*	--	1.10	2.7	2.07	2.9	3.45	--	--	1.0	1.14**	--	--	
67.	*Mangifera indica*	--	--	2.2	1.49	2.8	2.16	5.2	3.41	1.0	0.71**	1.3	0.84**	
68.	*Melaleuca leucadendron*	--	--	--	--	--	1.25	--	--	--	0.41*	--	--	
69.	*Mimusops elengi*	1.2	1.19	2.2	1.85	3.1	2.46	4.2	2.86	1.0	0.81**	1.0	0.70**	irr
70.	*Muntingia calabura*	6.2	3.97	8.7	4.51	12.6	5.25	--	--	4.2	1.74***	--	--	irr
71.	*Nephelium lappaceum*	1.6	1.34	2.5	2.21	--	3.60	--	--	--	1.19**	--	--	
72.	*Olea dioica*	--	--	--	--	--	--	--	--	--	--	--	--	
73.	*Palaquium ellipticum*	--	--	--	--	--	--	--	--	--	--	--	--	
74.	*Peltophorum pterocarpum*	2.8	2.38	5.1	3.28	5.9	4.06	7.6	4.45	2.0	1.35***	1.9	1.09**	
75.	*Persea macrantha*	--	0.94	--	1.33	2.7	2.45	--	--	.9	0.81**	--	--	
76.	*Phyllanthus emblica*	1.4	1.55	3.1	2.88	4.5	4.07	--	--	1.5	1.35***	--	--	
77.	*Polyalthia fragrans*	--	0.65	--	0.89	--	1.30	2.6	2.35	--	0.43*	.6	0.58*	
78.	*Polyalthia longifolia*	--	1.09	--	1.29	2.5	1.62	--	--	.9	0.54*	--	--	
79.	*Pongamia pinnata*	2.2	1.94	4.1	2.74	5.8	4.28	6.2	4.85	1.9	1.42***	1.6	1.19**	
80.	*Psidium guajava*	1.8	1.92	2.5	2.44	3.5	3.20	4.6	3.73	1.1	1.06**	1.2	0.92**	
81.	*Pterocarpus marsupium*	2.6	2.71	4.0	3.33	5.4	4.41	6.0	4.70	1.8	1.46***	1.5	1.15**	
82.	*Pterocarpus santalinus*	--	1.95	1.8	2.03	3.0	2.49	--	--	1.0	0.82**	--	--	irr
83.	*Pterocymbium tinctorium*	3.1	1.55	7.8	1.93	10.2	2.58	--	--	3.4	0.85**	--	--	
84.	*Punica granatum*	--	--	--	--	--	--	--	--	--	--	--	--	
85.	*Radermachera xylocarpa*	3.4	2.17	5.5	3.38	--	--	--	--	--	--	--	--	
86.	*Samanea saman*	3.1	2.50	5.8	3.95	7.8	5.03	--	5.65	2.6	1.67***	--	1.39***	
87.	*Santalum album*	--	0.87	--	1.25	--	1.57	--	--	--	0.52*	--	--	
88.	*Sapindus laurifolia*	.6	1.06	1.9	1.20	--	2.53	--	--	--	0.84**	--	--	
89.	*Saraca asoca*	1.5	1.24	2.3	1.88	2.6	2.49	--	--	.9	0.82**	--	--	
90.	*Schleichera oleosa*	1.5	1.76	2.1	2.59	2.4	2.89	--	--	.8	0.96**	--	--	
91.	*Spathodea campanulata*	3.6	2.49	5.6	3.67	8.6	5.05	11.7	5.96	2.9	1.67***	2.9	1.46***	
92.	*Spondias pinnata*	2.6	1.80	3.5	2.89	5.0	3.62	--	--	1.7	1.20***	--	--	
93.	*Strychnos nux-vomica*	1.6	--	--	--	--	--	--	2.63	--	--	--	0.65**	
94.	*Swietenia macrophylla*	3.3	2.90	4.1	3.02	5.6	4.82	7.1	5.86	1.9	1.59***	1.8	1.44***	
95.	*Syzygium cumini*	2.2	1.50	3.4	3.12	6.7	4.78	7.9	5.41	2.2	1.58***	1.9	1.33***	irr
96.	*Syzygium*	--	--	--	--	--	--	--	--	--	--	--	--	

Sl. No.	Species	Mean height and diameter at 1.37 m								Mean annual increment in height and diameter at breast height				Remarks
		Months after planting								Months after planting				
		18 month		27 month		36 month		48 month		36 month		48 month		
		Dia (cm)	Ht (m)	Dia (cm)	Ht (m)	Dia (cm)	Ht (m)	Dia (cm)	Ht (m)	Dia (cm)	Ht (m)	Dia (cm)	Ht (m)	
	malaccensis													
97.	*Tamarindus indica*	1.1	0.77	2.0	1.18	3.0	2.29	--	2.80	1.0	0.76**	--	0.69**	Irr
98.	*Terminalia arjuna*	1.6	--	--	--	--	1.40	--	--	--	0.46*	--	--	
99.	*Terminalia bellirica*	3.4	1.50	5.3	2.54	6.0	3.87	--	5.25	2.0	1.28***	--	1.29***	
100.	*Terminalia catappa*	3.8	1.98	6.3	3.21	7.9	3.98	--	5.00	2.6	1.32***	--	1.23***	
101.	*Terminalia chebula*	--	--	1.2	2.40	2.0	2.65	--	--	.7	0.88**	--	--	irr
102.	*Terminalia paniculata*	2.4	1.79	3.9	2.69	6.5	4.01	--	5.30	2.1	1.33***	--	1.30***	
103.	*Tetrameles nudiflora*	--	0.65	--	--	--	--	--	--	--	--	--	--	
104.	*Thyrsostachys siamensis*	1.3	3.00	--	--	--	--	2.2	5.26	--	--	.6	1.29***	
105.	*Vateria indica*	2.3	1.94	2.5	2.53	3.5	2.57	5.4	4.52	1.2	0.85**	1.3	1.11**	
106.	*Xylia xylocarpa*	2.4	2.09	3.1	2.41	3.6	2.92	4.8	3.53	1.2	0.97**	1.2	0.87**	irr

* Slow 0-60 cm, ** Average 61-120 cm, *** Fast 121-180 cm, **** Very fast >180 cm.

This classification is based on the suggestions made by Qureshi (1967) that a fast growing tree during its early years of growth puts on a mean annual height increment of more than 60 cm.

Irr = Irrigated.

-- = Data not recorded either because the trees have not grown to sufficient height for recording diameter measurement, or not recorded.

3.3. GENERAL HEALTH OF TREES

3.3.1. General health of trees planted under the project

General health of the trees at 18, 27, 36 and 48 months after planting, is summarised in Table 4. Of the 106 species for which health scoring was done, all species except *Disoxylum malabaricum* and *Punica granatum* showed above average health in terms of mean health values. It may be pointed out that *Disoxylum malabaricum* is an evergreen tree and the data on *Punica granatum* is based on a single tree.

Table 4. General health of trees planted in greenbelt plantation

Sl. No.	Species	Health score (1-3 scale) at different months after planting				
		18 months	27 months	36 months	48 months	Mean
1.	*Acacia mangium*	2.78	3.00	2.77	2.75	2.83
2.	*Acacia nilotica*	2.31	2.75	3.00	1.29	2.34
3.	*Achras sapota*	2.00	2.00	1.00	--	1.67
4.	*Acrocarpus fraxinifolius*	2.69	3.00	2.31	--	2.67
5.	*Adenanthera pavonina*	2.77	2.97	2.43	2.44	2.65
6.	*Aegle marmelos*	2.00	2.67	2.00	1.00	1.92

Sl. No.	Species	Health score (1-3 scale) at different months after planting				
		18 months	27 months	36 months	48 months	Mean
7.	*Aglaia barberi*	2.00	3.00	1.00	2.00	2.00
8.	*Ailanthus excelsa*	2.83	--	--	2.33	2.58
9.	*Ailanthus triphysa*	2.60	2.92	2.60	2.42	2.64
10.	*Albizia lebbeck*	2.56	2.80	1.50	2.14	2.25
11.	*Albizia odoratissima*	2.64	2.93	2.46	2.25	2.57
12.	*Alstonia scholaris*	2.48	2.91	1.91	2.17	2.37
13.	*Anacardium occidentale*	2.98	3.00	2.29	2.36	2.66
14.	*Annona squamosa*	2.11	2.69	1.90	2.06	2.19
15.	*Anogeissus latifolia*	2.00	3.00	3.00	--	2.67
16.	*Aphanamixis polystachya*	2.00	2.73	2.31	1.86	2.23
17.	*Artocarpus heterophyllus*	2.71	2.86	2.33	2.07	2.49
18.	*Artocarpus hirsutus*	2.69	2.88	1.93	2.43	2.48
19.	*Azadirachta indica*	2.57	2.83	2.26	1.97	2.41
20.	*Bambusa arundinacea*	2.50	--	--	2.56	2.53
21.	*Bambusa vulgaris*	3.00	3.00	3.00	3.00	3.00
22.	*Bauhinia purpurea*	2.61	2.71	2.32	2.11	2.44
23.	*Bischofia javanica*	--	--	--	--	--
24.	*Caesalpinia coriaria*	2.78	3.00	2.43	1.25	2.37
25.	*Caesalpinia sappan*	2.29	2.82	2.00	2.26	2.34
26.	*Calamus hookerianus*	3.00	--	--	2.42	2.71
27.	*Calamus thwaitesii*	--	--	1.00	2.00	1.50
28.	*Calospermum sapota*	2.24	2.85	1.93	--	2.34
29.	*Carallia brachiata*	2.36	3.00	2.38	2.00	2.44
30.	*Caryota urens*	--	--	2.00	--	2.00
31.	*Cassia fistula*	2.86	--	--	1.80	2.33
32.	*Cassia marginata*	1.85	2.67	1.90	1.76	2.05
33.	*Cassia siamea*	2.90	2.87	2.27	2.52	2.64
34.	*Castanospermum australe*	2.27	2.93	1.93	2.00	2.28
35.	*Casuarina equisetifolia*	2.82	3.00	2.67	--	2.83
36.	*Ceiba pentandra*	2.94	--	--	2.43	2.69
37.	*Chrysophyllum cainito*	2.38	3.00	2.18	1.75	2.33
38.	*Cinnamomum zeylanicum*	2.31	2.53	1.71	2.00	2.14
39.	*Citrus* spp.	2.21	2.59	1.48	--	2.09
40.	*Dalbergia lanceolaria*	2.90	3.00	2.86	2.50	2.82
41.	*Dalbergia sissoo*	2.46	2.75	2.50	1.80	2.38
42.	*Delonix regia*	2.69	2.94	2.20	2.33	2.54

Sl. No.	Species	Health score (1-3 scale) at different months after planting				
		18 months	27 months	36 months	48 months	Mean
43.	*Diospyros buxifolia*	--	3.00	2.00	--	2.50
44.	*Dysoxylum malabaricum*	1.00	--	--	--	1.00
45.	*Elaeocarpus ganitrus*	2.75	3.00	2.00	2.00	2.44
46.	*Enterolobium cyclocarpum*	2.71	2.86	2.15	2.14	2.47
47.	*Eugenia uniflora*	2.50	3.00	2.25	--	2.58
48.	*Ficus benghalensis*	2.64	2.93	2.23	2.00	2.45
49.	*Ficus dalhousiae*	2.57	3.00	2.54	1.00	2.28
50.	*Ficus religiosa*	2.68	2.93	2.25	1.25	2.28
51.	*Garcinia gummi-gutta*	1.74	2.33	2.27	1.43	1.94
52.	*Gmelina arborea*	3.00	--	--	2.13	2.57
53.	*Grewia tiliifolia*	1.67	3.00	1.78	1.00	1.86
54.	*Haldina cordifolia*	2.13	2.71	1.81	1.56	2.05
55.	*Hardwickia binata*	2.00	3.00	2.00	--	2.33
56.	*Holigarna arnottiana*	3.00	3.00	3.00	--	3.00
57.	*Holoptelia integrifolia*	1.71	3.00	2.00	2.13	2.21
58.	*Hopea parviflora*	2.33	3.00	2.22	1.50	2.26
59.	*Hopea ponga*	2.00	3.00	1.50	1.50	2.00
60.	*Hydnocarpus pentandra*	2.33	3.00	1.88	2.29	2.38
61.	*Jacaranda mimosifolia*	2.75	3.00	2.20	2.17	2.53
62.	*Lagerstroemia reginae*	2.50	2.94	2.10	1.82	2.34
63.	*Lepisanthes tetraphylla*	2.00	--	2.00	--	2.00
64.	*Leucaena leucocephala*	2.08	2.67	1.75	3.00	2.38
65.	*Litchi chinensis*	--	--	--	--	--
66.	*Litsea coriacea*	2.00	3.00	3.00	2.00	2.50
67.	*Mangifera indica*	2.64	2.70	2.11	1.95	2.35
68.	*Melaleuca leucadendron*	--	--	2.00	--	2.00
69.	*Mimusops elengi*	2.56	2.98	2.25	1.69	2.37
70.	*Muntingia calabura*	2.82	2.85	2.67	--	2.78
71.	*Nephelium lappaceum*	2.80	3.00	3.00	--	2.93
72.	*Olea dioica*	--	--	--	--	--
73.	*Palaquium ellipticum*	--	--	1.75	--	1.75
74.	*Peltophorum pterocarpum*	2.56	2.94	2.44	2.34	2.57
75.	*Persea macrantha*	1.50	2.67	1.67	--	1.95
76.	*Phyllanthus emblica*	2.53	2.78	2.20	1.00	2.13
77.	*Polyalthia fragrans*	1.86	2.40	1.67	3.00	2.23
78.	*Polyalthia longifolia*	2.44	2.88	2.48	--	2.60
79.	*Pongamia pinnata*	2.62	3.00	2.33	2.18	2.53

Sl. No.	Species	Health score (1-3 scale) at different months after planting				
		18 months	27 months	36 months	48 months	Mean
80.	*Psidium guajava*	2.54	2.85	2.20	2.13	2.43
81.	*Pterocarpus marsupium*	2.67	2.92	2.03	1.99	2.40
82.	*Pterocarpus santalinus*	2.00	2.50	2.00	--	2.17
83.	*Pterocymbium tinctorium*	2.00	2.78	2.00	2.00	2.20
84.	*Punica granatum*	1.00	--	--	--	1.00
85.	*Radermachera xylocarpa*	2.33	3.00	2.00	--	2.44
86.	*Samanea saman*	2.27	2.74	2.00	1.83	2.21
87.	*Santalum album*	2.33	3.00	1.00	--	2.11
88.	*Sapindus laurifolia*	1.67	2.33	1.75	--	1.92
89.	*Saraca asoca*	2.25	2.90	2.25	1.00	2.10
90.	*Schleichera oleosa*	2.50	2.67	1.71	--	2.29
91.	*Spathodea campanulata*	2.76	2.96	2.55	2.40	2.67
92.	*Spondias pinnata*	2.44	2.88	2.71	--	2.68
93.	*Strychnos nux-vomica*	--	--	--	2.00	2.00
94.	*Swietenia macrophylla*	2.86	2.94	2.51	2.47	2.70
95.	*Syzygium cumini*	2.88	3.00	2.75	2.00	2.66
96.	*Syzygium malaccensis*	2.00	2.00	1.00	--	1.67
97.	*Tamarindus indica*	2.16	2.40	1.58	1.75	1.97
98.	*Terminalia arjuna*	2.00	3.00	3.00	--	2.67
99.	*Terminalia bellirica*	2.64	2.95	2.19	1.83	2.40
100.	*Terminalia catappa*	2.83	2.96	2.48	2.50	2.69
101.	*Terminalia chebula*	2.00	3.00	2.00	--	2.33
102.	*Terminalia paniculata*	2.52	2.75	2.54	1.42	2.31
103.	*Tetrameles nudiflora*	--	2.00	--	--	2.00
104.	*Thyrsostachys siamensis*	2.66	--	--	2.46	2.56
105.	*Vateria indica*	2.40	2.76	2.00	2.50	2.42
106.	*Xylia xylocarpa*	2.25	2.78	2.09	1.83	2.24

_ Not available; 1. Poor; 2. Average; 3. Good.

3.3.2. General health of older trees present in KRL estate

Except for coconut (*Cocos nucifera*), the mean health of 22 older trees was good (Table 5). It is likely that the coconut trees were also affected by the common root wilt disease caused by micoplasma like organisms; however this aspect was not investigated.

Table 5. General health of older trees present in the campus

Sl. No.	Species	Mean Health score on 1-3 scale*
1.	*Acacia auriculiformis*	3.00
2.	*Alstonia scholaris*	3.00

3.	*Anacardium occidentale*	3.00
4.	*Artocarpus heterophyllus*	3.00
5.	*Artocarpus hirsutus*	3.00
6.	*Azadirachta indica*	2.00
7.	*Bambusa arundinacea*	3.00
8.	*Carallia brachiata*	2.00
9.	*Casuarina equisetifolia*	2.00
10.	*Ceiba pentandra*	2.00
11.	*Cocos nucifera*	1.67
12.	*Delonix regia*	3.00
13.	*Ficus benghalensis*	3.00
14.	*Ficus hispida*	3.00
15.	*Jacaranda mimosifolia*	3.00
16.	*Lannea coromandelica*	2.00
17.	*Macaranga peltata*	2.83
18.	*Mangifera indica*	3.00
19.	*Peltophorum pterocarpum*	3.00
20.	*Polyalthia longifolia*	3.00
21.	*Spathodea campanulata*	2.00
22.	*Syzygium cumini*	3.00
23.	*Trema orientalis*	3.00

1. Poor; 2. Average; 3. Good.

3.4. PEST, DISEASE AND OTHER PHYSIOLOGICAL DISORDERS

Serious disease and pest problems were not recorded on the planted species during the period of study as seen from the mean score at 18, 27, 36 and 48 months (Table 6).

Table 6. Pest and disease problems on trees in greenbelt plantation (Scoring was done on a 0-3 scale; higher the score greater was the problem)

Sl. No.	Species	Diseases and disorders at different months after planting*					Pest incidence at different months after planting*				
		18 months	27 months	36 months	48 months	**Mean**	18 months	27 months	36 months	48 months	**Mean**
1.	*Acacia mangium*	0.08	0.87	0.46	0.75	**0.54**	0.08	0.00	0.08	0.00	**0.32**
2.	*Acacia nilotica*	0.02	0.80	0.00	0.33	**0.29**	0.00	0.00	0.00	0.00	**0.16**
3.	*Achras sapota*	0.00	0.00	1.00	--	**0.33**	0.00	0.00	0.00	--	**0.19**
4.	*Acrocarpus fraxinifolius*	0.25	1.07	0.53	--	**0.62**	0.10	0.14	0.07	--	**0.40**
5.	*Adenanthera pavonina*	0.00	0.60	0.46	0.44	**0.38**	0.00	0.03	0.04	0.00	**0.22**

Sl. No.	Species	Diseases and disorders at different months after planting*					Pest incidence at different months after planting*				
		18 months	27 months	36 months	48 months	**Mean**	18 months	27 months	36 months	48 months	**Mean**
6.	*Aegle marmelos*	0.22	0.67	0.33	0.50	**0.43**	0.22	1.00	0.67	0.00	**0.45**
7.	*Aglaia barberi*	0.00	1.00	1.50	1.00	**0.88**	0.00	0.50	0.00	0.00	**0.54**
8.	*Ailanthus excelsa*	0.00	--	--	0.33	**0.17**	0.30	--	--	0.00	**0.16**
9.	*Ailanthus triphysa*	0.07	1.00	0.60	0.60	**0.57**	0.04	0.77	0.00	0.27	**0.44**
10.	*Albizia lebbeck*	0.08	1.40	1.50	0.75	**0.93**	0.03	0.80	1.00	0.65	**0.79**
11.	*Albizia odoratissima*	0.10	1.07	0.47	0.25	**0.47**	0.15	0.40	0.33	0.00	**0.36**
12.	*Alstonia scholaris*	0.16	0.96	0.82	0.86	**0.70**	0.16	0.91	0.09	0.29	**0.55**
13.	*Anacardium occidentale*	0.03	1.13	1.29	1.15	**0.90**	0.00	0.38	0.00	0.02	**0.54**
14.	*Annona squamosa*	0.10	1.27	0.58	0.22	**0.54**	0.01	0.07	0.00	0.00	**0.31**
15.	*Anogeissus latifolia*	0.00	2.00	2.00	0.00	**1.00**	0.33	1.00	0.00	0.00	**0.70**
16.	*Aphanamixis polystachya*	0.00	0.73	0.85	0.50	**0.52**	0.00	0.00	0.08	0.00	**0.30**
17.	*Artocarpus heterophyllus*	0.14	0.63	0.60	0.76	**0.53**	0.05	0.00	0.00	0.00	**0.30**
18.	*Artocarpus hirsutus*	0.00	0.85	0.72	0.47	**0.51**	0.00	0.00	0.00	0.00	**0.28**
19.	*Azadirachta indica*	0.05	1.08	0.44	0.66	**0.56**	0.00	0.08	0.00	0.00	**0.32**
20.	*Bambusa arundinacea*	0.00	--	--	0.44	**0.22**	0.00	--	--	0.74	**0.28**
21.	*Bambusa vulgaris*	0.00	1.00	1.00	0.85	**0.71**	0.00	0.00	0.00	1.00	**0.51**
22.	*Bauhinia purpurea*	0.04	1.04	0.52	0.87	**0.62**	0.04	0.24	0.04	0.12	**0.39**
23.	*Bischofia javanica*	0.00	0.00	0.00	--	**0.00**	0.00	0.00	0.00	--	**0.00**
24.	*Caesalpinia coriaria*	0.08	0.86	0.14	1.25	**0.58**	0.03	0.00	0.00	0.00	**0.33**
25.	*Caesalpinia sappan*	0.19	0.88	1.00	0.74	**0.70**	0.10	0.75	0.44	0.31	**0.57**
26.	*Calamus hookerianus*	0.00	--	--	0.59	**0.30**	0.00	--	--	0.12	**0.20**
27.	*Calamus thwaitesii*	--	--	1.00	1.00	**1.00**	--	--	0.00	0.00	**0.60**
28.	*Calospermum sapota*	0.05	0.91	0.56	0.00	**0.38**	0.04	0.00	0.00	0.00	**0.22**
29.	*Carallia brachiata*	0.07	0.82	0.56	0.00	**0.36**	0.13	1.00	0.89	1.00	**0.54**
30.	*Caryota urens*	--	--	1.00	--	**1.00**	--	--	0.00	--	**0.67**
31.	*Cassia fistula*	0.00	--	--	0.78	**0.39**	0.03	--	--	1.00	**0.44**
32.	*Cassia marginata*	0.01	0.93	0.42	0.45	**0.45**	0.01	0.93	0.67	0.48	**0.48**
33.	*Cassia siamea*	0.08	1.06	0.71	0.70	**0.64**	0.10	1.63	0.76	0.66	**0.70**
34.	*Castanospermum australe*	0.17	1.31	1.40	2.00	**1.22**	0.00	0.06	0.00	0.00	**0.68**
35.	*Casuarina equisetifolia*	0.00	0.10	0.56	--	**0.22**	0.00	0.00	0.00	--	**0.13**
36.	*Ceiba pentandra*	0.05	--	--	0.70	**0.38**	0.05	--	--	0.09	**0.25**
37.	*Chrysophyllum cainito*	0.00	0.09	0.43	0.60	**0.28**	0.00	0.27	0.00	0.00	**0.19**
38.	*Cinnamomum zeylanicum*	0.23	1.06	1.27	0.65	**0.80**	0.10	0.72	0.47	0.55	**0.65**
39.	*Citrus* spp.	0.16	1.28	1.24	--	**0.89**	0.23	1.14	0.10	--	**0.72**
40.	*Dalbergia lanceolaria*	0.26	1.00	0.71	0.25	**0.56**	0.47	0.56	0.00	0.25	**0.45**
41.	*Dalbergia sissoo*	0.12	1.00	0.60	0.44	**0.54**	0.04	0.20	0.00	0.16	**0.34**
42.	*Delonix regia*	0.00	0.71	0.72	0.76	**0.55**	0.05	0.00	0.06	0.00	**0.32**
43.	*Diospyros buxifolia*	--	1.00	0.00	--	**0.50**	--	0.00	0.00	--	**0.30**
44.	*Dysoxylum malabaricum*	0.11	--	0.00	0.00	**0.04**	0.00	--	0.00	0.00	**0.02**
45.	*Elaeocarpus ganitrus*	0.00	1.25	1.00	0.00	**0.56**	0.00	0.00	0.67	1.00	**0.50**

Sl. No.	Species	Diseases and disorders at different months after planting*					Pest incidence at different months after planting*				
		18 months	27 months	36 months	48 months	**Mean**	18 months	27 months	36 months	48 months	**Mean**
46.	*Enterolobium cyclocarpum*	0.00	0.88	0.78	0.63	**0.57**	0.00	0.08	0.09	0.00	**0.34**
47.	*Eugenia uniflora*	0.00	1.00	0.50	--	**0.50**	0.00	0.00	0.00	--	**0.29**
48.	*Ficus benghalensis*	0.10	0.93	1.21	0.50	**0.69**	0.05	0.07	0.07	0.00	**0.40**
49.	*Ficus dalhousiae*	0.40	1.69	1.54	0.00	**0.91**	0.00	0.15	0.08	0.00	**0.53**
50.	*Ficus religiosa*	0.42	1.19	1.00	0.50	**0.78**	0.09	0.09	0.00	0.00	**0.45**
51.	*Garcinia gummi-gutta*	0.02	0.09	0.27	0.30	**0.17**	0.00	0.00	0.00	0.00	**0.09**
52.	*Gmelina arborea*	0.00	--	--	0.25	**0.13**	0.00	--	--	0.33	**0.14**
53.	*Grewia tiliifolia*	0.00	1.00	0.20	0.40	**0.40**	0.00	0.67	0.30	0.00	**0.33**
54.	*Haldina cordifolia*	0.27	1.22	0.94	1.10	**0.88**	0.00	0.11	0.00	0.00	**0.50**
55.	*Hardwickia binata*	0.00	1.00	1.00	--	**0.67**	0.00	0.00	0.00	--	**0.38**
56.	*Holigarna arnottiana*	0.00	0.00	0.00	--	**0.00**	0.00	0.00	0.00	--	**0.00**
57.	*Holoptelia integrifolia*	0.06	1.00	1.00	0.49	**0.64**	0.00	0.00	0.00	0.04	**0.36**
58.	*Hopea parviflora*	0.00	0.44	0.75	1.00	**0.55**	0.00	0.11	0.17	0.50	**0.39**
59.	*Hopea ponga*	0.00	1.00	0.60	0.71	**0.58**	0.00	0.00	0.00	0.00	**0.32**
60.	*Hydnocarpus pentandra*	0.00	0.78	1.13	0.63	**0.64**	0.00	0.00	0.13	0.13	**0.38**
61.	*Jacaranda mimosifolia*	0.00	0.67	0.00	0.33	**0.25**	0.00	0.00	0.00	0.00	**0.14**
62.	*Lagerstroemia reginae*	0.45	1.10	0.85	0.85	**0.81**	0.32	0.88	0.60	0.32	**0.69**
63.	*Lepisanthes tetraphylla*	0.00	--	1.00	--	**0.50**	0.00	--	0.00	--	**0.30**
64.	*Leucaena leucocephala*	0.07	0.80	0.64	0.00	**0.38**	0.21	0.10	0.00	0.00	**0.24**
65.	*Litchi chinensis*	--	--	0.00	--	**0.00**	--	--	0.00	--	**0.00**
66.	*Litsea coriacea*	0.67	1.50	1.00	1.00	**1.04**	0.00	0.00	1.00	0.00	**0.69**
67.	*Mangifera indica*	0.13	1.30	1.00	1.04	**0.87**	0.07	0.40	0.00	0.04	**0.54**
68.	*Melaleuca leucadendron*	--	--	0.50	--	**0.50**	--	--	0.00	--	**0.33**
69.	*Mimusops elengi*	0.10	0.46	0.91	0.82	**0.57**	0.04	0.02	0.02	0.02	**0.33**
70.	*Muntingia calabura*	0.17	0.93	0.46	--	**0.52**	0.00	0.13	0.08	--	**0.33**
71.	*Nephelium lappaceum*	0.20	1.33	2.00	--	**1.18**	0.60	0.67	0.00	--	**0.85**
72.	*Olea dioica*	--	0.00	0.00	--	**0.00**	--	0.00	0.00	--	**0.00**
73.	*Palaquium ellipticum*	--	--	0.57	--	**0.57**	--	--	0.00	--	**0.38**
74.	*Peltophorum pterocarpum*	0.10	1.00	0.97	0.84	**0.73**	0.11	0.94	0.12	0.20	**0.56**
75.	*Persea macrantha*	0.50	1.33	1.00	--	**0.94**	0.00	0.33	0.67	--	**0.68**
76.	*Phyllanthus emblica*	0.03	0.54	0.58	0.00	**0.29**	0.00	0.31	0.00	0.00	**0.19**
77.	*Polyalthia fragrans*	0.29	1.00	0.75	3.00	**1.26**	0.14	0.00	0.00	2.00	**0.94**
78.	*Polyalthia longifolia*	0.00	1.04	0.93	--	**0.66**	0.00	0.00	0.15	--	**0.40**
79.	*Pongamia pinnata*	0.16	1.17	1.00	0.84	**0.79**	0.04	0.50	0.31	0.13	**0.55**
80.	*Psidium guajava*	0.11	1.06	1.04	0.94	**0.79**	0.37	0.29	0.07	0.00	**0.52**
81.	*Pterocarpus marsupium*	0.25	1.10	1.23	1.14	**0.93**	0.10	0.75	0.21	0.21	**0.66**
82.	*Pterocarpus santalinus*	0.25	0.50	1.50	--	**0.75**	0.00	0.00	0.00	--	**0.43**
83.	*Pterocymbium tinctorium*	0.04	0.82	0.60	0.50	**0.49**	0.04	0.36	0.80	0.50	**0.46**

Sl. No.	Species	Diseases and disorders at different months after planting*					Pest incidence at different months after planting*				
		18 months	27 months	36 months	48 months	**Mean**	18 months	27 months	36 months	48 months	**Mean**
84.	*Punica granatum*	0.00	--	--	--	**0.00**	0.00	--	--	--	**0.00**
85.	*Radermachera xylocarpa*	0.00	0.00	0.00	--	**0.00**	0.00	0.00	1.00	--	**0.14**
86.	*Samanea saman*	0.40	1.12	1.00	1.14	**0.92**	0.51	0.80	1.04	0.86	**0.87**
87.	*Santalum album*	0.00	0.67	0.67	--	**0.45**	0.00	0.00	0.00	--	**0.26**
88.	*Sapindus laurifolia*	0.25	1.33	1.25	--	**0.94**	0.00	0.33	0.00	--	**0.59**
89.	*Saraca asoca*	0.40	0.93	0.94	2.00	**1.07**	0.00	0.00	0.06	0.00	**0.60**
90.	*Schleichera oleosa*	0.57	1.50	1.43	--	**1.17**	0.14	0.33	0.71	--	**0.84**
91.	*Spathodea campanulata*	0.27	0.83	0.60	0.55	**0.56**	0.14	0.07	0.35	0.35	**0.41**
92.	*Spondias pinnata*	0.10	1.11	0.67	--	**0.63**	0.00	0.11	0.22	--	**0.41**
93.	*Strychnos nux-vomica*	0.00	--	--	0.50	**0.25**	0.00	--	--	0.00	**0.15**
94.	*Swietenia macrophylla*	0.10	0.76	0.54	0.88	**0.57**	0.01	0.00	0.00	0.00	**0.32**
95.	*Syzygium cumini*	0.04	1.00	0.75	1.09	**0.72**	0.04	1.25	1.00	0.57	**0.72**
96.	*Syzygium malaccensis*	0.00	1.00	1.00	--	**0.67**	0.00	0.00	0.00	--	**0.38**
97.	*Tamarindus indica*	0.09	0.75	0.92	0.65	**0.60**	0.02	0.13	0.00	0.05	**0.36**
98.	*Terminalia arjuna*	1.00	1.00	2.00	--	**1.33**	0.50	1.00	2.00	--	**1.26**
99.	*Terminalia bellirica*	0.73	1.12	1.22	0.83	**0.98**	0.67	0.85	0.85	0.92	**0.91**
100.	*Terminalia catappa*	0.49	1.08	0.91	1.00	**0.87**	0.70	1.00	1.09	0.67	**0.87**
101.	*Terminalia chebula*	0.00	1.00	0.00	--	**0.33**	0.00	1.00	0.00	--	**0.33**
102.	*Terminalia paniculata*	0.35	1.00	0.78	0.77	**0.73**	0.28	1.00	1.28	0.63	**0.76**
103.	*Tetrameles nudiflora*	0.00	2.00	--	--	**1.00**	0.00	0.00	--	--	**0.60**
104.	*Thyrsostachys siamensis*	0.00	--	--	0.66	**0.33**	0.00	--	--	0.28	**0.25**
105.	*Vateria indica*	0.04	0.92	0.91	0.71	**0.65**	0.02	0.32	0.17	0.12	**0.43**
106.	*Xylia xylocarpa*	0.00	0.83	1.17	0.67	**0.67**	0.00	0.00	0.25	0.50	**0.45**

0. Nil; 1. Low; 2. Medium; 3. High.

3.5. FLOWERING AND FRUITING PATTERN

It is noteworthy that 35 species flowered during the period of study (Table 7). *Annona squamosa* and *Muntingia calabura* flowered during the

Table 7. First flowering of plants planted in KRL Greenbelt plantation

Sl. No.	Species	Age at first flowering after planting (months)
1.	*Acacia mangium*	17
2.	*Acacia nilotica*	36
3.	*Adenanthera pavonina*	25
4.	*Albizia lebbeck*	20
5.	*Anacardium occidentale*	20
6.	*Annona squamosa*	10
7.	*Azadirachta indica*	26
8.	*Bauhinia purpurea*	16
9.	*Caesalpinia coriaria*	29
10.	*Caesalpinia sappan*	16
11.	*Calamus hookerianus*	42
12.	*Cassia marginata*	36
13.	*Cassia siamea*	20
14.	*Casuarina equisetifolia*	25
15.	*Ceiba pentandra*	31
16.	*Chrysophyllum cainito*	36
17.	*Cinnamomum zeylanicum*	20
18.	*Delonix regia*	36
19.	*Eugenia uniflora*	25
20.	*Grewia tiliifolia*	25
21.	*Holoptelia integrifolia*	36
22.	*Hydnocarpus pentandra*	29
23.	*Jacaranda mimosifolia*	30
24.	*Lagerstroemia reginae*	21
25.	*Leucaena leucocephala*	16
26.	*Mimusops elengi*	37
27.	*Muntingia calabura*	7
28.	*Peltophorum pterocarpum*	16
29.	*Phyllanthus emblica*	26
30.	*Pongamia pinnata*	40
31.	*Psidium guajava*	17
32.	*Pterocarpus marsupium*	29
33.	*Saraca asoca*	34
34.	*Spathodea campanulata*	19
35.	*Terminalia catappa*	25

first year; *Acacia mangium, Albizia lebbeck, Anacardium occidentale, Bauhinia purpurea, Caesalpinia sappan, Cassia siamea, Cinnamomum zeylanicum, Lagerstroemia reginae, Leucaena leucocephala, Peltophorum pterocarpum, Psidium guajava* and *Spathodea campanulata* flowered during the second year; *Acacia nilotica, Adenanthera pavonina, Azadirachta indica, Cassia marginata, Casuarina equisetifolia, Ceiba pentandra, Chrysophyllum cainito, Delonix regia, Eugenia uniflora, Grewia tiliifolia, Holoptelia integrifolia, Hydnocarpus pentandra, Jacaranda mimosifolia, Phyllanthus emblica, Pterocarpus marsupium, Saraca asoca,* and *Terminalia catappa* flowered during the third year and *Calamus hookerianus, Mimusops elengi* and *Pongamia pinnata* flowered in the forth year. Early flowering can be due to species characteristics, genetic variation or due to environmental stresses such as drought, pollution etc. It was however not possible to correlate flowering incidences to pollution for want of (control) plants grown in pollution-free environment.

3.6. PROBLEMS ENCOUNTERED

As the area was in general, protected by special security-forces, there was no damage due to animals or people. However, lack of a master plan for green belt development caused considerable damage to the plantations as many planted areas were subsequently diverted for developmental activities of KRL ignoring the plantations already raised in those areas.

4. CONCLUSION

All the 106 species planted established well, and for most of them the growth was good. A few species, which normally grow slow, recorded remarkably higher mean annual height increment at the fourth year after planting; they are *Azadirachta indica* (mean annual height increment of 0.99 m), *Hopea parviflora* (1.03 m), *Mimusops elengi* (0.70 m), *Pterocarpus marsupium* (1.15 m), *Xylia xylocarpa* (0.87 m) and *Calamus hookerianus* (0.56 m). Among 23 older trees present in the campus, except coconut (*Cocos nucifera)* all other species were healthy. Flowering and fruiting was recorded on 35 species during the initial 40 months after planting. The study on the whole suggests that a large number of the tree species and a few bamboo and rattan species can successfully withstand air pollution as in the case of KRL and can be recommended for greenbelt planting in and around similar industrially polluted areas.

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Appendix -1.

Number of trees for which height and diameter measurement and various observations were made in the KRL green belt plantations at different months after planting

Sl. No.	Species	Total height				Diameter at breast height				Health				Pest, diseases and disorder			
		18 months	27 months	36 months	48 months	18 months	27 months	36 months	48 months	18 months	27 months	36 months	48 months	18 months	27 months	36 months	48 months
1.	*Aglaia barberi*	2	2	2	--	--	--	--	--	2	2	2	2	2	2	2	2
2.	*Acacia mangium*	17	14	13	2	10	12	13	4	18	14	13	4	25	15	13	4
3.	*Acacia nilotica*	59	4	3	--	62	2	2	--	13	4	3	7	101	5	4	21
4.	*Achras sapota*	1	1	--	--	--	--	--	--	1	1	1	--	1	1	1	--
5.	*Acrocarpus fraxinifolius*	14	11	13	--	13	10	10	--	13	11	13	--	20	14	15	--
6.	*Adenanthera pavonina*	39	29	23	9	25	28	21	3	35	30	23	9	44	30	24	9
7.	*Aegle marmelos*	3	3	1	--	1	1	1	--	3	3	2	2	9	3	3	2
8.	*Ailanthus excelsa*	8	--	--	3	8	--	--	3	6	--	--	6	10	--	--	6
9.	*Ailanthus triphysa*	26	12	8	7	17	5	6	7	15	13	10	12	28	13	10	15
10.	*Albizia lebbeck*	180	5	1	81	147	4	1	59	68	5	2	85	205	5	2	110
11.	*Albizia odoratissima*	16	14	10	--	9	10	9	--	14	14	13	4	20	15	15	4
12.	*Alstonia scholaris*	38	21	19	5	18	3	3	5	29	22	22	6	38	23	22	7
13.	*Anacardium occidentale*	71	7	6	42	72	7	6	39	45	7	7	45	76	8	7	53
14.	*Annona squamosa*	68	8	6	12	45	2	2	2	18	13	10	18	90	15	12	37
15.	*Anogeissus latifolia*	1	1	1	--	--	--	--	--	2	1	1	--	6	1	1	1
16.	*Aphanamixis polystachya*	9	11	7	--	1	1	5	--	10	11	13	7	12	11	13	8
17.	*Artocarpus heterophyllus*	44	27	25	10	31	18	20	8	38	28	27	15	59	30	30	17
18.	*Artocarpus hirsutus*	44	23	15	17	31	15	14	16	39	24	42	46	64	27	43	55
19.	*Azadirachta indica*	88	34	29	23	63	27	18	6	60	36	31	30	100	38	34	38
20.	*Bambusa arundinacea*	54	--	--	24	55	--	--	23	28	--	--	27	55	--	--	27
21.	*Bambusa vulgaris*	30	1	1	12	28	1	1	2	23	1	1	13	30	1	1	13
22.	*Bauhinia purpurea*	109	8	8	39	96	20	13	35	56	24	22	45	116	25	23	60
23.	*Bischofia javanica*	--	--	--	--	--	--	--	--	--	--	--	--	2	2	2	--
24.	*Caesalpinia coriaria*	30	7	6	--	20	2	5	1	27	7	7	8	38	7	7	8
25.	*Caesalpinia sappan*	21	11	7	33	10	8	1	28	21	11	8	39	21	16	9	42
26.	*Calamus hookerianus*	18	--	--	8	11	--	--	4	10	--	--	12	24	--	--	17
27.	*Calospermum sapota*	--	19	13	--	121	--	3	--	50	20	14	--	163	22	18	13
28.	*Carallia brachiata*	11	9	6	1	2	5	4		11	10	8	1	15	11	9	1
29.	*Cassia fistula*	28	--	--	10	24	--	--	7	7	--	--	10	30	--	--	18
30.	*Cassia marginata*	42	10	6	5	41	3	5	7	13	12	10	29	75	14	12	40
31.	*Cassia siamea*	132	15	14	62	121	12	12	57	72	15	15	64	136	16	17	77
32.	*Castanospermum australe*	16	14	12	1	7	8	7		22	14	14	1	29	16	15	1
33.	*Casuarina equisetifolia*	11	9	7	--	8	9	9	--	11	9	9	--	12	10	9	--
34.	*Ceiba pentandra*	37	--	--	21	37	--	--	20	17	--	--	21	37	--	--	23
35.	*Chrysophyllum cainito*	7	8	8	3	--	5	4	--	8	8	11	4	9	11	14	5
36.	*Citrus* spp.	34	26	15	--	--	--	1	--	43	27	21	--	44	29	21	--
37.	*Calamus thwaitesii*	--	--	--	2	--	--	--	--	--	--	1	6	--	--	1	6

Sl. No.	Species	Total height				Diameter at breast height				Health				Pest, diseases and disorder			
		18 months	27 months	36 months	48 months	18 months	27 months	36 months	48 months	18 months	27 months	36 months	48 months	18 months	27 months	36 months	48 months
38.	*Caryota urens*	--	--	1	--	--	--	--	--	--	--	1	--	--	--	1	--
39.	*Cinnamomum zeylanicum*	59	13	9	11	49	--	2	1	39	15	14	15	96	18	15	20
40.	*Diospyros buxifolia*	--	1	1	--	--	1	1	--	--	1	1	--	--	1	1	--
41.	*Dalbergia lanceolaria*	18	8	7	--	12	8	7	1	10	8	7	4	19	9	7	4
42.	*Dalbergia sissoo*	40	3	4	4	38	3	3	1	13	4	4	15	49	5	5	25
43.	*Dysoxylum malabaricum*	--	--	--	--	--	--	--	--	4	--	--	--	9	--	1	1
44.	*Delonix regia*	59	13	7	9	55	14	11	18	39	16	15	21	61	21	18	25
45.	*Enterolobium cyclocarpum*	45	21	18	1	44	20	15	1	34	21	20	7	51	25	23	8
46.	*Elaeocarpus ganitrus*	4	4	3	--	3	2	2	--	4	4	3	1	7	4	3	1
47.	*Eugenia uniflora*	--	4	3	--	--	--	--	--	4	4	4	--	4	4	4	--
48.	*Ficus benghalensis*	12	12	11	--	10	11	9	--	14	14	13	1	20	15	14	2
49.	*Ficus dalhousiae*	14	12	9	--	6	10	7	--	14	12	13	1	15	13	13	1
50.	*Ficus religiosa*	35	24	20	--	25	23	19	--	40	28	24	8	53	32	28	10
51.	*Gmelina arborea*	18	--	--	8	20	--	--	6	3	--	--	8	21	--	--	12
52.	*Garcinia gummi-gutta*	18	5	10	1	9	--	--	--	19	6	22	7	41	11	22	10
53.	*Grewia tiliifolia*	3	2	2	--	--	2	2	--	3	2	9	5	4	3	10	5
54.	*Holigarna arnottiana*	1	1	1	--	1	1	1	--	1	1	1	--	2	2	2	--
55.	*Hardwickia binata*	1	1	1	--	--	--	--	--	1	1	1	--	1	1	1	--
56.	*Haldina cordifolia*	8	6	3	--	--	1	--	--	8	7	16	9	11	9	16	10
57.	*Holoptelia integrifolia*	106	3	--	20	120	3	1	22	58	3	2	47	179	4	3	67
58.	*Hopea parviflora*	12	5	7	1	6	2	2	--	12	6	9	2	16	9	12	2
59.	*Hydnocarpus pentandra*	19	8	6	6	--	3	4	3	9	8	8	7	19	9	8	8
60.	*Hopea ponga*	1	1	1	--	--	--	--	--	1	1	4	6	1	2	5	7
61.	*Jacaranda mimosifolia*	29	6	5	6	31	3	4	5	12	6	5	6	33	6	5	9
62.	*Litchi chinensis*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--
63.	*Litsea coriacea*	2	2	1	--	--	1	1	--	3	2	1	1	3	2	1	1
64.	*Leucaena leucocephala*	12	9	5	1	6	6	4	1	12	9	8	1	14	10	11	1
65.	*Lagerstroemia reginae*	114	77	54	10	65	47	41	6	98	81	81	33	154	90	86	41
66.	*Lepisanthes tetraphylla*	1	--	--	--	--	--	--	--	1	--	1	--	1	--	1	--
67.	*Muntingia calabura*	18	6	4	--	15	12	10	--	17	13	12	--	24	15	13	--
68.	*Mimusops elengi*	77	50	39	12	28	18	23	5	64	56	56	39	93	61	57	45
69.	*Mangifera indica*	--	9	8	15	--	2	4	13	25	10	9	21	45	10	9	27
70.	*Melaleuca leacadendron*	--	--	1	--	--	--	--	--	--	--	2	--	--	--	2	--
71.	*Nephelium lappaceum*	5	3	1	--	1	1	--	--	5	3	1	--	5	3	1	--
72.	*Olea dioica*	--	--	--	--	--	--	--	--	--	--	--	--	5	3	1	--
73.	*Palaquium ellipticum*	--	--	--	--	--	--	--	--	--	--	4	--	--	--	7	--
74.	*Phyllanthus emblica*	27	9	7	--	24	8	7	--	15	9	10	1	39	13	12	5
75.	*Polyalthia fragrans*	7	5	1	1	--	--	--	1	7	5	3	1	7	6	4	1
76.	*Punica granatum*	--	--	--	--	--	--	--	--	1	--	--	--	2	--	--	--
77.	*Psidium guajava*	113	26	23	33	92	19	19	11	52	26	25	39	126	34	28	54
78.	*Polyalthia longifolia*	24	23	21	--	--	--	5	--	25	24	25	--	28	27	27	--
79.	*Persea macrantha*	2	3	1	--	--	--	1	--	2	3	3	--	4	3	3	--
80.	*Pterocarpus*	217	35	27	71	190	31	24	46	150	36	33	73	236	40	39	91

Sl. No.	Species	Total height				Diameter at breast height				Health				Pest, diseases and disorder			
		18 months	27 months	36 months	48 months	18 months	27 months	36 months	48 months	18 months	27 months	36 months	48 months	18 months	27 months	36 months	48 months
	marsupium																
81.	*Pongamia pinnata*	74	12	8	10	62	7	7	2	26	12	12	33	80	12	13	45
82.	*Peltophorum pterocarpum*	122	35	31	48	125	28	27	35	66	35	32	56	146	36	33	70
83.	*Pterocarpus santalinus*	2	2	2	--	--	1	1	--	3	2	2	--	4	2	2	--
84.	*Pterocymbium tinctorium*	11	7	5	--	2	1	1	--	11	9	8	2	25	11	10	2
85.	*Radermachera xylocarpa*	3	2	--	--	2	2	--	--	3	2	1	--	3	2	1	--
86.	*Santalum album*	3	3	2		--	--	--	--	3	3	2	--	3	3	3	--
87.	*Saraca asoca*	13	9	8	--	2	3	6		12	10	12	1	20	14	17	1
88.	*Spathodea campanulata*	69	45	42	7	60	44	41	3	66	49	47	15	83	54	52	20
89.	*Syzygium cumini*	47	4	3	7	45	4	3	3	16	4	4	30	49	4	4	35
90.	*Sapindus laurifolia*	2	3	1	--	1	1	--	--	3	3	4	--	4	3	4	--
91.	*Swietenia macrophylla*	92	50	41	32	81	39	37	28	85	52	45	36	118	55	50	42
92.	*Syzygium malaccensis*	--	--	--	--	--	--	--	--	1	1	1	--	1	1	1	--
93.	*Strychnos nux-vomica*	--	--	--	2	2	--	--	--	--	--	--	2	2	--	--	2
94.	*Schleichera oleosa*	4	4	2	--	2	4	1	--	6	6	7	--	7	6	7	--
95.	*Spondias pinnata*	9	7	7	--	3	5	6	--	9	8	7	--	10	9	9	--
96.	*Samanea saman*	32	18	15	1	24	17	14	--	26	23	22	6	35	25	23	7
97.	*Tamarindus indica*	40	14	7	2	22	2	3	--	25	15	12	16	56	16	12	20
98.	*Terminalia arjuna*	--	--	1	--	1	--	--	--	1	1	1	--	2	1	1	--
99.	*Terminalia bellirica*	22	22	17	1	7	13	16	--	25	22	26	12	30	26	27	12
100.	*Terminalia catappa*	32	19	19	1	17	17	17	--	30	24	21	2	37	26	23	3
101.	*Terminalia chebula*	--	1	1	--	--	1	1	--	1	1	1	--	2	1	1	--
102.	*Terminalia paniculata*	59	15	11	1	55	10	9	--	23	16	13	19	69	19	18	30
103.	*Tetrameles nudiflora*	1	--	--	--	--	--	--	--	--	1	--	--	1	1	--	--
104.	*Thyrsostachys siamensis*	52	--	--	24	42	--	--	20	35	--	--	26	58	--	--	29
105.	*Vateria indica*	35	10	18	10	23	9	9	10	30	21	21	14	56	25	23	17
106.	*Xylia xylocarpa*	9	7	8	2	6	4	5	1	12	9	11	6	21	12	12	6