

Plants as Combatant to Environment Pollution: A Review

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Abstract—In recent times environment pollution is a major issue of concern, a disaster leading to survival difficulties of biological species. Severe urbanization and industrialization laid the platform for deforestation resulting in many negative effects on environment and hence climate change. Deforestation has also paved way to increased pollution of air, water and soil. In the last decade air quality in cities, industrial sites and its surroundings have degraded at a rapid rate, therefore, growing plants is considered to be the most effective way for abatement of pollution. Absorption of CO₂ and release of O₂ during photosynthesis thus reduces greenhouse effect through carbon sequestration. Plants in landscape, whether urban or rural, have other benefit besides reducing air pollution directly. They maintain ecological balance, reduce sound pollution, acts as shelter belts, windbreaks, reduces radiation and solar heat and serves as energy savers. The greenery is soothing to stress free living conditions and become an indispensable part of urban life. Landscape designs now targets for more precise planning and programming approaches which may serve the needs to combat environment pollution through checking dust, smoke and sound being polluted. For green space development, the plant selected should have the adsorption- absorption efficiency of air pollutants. The plant phyllotaxy, morphology and their pollutant tolerant capacity should also be congenial as contributing factors to its efficiency as dust collector, attenuating noise through reflection and absorption of sound energy and phyto-remediation. This paper aims to highlight the role of plants in combating environmental pollution, identifies a framework on effective planting strategies and suggests suitable plants with the ability to upgrade air quality and upgrade overall environment quality.

1. INTRODUCTION

Now-a-days pollution has become the biggest disaster for the survival of the biological species. There are various types of pollution like air, water, noise, soil, etc. Human being has ruthlessly exploited all the available resources for their own greed and lust from the beginning of civilization and become extreme since last century. Huge industrialization, excessive use of natural resources, urbanization etc. are the major sources of pollution. Plants are very important to maintain ecological balance. However, they are severely affected directly or indirectly by air pollution (Agbaire, 2009). Planting of trees and shrubs for abatement of pollution and improvement of environment is an effective way and well recognized remedy to check pollution throughout the world. Earlier the purpose of

planting trees in urban areas was purely aesthetic (Anon, 1981). Since the degradation of air quality is major environmental problem that affects many urban and industrial sites and the surrounding regions worldwide (Kuddus et al., 2011). Plants are planted to improve air quality, especially for people living in smog/smoke choked cities.

The levels of air pollutants are rapidly increasing in urban, peri-urban and rural areas in many mega cities (urban population greater than 10 million) of developing world. Landscape architects can solve the pollution problems related to urban landscape by creating a microclimate (Agarwal et al., 1980).

What are pollutants: The substances which cause pollution are called pollutants. According to Bernatzky (1978) pollutant is defined as any substance that is released intentionally or inadvertently by man into the environment in such a concentration that may have adverse effect on environmental health. Environment protection act, 1986 (EPA, 1986) defines pollutant, as any solid, liquid or gaseous substance present in such a concentration as may be or tend to be injurious to environment.

Air pollution and its control by different plant species: pollution of air by different types of pollutants like smog, dust, pollen, ash, etc. is called air pollution. Air pollution is a serious problem throughout the world. Rapid industrialization and vehicular traffic especially in the urban areas of India has led to the deterioration of air quality by adding toxic gases and other substances to the atmosphere. All combustion releases gases and particulate matter into the air which includes SO_x, NO_x, CO and other particles as well as smaller particles of toxic metals, organic molecules and radioactive isotopes (Agbair and Esiefarienrhe, E., 2009).

The variation of dust deposition in different plants is due to the fact that different plants have acquired different morphological features apart from those factors like phyllotaxy, leaf shape, plant height, leaf texture, presence or absence of hairs, stomatal frequency are also related to the efficiency of dust collecting capacity of plants. Das et al. (1978), have shown that not only the upper surface but the

lower surface of the leaf also collect significant amount of dust particles.

Nyctanthes arbor-tristis leaves are rough and hairy which help in retaining the dust and particulate pollution. Whereas, trees such as tamarind having smaller compound leaves are generally more efficient as particle collector than larger leaves. Particle deposition is heaviest at the leaf tip and along leaf margin. According to Prajapati (2008), plants remove pollutants from air by three processes namely deposition of particles, absorption by leaves and aerosols over leaf surface. But the problem is that different species having different capacities for providing these services (Hove *et al.*, 1999).

For example, neem has been referred as an “air purifier” as it absorbs SO₂. The leaves of *Ficus religiosa* are known to emit a lot of O₂ into the environment. It can be used as a biomarkers and mitigators of pollutant coming out of automobile exhaust. *Tamarindus indica* is excellent for removal of chromium ion. *Anthocephalus cadamba* is also resistant to gaseous pollutants. It sheds large amount of leaf and non-leaf litter which on decomposition improves soil physical and chemical properties under its canopy.

It is necessary that plants used must be tolerant to air pollution. Dust removal capacities and air pollution tolerant index (APTI) of plants commonly used for green belt establishment (Singh, 2013). Many trees like *Bombax ceiba*, *Cassia fistula*, *Cassia siamea*, *Delonix regia*, *Ficus religiosa*, *Jacaranda mimosifolia*, *Lagerstroemia indica*, *Plumeria rubra*, *Plumeria alba* and *Syngium cumini* and several other roadside and street trees have found more suitable for urban environment (Maheshwari, J.K., 1963).

Plant sp.	T	P	A	R	APTI
Albizia lebbek	8.0	6.2	18.0	54	29
Cassia fistula	6.89	6.2	16	72	28
Ficus religiosa	14.86	8.0	4.78	87	20
Psidium guajava	7.12	6.4	7.78	72	18
Tamrindus indica	4.87	4.0	6.0	8.5	14
Moringa olifera	6.60	6.2	2.5	87	12
Annona squamosa	4.0	5.6	2.75	71	10
Delonix regia	6.27	6.4	2.0	45	7.0
Tectona grandis	4.5	7.2	1.25	54	6.0
Morus alba	6.0	6.7	1.0	40	5.0
Polyalthia longifolia	5.78	6.2	8.68	80	18

Source: Agarwal, 2006

T=total chlorophyll (mg/gm of dry wt.);A =Ascorbic acid(mg/gm of fresh wt.);P=leaf extract pH;R=relative water content% ;APTI=Air Pollution Tolerance Index .

A study was taken to determine the air pollution tolerance index of important moist deciduous forest species found near Malabar Cements Ltd. Walayar. *Butea monosperma* was the most tolerant to particulate pollution stress while *Bombax ceiba* was the most sensitive to particulate pollution, while

Tectona grandis which has intermediate tolerance level(Anoob *et al.*, 2016).

A survey was taken by central Pollution Control Board, 2007, which says that the average dust capturing efficiency of leaf ranged from 0.001 gm/cm² to 0.567 gm/cm² during summer and 0.008 gm/cm² to 0.5386 gm/cm² during winter at Mumbai. Out of the 39 species, *Delonix regia* was observed minimum dust capturing capacity while *Ficus bengalensis* has highest dust capturing capacity. It was seen that the maximum dust capturing leaf was of those plants which produce latex and were having moist leaf surface namely *Ficus bengalensis*, *Ficus elastic*, *Thespesia populnea*, *Mangifera indica*, *Anthocephalus cadamba*, *Morus alba* (Shrivastava *et al.*, 2007).

Plants are known to be the sink for air pollutants. Planting trees and shrubs in the form of green belt around the industry is an effective way for abatement of pollution and improvement of environment and well recognized throughout the world. According to a report that green belt of 500 m width was found to be 36% to 40% efficient in removal of SO₂, NO_x and suspended particulate matter (SPM) and 84% to 94% efficient in removal of THC, VOC, CO. (Gupta *et al.*, 2008.)

A recent NASA study by Greg Seaman (2009) has determined the top 10 plants for reducing indoor air pollutants. These are Areca Palm (*Chrysalidocarpus lutescens*), Lady palm (*Rhapis excelsa*), Bamboo palm (*Chamaedora seifrizii*), Rubber plant(*Ficus robusta*), *Dracaena* “Janet Craig” (*Dracaena deremensis*), *Philodendron* (*Philodendron* spp), Dwarf datepalm (*Phoenix roebelenii*), *Ficus Alii* (*ficus macleilandii* “Alii”, *Baston fern* *Nephrolepis exaltata*), *Peace Lily* (*Spathiphyllum* spp).

Noise pollution and its control: Noise pollution or noise disturbance is the disturbing or huge noise that may harm the activity or balance of human or animal life. An increasing trend of noise pollution has been observed in major cities of the country. The source of most outdoor noise worldwide is mainly caused by motor vehicles, transportation system, machines, aircrafts and trains (Senate Public Works Committee, Noise Pollution and Abatement Act, 1972) . Singh and Davar, (2004) says that main source of noise pollution are loud speakers and automobiles.

Major effects of noise pollution include interference with communication, sleeplessness, deafness, mental breakdown etc. High noise levels can affect cardiovascular system, rise in blood pressure, increase stress and vasoconstriction and increase the incidence of coronary artery disease (Rosen *et al.*, 1965). To regulate and control noise pollution, the govt. has issued various notifications under the Environment Protection Act, 1986. The State Pollution Control Board and The Pollution Control Committees will regulate the limits. Public education appears to be the best method as suggested by the respondents.

Green buffer can reduce noise pollution from roads and other sources. A hundred ft. wide planted buffer will reduce noise by 5-8 decibels.

Buffer guidelines for noise reduction along roads:

Moderate speed roads(<40mph)	High speed roads(≥40mph)
Plant a 20-50 ft. wide buffer with the near edge of the buffer within 20-50 ft. of the center of the nearest lane.	Plant a 65-100 ft. wide buffer with the near edge of the buffer within 50-80 ft. of the center of the nearest traffic lane.

Source: Chakre, 2006

Trees having thick and fleshy leaves with petiole and capacity to withstand vibration are suitable. The heavier branches and trunk of the tree also deflects or reflects the sound waves. The density, height and width are critical factors in designing an adequate noise screen plantation. The industry area which produce more than 65 dB. noise is unhealthy to living world. The following species which reduces noise pollution are *Alstonia scholaris*, *Butea monosperma*, *Azadirachta indica*, *Gravellia robusta*, *Tamarindus indica*, *Terminalia arjuna*, *Calotropis gigantea*, *Inga dulcis*, *Sacchara munga*, *Nyctanthes arbor-tristis*, *Nerium oleander*, *Ipomea sp.* etc.

Soil pollution and its control: Soil pollution is defined as “contamination of soil by human and natural activities which may cause harmful effect on living organisms”. On the other hand, soil pollution is define as the chemical or natural materials, entered into the soil, which has cost interference in the natural balance of the soil (Heidari *et al.*, 2014).

Phyto-remediation involves growing plants in a contaminated matrix to remove environmental contaminants by facilitating sequestration and/or degradation (detoxification) of the pollutants (Melinda *et al.*, 2013).

Plants are called hyper accumulators absorb high levels of pollutants without being poisoned themselves. Hyper accumulators take up toxins in soil or waters including heavy metals radioactive contaminants, products. A September 2000 report released by The U.S. Dept. of Agriculture Natural Resources conservation service noted that annual sunflowers (*Helianthus sp.*) were used to remove radioactive contaminants from groundwater. Wild flowers and prairie grasses are contributed to cleanup efforts by degrading petroleum contaminants on oil-spill sites in Kuwait.

Plants that are able to decontaminate soils thus one or more of the following: 1.Plant uptake of contaminant from soil particles or soil liquid into their roots, 2.Binds the contaminants into their root tissue, physiologically or chemically and 3.Transport the contaminant from their root into growing shoot and prevent or inhibit the contaminant from leaching out of the soil.

Water Pollution: Water pollution is the contamination of water bodies (e.g. lakes, rivers, oceans, aquifers and ground water). This type of environmental degradation happens when

different types of pollutants are directly or indirectly discharge into water bodies without adequate treatment to remove harmful compounds.

Water pollution affects the entire biosphere plants and organisms living in these bodies of water .In almost all cases the effect is damaging not only the individual species and population, but also to the natural biological communities.

Water pollution is a major global problem which requires ongoing evaluation and revision of water resource policy at all levels .It has been suggested that water pollution is the leading worldwide cause of death and diseases ,and that it accounts for the deaths of more than 14000 people daily (West *et al.*, 2006).

There are different sources of water pollution like agricultural chemicals, detergents, petroleum hydrocarbons, volatile organic compounds, food processing wastes chlorinated solvents, fertilizers etc. According to Ashraf *et al.*, (2010) says that polluted water consists of industrial discharged effluents, sewage water and rain water pollution. Some water pollution effects are recognized immediately, whereas others don't show up for months or years . Estimation indicates that more than 50 countries of the world with an area of 20 million hectors area are treated with polluted or partially treated polluted water (Hussain *et al.*, 2001) .

Some aquatic plants used for removal of pollutants (Pb ,Cu, Cd, Fe, Hg and Cr) from leather industries are *Hydrilla verticillita*, *Spirodela polyrrhiza*, *Bacopa monnieri*, *Phragmites kaka*, *Seirpus lacustris*, Water hyacinth (*Eichhornia crassipes*), Pennywarth (*Hydrocotyle umbellata*), Duck weed (*Lemna minor*), water velvet (*Azolla pinnata*) .

Results of the plant chemical analysis showed that Kangkong(*Ipomoea aquatic*) and Duck lettuce (*Ottelia alismoides*) were both efficient in phytoremediating Pb. Analysis of the plants further suggest that the concentration of Pb in Morning Glory (*Ipomoea violatia*) and Duck lettuce (*Ottelia alismoides*) was about 210 percent more than the concentration of Pb of water (Xia and Ma, 2005) **20**.

2. CONCLUSION

Based on the above study it can be concluded that the plant has crossed the threshold of the environmental pollution. So, we should aware to rescue our world by reducing Environmental pollution and make healthy atmosphere for human as well as others. At present, planting of different plants like trees, shrubs, house plants, etc. can reduce the pollution and minimize human diseases. While comparing the other strategies, policies and technologies for controlling pollution and protecting life on earth, increasing green infrastructure remains unparalleled, incomparable and most effective technology.

“Plants clean our air to a greater extent than we realized”

—Karl Thomas

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