# ASSESSMENT OF AIR POLLUTION ON MORPHOLOGICAL AND PHOTOSYNTHETIC RESPONSES OF SOME HIGHER PLANTS

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**Abstract**

*Air pollutants are responsible for reduction of biological and physiological response of various plants and crops grown in polluted areas. Plants are an integral basis for all ecosystems and also most likely to be affected by air borne pollution which are identified as the organisms with most potential to receive impacts from ambient air pollution. The resistivity level of tree species to air pollution within polluted area has been evaluated on the basis of air pollution tolerance index (APTI) value. Six parameters such as pH of leaf extract, morphological parameters, Photosynthetic activities, turgid weight, ascorbic acid content were determined and APTI was computed. In general, the growth and development of plant was found to be negatively affected by cement dust, which may be due to the presence of different toxic pollutants in the cement dust.* It concluded that the cement industry pollution affect the photosynthetic activity and biochemical content adversely.

Keywords: *Cement, Air pollution, Chlorophyll, Toxic effects, Dry weight, Ascorbic acid*

## 1. INTRODUCTION

Atmospheric mineral dust is an important source of air pollution, contains high concentration of many metals known to have toxic effects not only on plants and animals but also on humans. On account of the gravity of the problem, predictions of air pollutants such as sulphur dioxide ($SO_2$), nitrogen dioxide ($NO_2$), carbon monoxide (CO) and suspended particulate matter (SPM) during the manufacturing with the causes, effects and the cost to the mankind. The proposed measures should limit the ambient air pollutant concentrations to be incompliance with the standard values the selected parameters.

Air pollution can be defined as the human introduction into the atmosphere of chemicals, particulate matter or biological materials that cause harm or discomfort to humans, or other living organism or damage the environment[1]. It is a major problem arising mainly from industrialization [2]. It can directly affect plants by leaves or indirectly via soil acidification [3]. It has also been reported that when exposed to air pollutants, most plant experience physiological changes before exhibiting visible damage to leaves [4]. It is one of the greatest environment evils.

The air breathe has not only life supporting properties but also life damaging properties of human. It has been known for at least 240 years that air pollution can have damaging effects on plants [5]. Air pollutants both, gaseous and particulate are known to produce a measurable effect on plants. The adverse effect of dust settled on leaves has been reported by [6]. The harmful effects of air pollution on vegetation have already been well documented. It is a chemical or particulate matter or biological agent that changes the natural characteristics of the atmosphere. Air pollution due to lime and cement producing industries has been found to cause serious occupational health hazards, and adverse effects on crops, orchards and buildings.

The symptoms of plant or any biochemical changes in the plants acts as an indicator of the polluted environment. Since, the plant system is completely exposed to atmosphere and always the leaves exchange the gaseous molecules in and out of the system, any change in the atmosphere are reflected on the plant health. Thus regular monitoring of certain parameters of the plant physiology and biochemical parameters in plant indicates air pollution in terms of the severity and degree. Most obvious symptoms are chlorosis, necrosis and epinasty [7]. Plants experience a wide array of symptoms when exposed to pollutants during photosynthesis, respiration, enzymatic reactions, stomatal behaviour, membrane disruption, senescence and ultimately death. In India, the economic loss of plants as a result of air pollution is not documented yet, but there are reports that it does damages to the crops [8].

V. Kaikatti is an important place in Tamilnadu, located in Ariyalur district. It is located 250 kms south west of Chennai and 60 kms from Trichy. It is also called as 'Cement City' there is many cement plants in and around Ariyalur and the soil is rich in limestone. Hence, there is heavy amount of smoke released in the surrounding areas polluting the environment. Electro static precipitator abbreviated as ESP is mandatory for the cement

factories which minimizes the dust particles by electrostatic precipitation for making the environment clean. Even after the instillation of ESP, air pollution level in Ariyalur is reported to be high.

Plants have a very close interrelationship with the environment and any altered condition of the atmosphere plays strong impact on its physiology and biochemistry. The damage to the vegetation as a result of air pollution is important from the point of both agricultural production and ecological balance. Plants exposed to the atmospheric pollution; they altered physiological activity by expressing changes in its biochemical parameters. The plants can be used as a bio-indicator to monitor the local air quality. Trees being very important in providing medicinal and dietary values for human beings and also providing shelter in road side are the victims of the drastically increased air pollution.

This present investigation on air pollution tolerance indices of trees growing around the industrial and automobile areas is to evaluate the tolerance levels of selected plants. For the estimation of air pollution levels, three plants in and around Ariyalur would be considered for the study. All plant leaves collected from the V. Kaikati, for the estimation of morphological and biochemical responses. Control plant leaves are collected from Ka.Ponparappiyan Street, is Kavanur village in the Ariyalur taluk of Ariyalur district, Tamil Nadu, India, since the place is considered to be free from cement dust.

## 2. MATERIALS AND METHODS

### 2.1 Study area

V. Kaikatti is located at 11.112°N and 79.1711°E, respectively. Latitude and Longitude can be mapped to closest address of Ariyalur, Tamil Nadu, India.

### 2.2 Collection of plant samples

a. *Mangifera indica* (Neelum) b. *Anacardium occidentale* (Virudhahcalam-3) and c. *Eucalyptus globulus* (Southern blue gum). The leaves from each matured plants were collected for analysis and immediately placed in labelled for laboratory testing.

### 2.3 Morphological and Biochemical parameters

Leaves brought to the laboratory are weighed with dust and then washing, width and length of the leaves were measured. Chlorophyll and carotenoids were estimated by method of [9]. The pH of leaf extract was determined by [10]. The level of significance of the ascorbic acid was determined by [11].

## 3. RESULTS AND DISCUSSION

The present study showed that air pollution causes significant changes in leaf micro morphology of three plant species such as *Mangifera indica, Anacardium occidentale* and *Eucalyptus globulus* growing at polluted site compared with the same plant species growing at the unpolluted site.

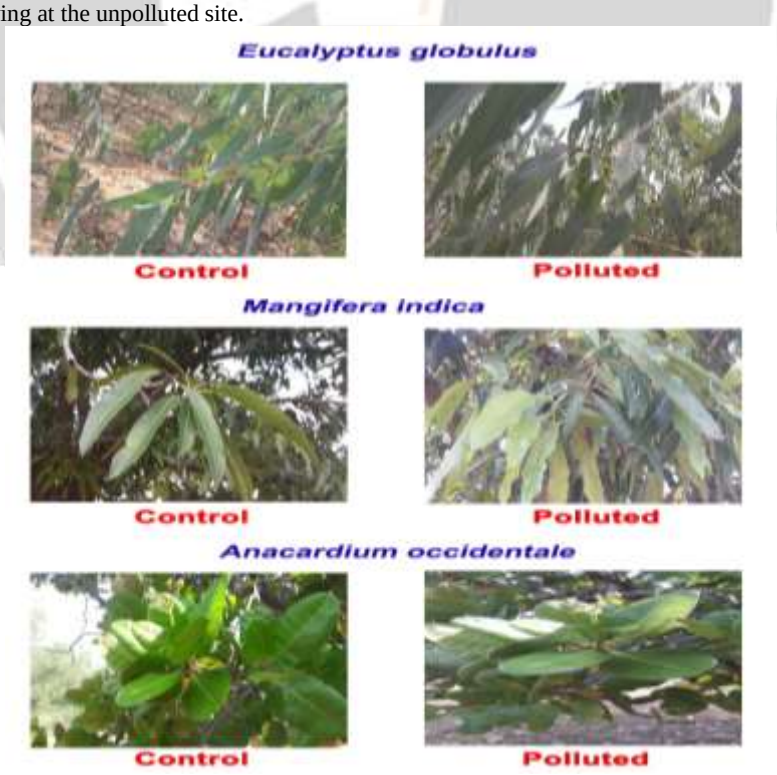


**Fig -1** Collection of polluted and unpolluted leaf

The pH of leaf extractives from polluted and non-polluted areas are summarized in Fig-2. The pH in plants from polluted and Non-polluted plants ranged from 4.98 to 6.1 and 5.97 to 6.11 respectively. There were significant ($P < 0.05$) variations observed in mean pH of plants from polluted and Non-pollute areas. Similar

result was observed by [12], who recorded the higher pH of leaf extractives provides optimal pH for synthesis or reducing activity of important antioxidants such as ascorbic acid, thereby protects enzymes involved in $CO_2$ fixation cycle and chlorophyll inactivation from the oxidative stress induced by pollutants.

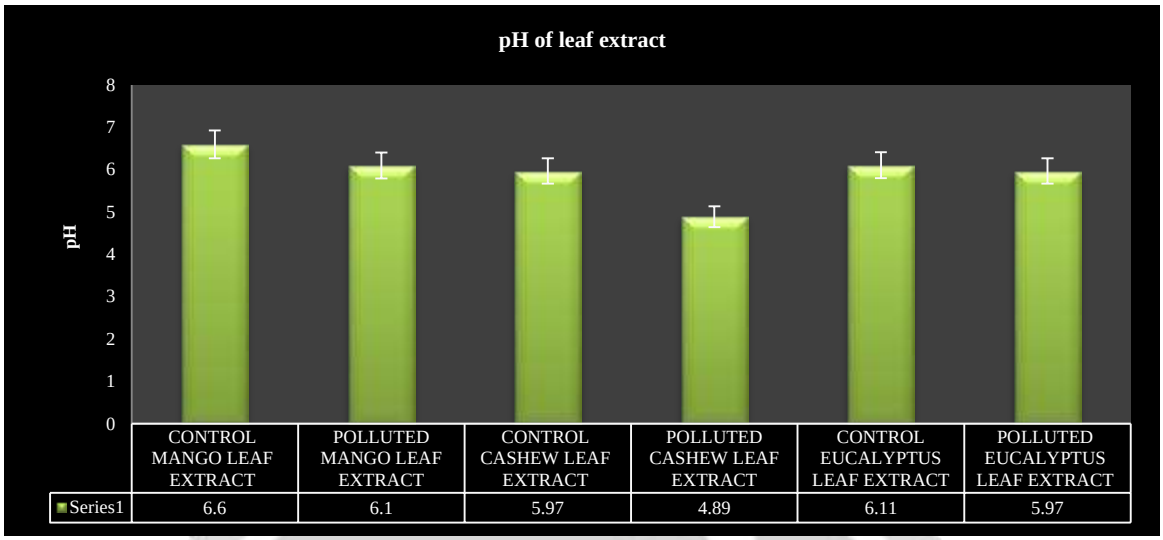


**Fig.2** Effect of air pollution tolerance on pH of leaf extract

The dust accumulation of the selected plant species varied significantly with species, horizontal distances. The maximum dust was accumulated in *Mangifera indica* which was significantly different from all other values whereas, minimum dust was noticed in *Eucalyptus globulus* Fig-3. The present findings are in congruence with [13] and [14] who reported that dust deposition capacity of plants depends on their surface geometry and leaf external characteristics. The similar results were reported by [15] who concluded that morphological characters play a significant role in the interception of dust load.

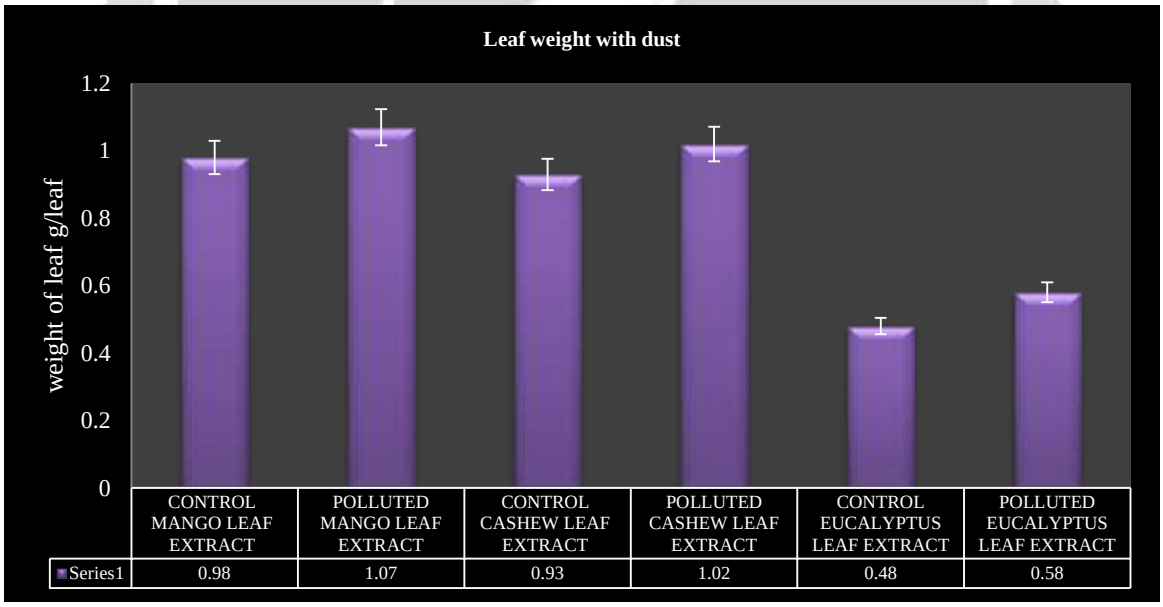


**Fig.3** Effect of air pollution tolerance on dust with weight of leaf

Leaf length and width of leaf was higher in control site and lowest leaf length and width of leaf was observed in polluted site of three plant species growing at polluted site compared with the same plant species growing at the unpolluted site Fig. 4, 5. Similar results finding by following authors who recorded the accumulation of dust particles depends on internodal distance, petiole length, leaf area, orientation, margin, folding and arrangement, hair density, hair type and length [16] and [17]. Most of the effects of the dust particles on plants include the potential to block and damage the stomata such that photosynthesis and respiration are affected. Particulate pollutants can cause many lethal effects on plants like stomatal clogging, reduced photosynthetic activity, leaf fall and death of tissues [18].

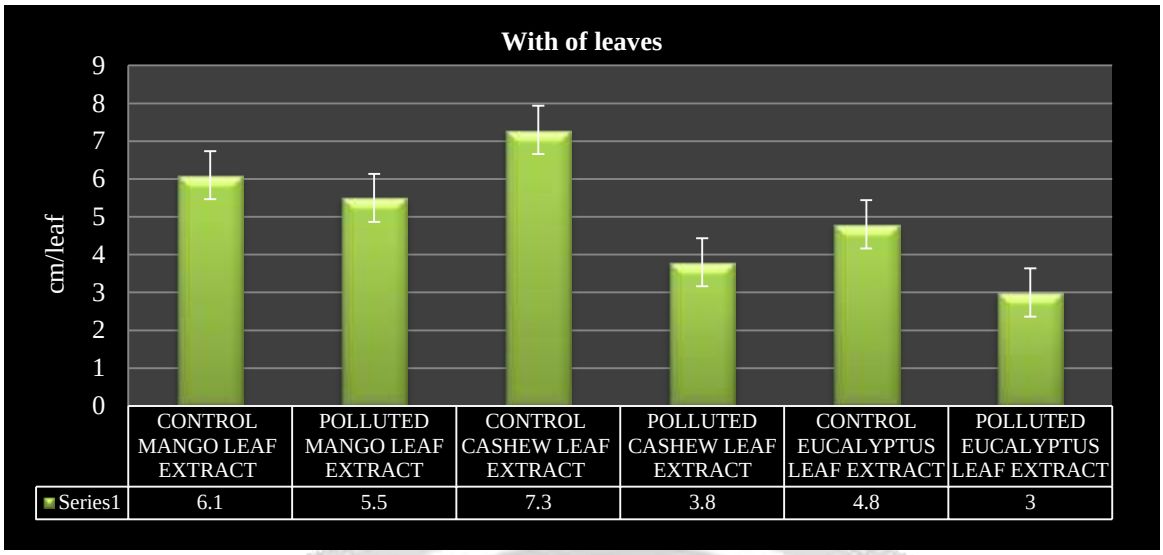


**Fig.4** Effect of air pollution tolerance on width of leaf

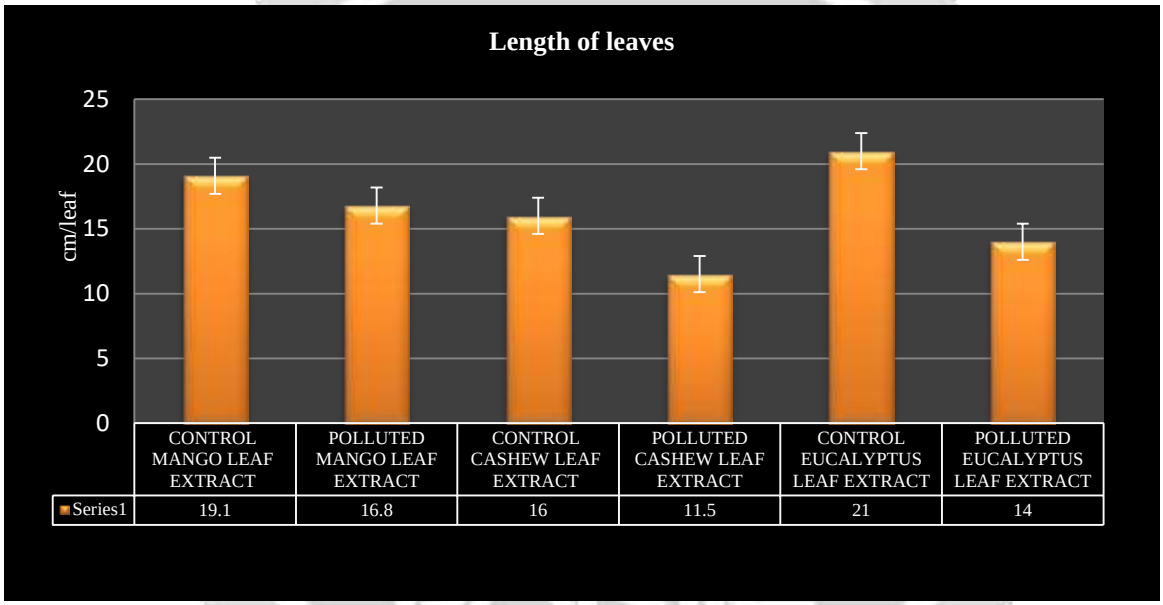


**Fig.5** Effect of air pollution tolerance on leaf length

The chlorophyll and carotenoid were higher in control site and lowest chlorophyll and carotenoid were observed in polluted site of three plant species such as mango, cashew nut and eucalypton compared with the same plant species growing at the unpolluted site Fig. 6 and 7. These results are in line with findings of following authors who reported the deposition of cement dust over the surfaces of the groundnut crops leaf reflects changes in morphological and biochemical content of the plant when compared with non-cement dusted plant. Chlorophyll content of plant signifies its photosynthetic activity as well as the growth and development of biomass. Chlorophyll content of plant varies from species to species depending upon the age of leaf, pollution level as well as other biotic and abiotic condition by [19]. The chlorophyll content was found to be low in the leaf samples collected from industrial site as compared to the non-industrial site for all the investigated plant species. Carotenoids protect photosynthetic organisms against potentially harmful photoxidative processes and are essential structural components of the photosynthetic antenna and reaction centre [20].

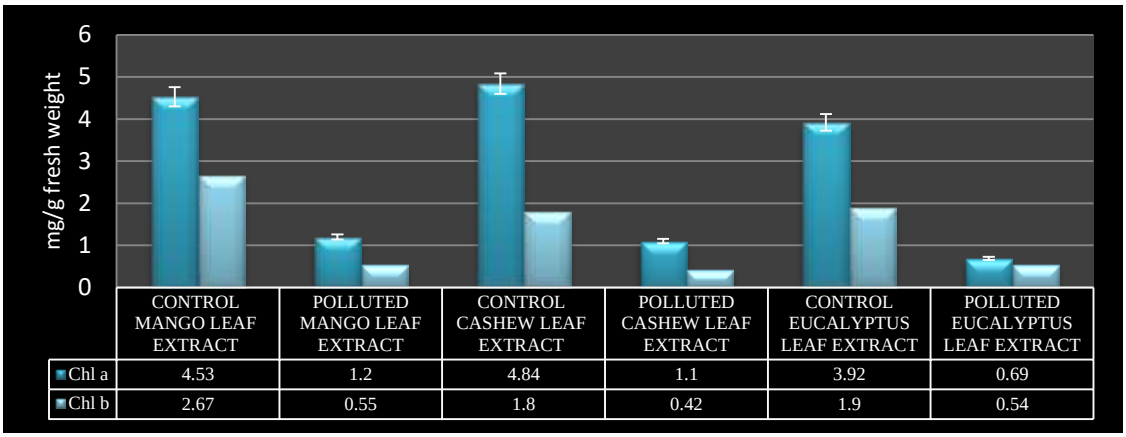


**Fig.6** Effect of air pollution tolerance on chl 'a' and chl 'b' of leaf

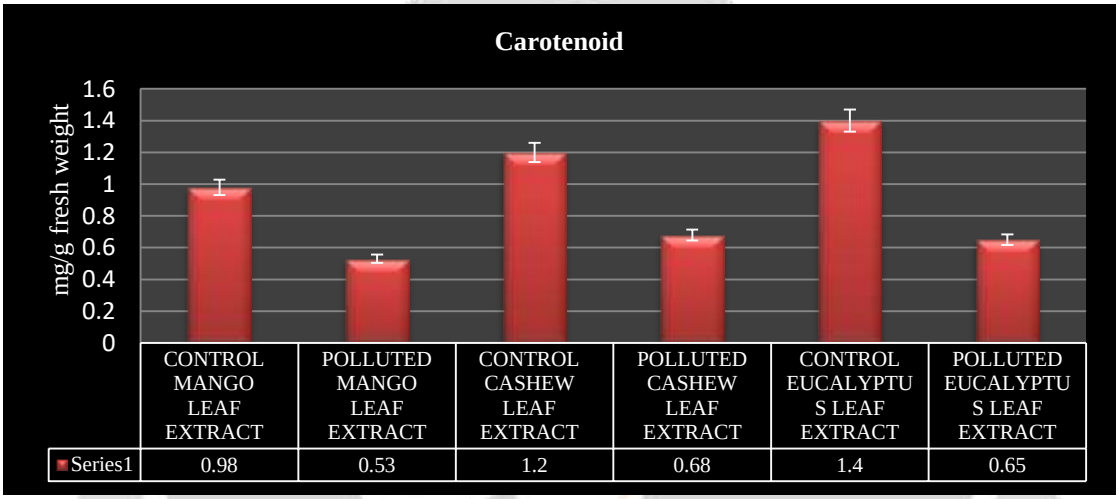


**Fig.7** Effect of air pollution tolerance on carotenoid of leaf

Impact of dust accumulation was observed fresh, dry weights and turgid weight from leaves of these species. The maximum dust accumulation occurred in the plants growing at polluted sites while, trace of the dust was found on plants growing at control site (Fig. 8, 9 & 10). These results are also accordance with findings of following authors who reported the dust accumulation has caused a significant effect on almost all foliage and biochemical attributes of all the plant species. Foliage attributes of all the plant species showed specific responses because in some plants a positive correlation was observed between foliage attributes and dust load but in other plants it was negative by [21].

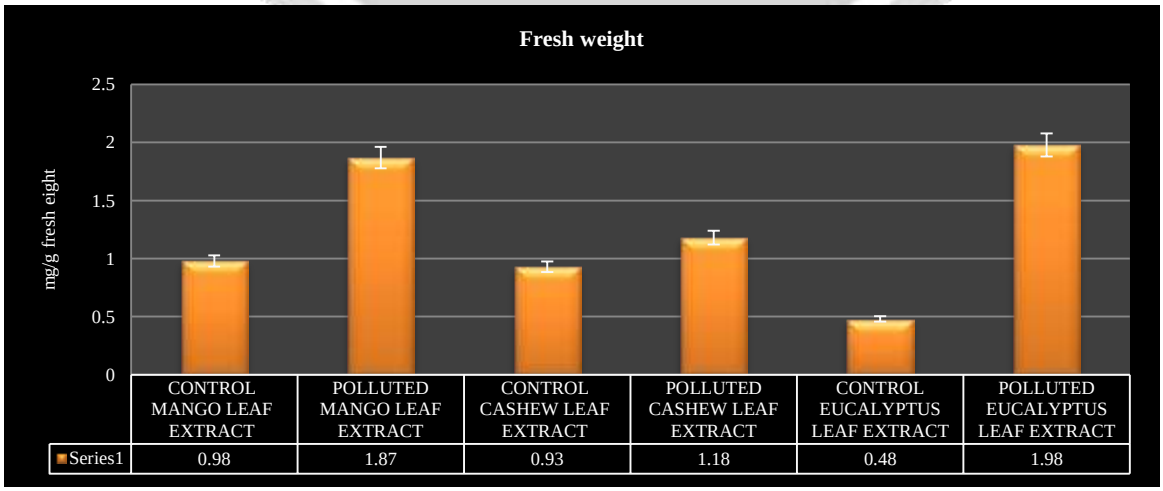


**Fig.8** Effect of air pollution tolerance on fresh weight of leaf.

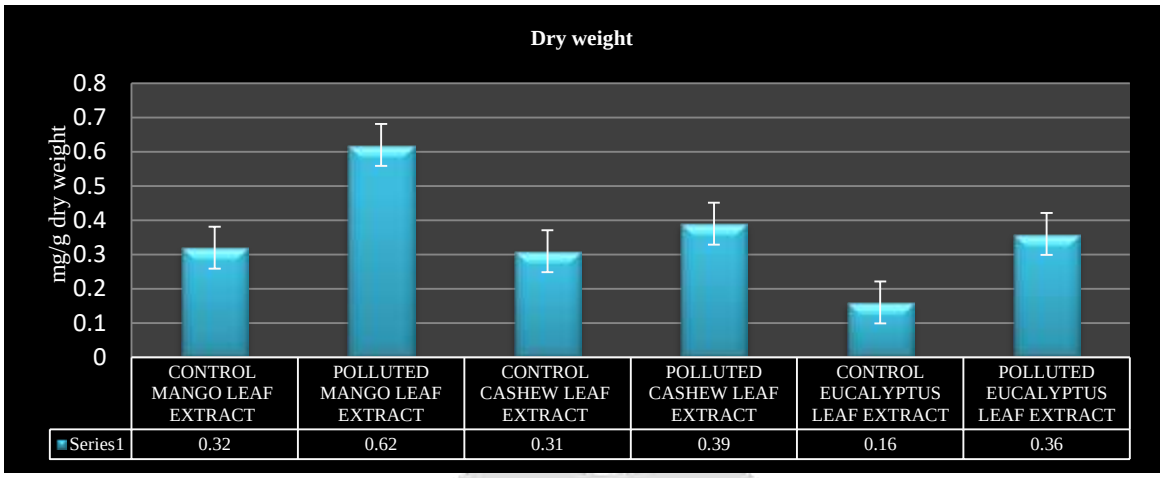


**Fig.9** Effect of air pollution tolerance on dry weight of leaf

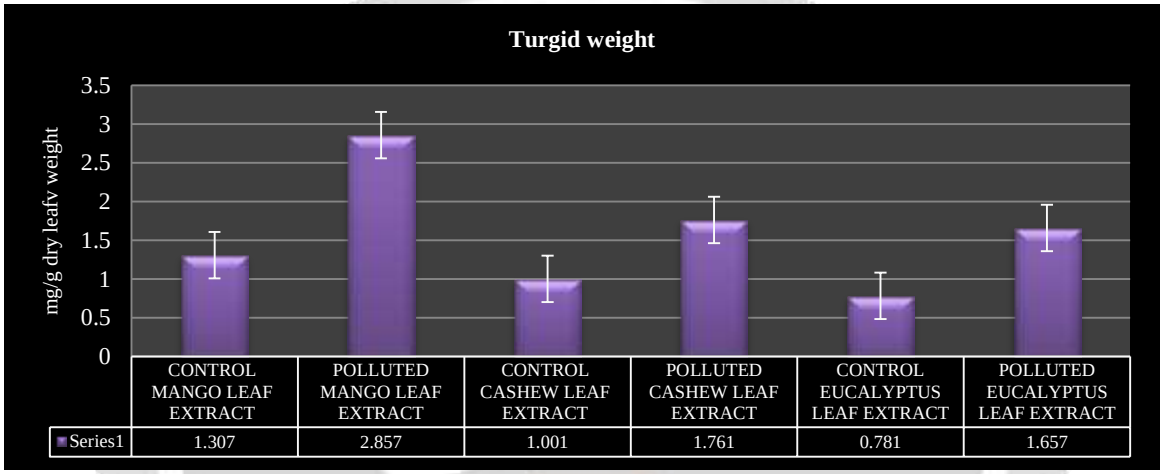


**Fig.10** Effect of air pollution tolerance on turgid weight of leaf

The highest content of ascorbic acid was found in *Anacardium occidentale* (7.14 ± 0.97 mg/g fresh weight) and the lowest value was recorded (5.73 ± 0.76 mg/g fresh weight) for *Eucalyptus globules* Fig.11. The present result consonance with [12] reported that higher amount of ascorbic acid in the leaves shows the tolerant capacity of plants towards pollution. Boost in the level of ascorbic acid content may be due to the resistance mechanism of plant with stress condition [21]. Ascorbic acid being a strong recusant protects chloroplasts against sulphur dioxide induced hydrogen peroxide in to oxygen and OH accumulation and this protects the enzymes of the $CO_2$ fixation cycle and chlorophyll from inactivation by [22].

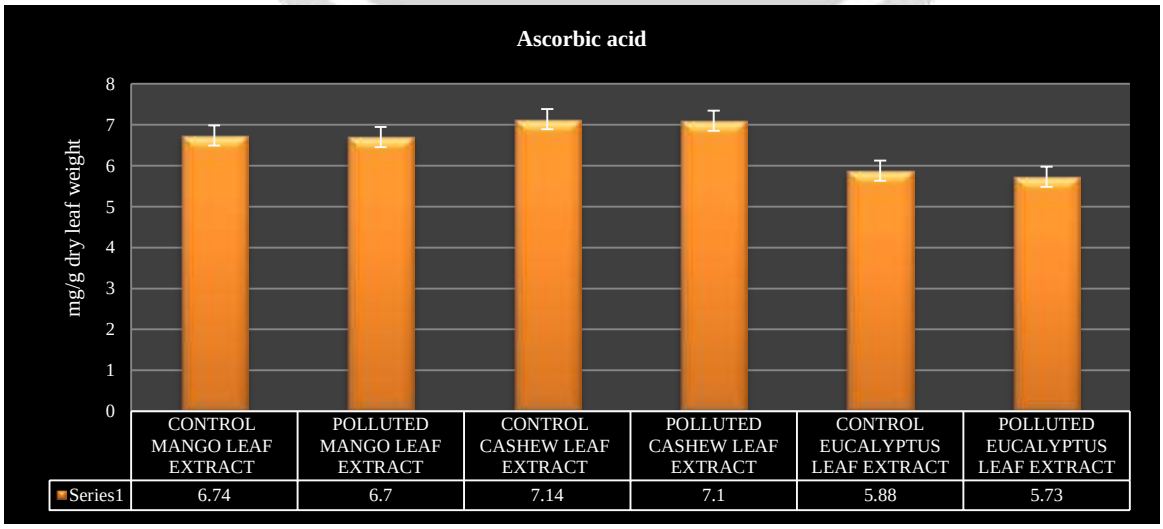


**Fig.11** Effect of air pollution tolerance on ascorbic acid content of leaf

The highest air pollution tolerance index (APTI) was found in *Eucalyptus globules* (8.42 ± 1.65 mg/g fresh weight) and the lowest value was recorded (6.61 ± 1.05 mg/g fresh weight) for *Mangifera indica* Fig.12. These result is in line with findings of [15], who investigated APTI of six plant species, namely, *Conocarpus, Myrtus, Prosopis, Eucalyptus, Ziziphus* and *Lebbek* in polluted and in Ahvaz region, Iran. The order of tolerance reported 4.97 for *Prosopis*, > 5.25 for *Ziziphus* > 6.24 *Lebbek* > 6.59 *Conocarpus*, > 6.77 *Eucalyptu*>7.80 *Myrtus* in blank site and 4.57 for *Prosopis*, 4.82 for *Ziziphus*, 5.79 for *Lebbek*, 5.84 for Eucalyptus, 6.30 for *Conocarpus* and 7.21 for *Myrtus* in the polluted area at the end of study. The APTI showed that *Myrtus* is resistant to plant pollution, whereas *Prosopis* is sensitive to plant pollution. In addition, the results of assessment of the above mentioned index showed that plants with higher APTI can be used as reducers of pollution and plants with lower APTI can be used to measure air pollution.

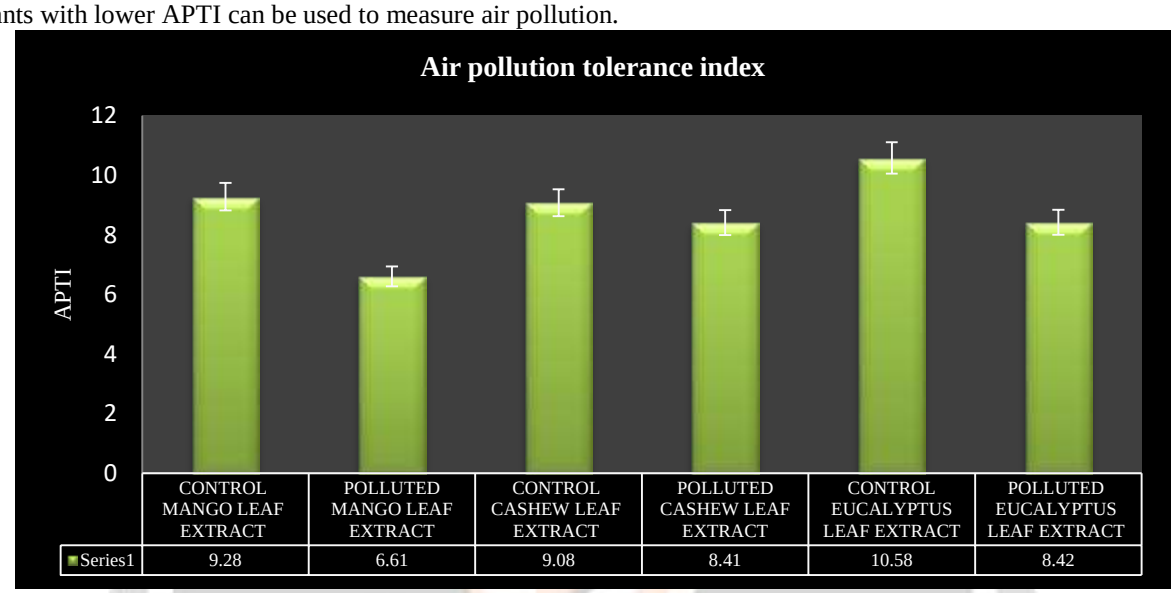


**Fig.11** Effect of air pollution tolerance index (APTI) on leaf

## 4. CONCLUSION

The present study has shown that the deposition of cement dust. It has an effect on vegetation characteristics and natural communities that may alter the competitive balance between plant species. The physico-morphological characters of trees were studied at different distances from the industry and compared with control plant. It could be concluded that the various photosynthetic and biochemical parameter like chlorophyll 'a', 'b' carotenoids and ascorbic acid of the three species, *Mangifera indica*, *Anacardium occidentale* and *Eucalyptus globulus* were found to be highly affected. Increasing and decreasing levels of various plant parameters at selected sites can be considered as an adaptation of the plant that environmental condition to protect plants against air pollution stress. Thus, they could be considered as bio-indicators of air pollution.

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