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Effect of airborne lead pollution on some avenue trees in Moradabad city.

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Abstract *: The present investigation was undertaken to assess the atmospheric lead pollution on the highway and its effect on the leaves of some avenue trees. Emission of lead from the automobile exhaust contaminates soil and surrounding plants. Samples of unwashed leaves were used to assess the concentration level of lead (Pb) in plants and for the purpose the leaves of five different avenue plant species i.e. Holoptelea integrifolia , Ficus rumphii, Anthocephalus kadamba, Alstonia scholaris and Bauhinia variegata were collected from five different locations and were analyzed by ICP. The results indicate that among the plants Bauhinia variegata have the highest concentration of lead (1.81μgg^{-1}) at unpolluted site as well as at polluted site (4.56μgg^{-1}) while Holoptelea intagrifolia the have the lowest (1.01 μgg^{-1}) at unpolluted site compared to the polluted site (2.94μgg^{-1}) possibly due to difference in plant morphology and leaf surfaces. On this basis it may be concluded that Holoptalea integrifolia, Ficus rumphii and Anthocephalus kadamba, are the resistant cultivars and may be grown as avenue trees near highways.*

Key Words: Lead pollution, Avenue trees, automobile exhaust, gasoline.

Introduction

Normally lead is a natural but minor component of soil and plants, contamination of environment with high concentration of heavy metals including lead mainly emitted from automobile exhaust were investigated by various researchers (Sabbioni, 1981; Tripathi, 1994; Singh *et al.*, 2008; Kummer *et al.*, 2009). Thus lead in gasoline being the most significant emission source of lead in the atmosphere.

Plants developed characteristic response and symptoms in response to particular types and level of air pollution, such information can be used in the field surveys of air pollution and the concept of plants as indicators of air pollution was developed by Vousta *et al.* in 1996. Vegetation naturally cleans the atmosphere by absorbing particulate matter through leaves as plant leaf may act as a persistent absorber when exposed to the polluted environment (Maher *et al.*, 2008; Tang *et al.*,2009; Klumpp *et al.*, 2009).

In the urban areas monitoring of heavy metal contamination in vegetation is done by Kozlov *et al* ., (2000) and Peachey *et al.*, (2009) especially growing near roadside . As reported by Ross (1994) aerial sources of metals can contribute >90% of the Pb present in the leaves of various plants in comparison to other metals. In fact deposition of trace metals can be detected mainly on the outer morphology of leaf i.e. their epidermis which makes the possible diffusion of both organic or inorganic ions. (Tomasevic *et al.*, 2005).

In recent years the role of urban trees in improving air quality has recevied increasing attention as trees have relatively higher capacity of metal accumulation compared with other types of vegetation (Monaci *et al.*, 2000; Bealey *et al.*, 2007). Since different plant species differ greatly in their sensitivity to air pollutants it is necessary to choose the resistant trees for the roadside plantations . However, in order to fully assess the effect of heavy metals on plants, there is a need to quantify the role of metals deposition in plants and its potential to accumulate ecologically significant amount of metals. Lead level in plants and vegetables has

Table1. Motor Vehicles in Moradabad (Upto March 2009)

Year	Heavy Vehicles	Passenger Vehicles	Taxi/ Tempo	Four wheeler	Two wheeler	Other	Total
98-99	403	49	222	828	9111	1035	11648
99-2000	312	88	82	944	8309	903	106338
2000-01	192	98	44	830	7581	856	9601
01-02	158	14	80	784	9810	671	11517
02-03	220	52	74	765	11868	607	13586
03-04	822	90	99	1138	14708	424	172081
04-05	1000	98	64	1432	17204	510	20388
05-06	754	136	108	1305	18093	467	20863
06-07	896	89	106	1590	18638	402	21721
07-08	1377	45	100	1829	18678	596	22625
08-09	1247	137	361	1890	19892	550	24077

been also evaluated by Naik and Deshpande, (2000) and Sharma *et al.*, (2008).

Since plants are sensitive to air pollutants they are often used as warning indicator to indicate the presence of a pollutant (Onder and Dersun, 2006). Characteristic injuries to certain plants can be interpreted to show not only the presence but also the relative concentration of the air pollutants. As reported since early times the leaves of higher plants have been used for biomonitoring heavy metals as they act as the scavengers of many airborne particulates in the atmosphere. (Aksoy and Sahin 1999; Kopittke *et al.*, 2007; Baptista *et al.*, 2008; Bidar *et al.*, 2009). Vegetation plays the role of major sink of atmospheric dust (Tripathi *et al.*, 1990; Abdelaziz and Omar, 2007) containing a fair amount of highly toxic heavy metal particles.

Moradabad is known as the Brass city of India and it has been facing unprecedented urban and vehicular population growth which is causing serious degradation of air quality. Brass industries emits huge amount of metal fumes, which adversely affects the plants (Tripathi *et al.*, 1989; Tripathi *et al.*, 2009). In recent years the number of vehicles are increased resulting in ambient air pollution (Tripathi *et al.*, 2010). Thus the present study was conducted to quantify the lead concentration in some avenue trees and to select the resistant plants suitable for roadside plantation.

Materials and Methods

Moradabad is known as 'Pital nagri' as it is famous for brassware industries and contains around 40 lac population . Numerous sources emit air pollutants including several major and minor Brass industries along with other industries located within the city. Moradabad is one of the semi-arid zones towards the north-west of India with extreme summer and winter conditions. It is located at an average height of 76.19 mts above sea level in the western gangetic plain of Indian subcontinent at latitude 28.15 N and longitude 74.49 E .In this congested city, the vehicles are poorly maintained, roads

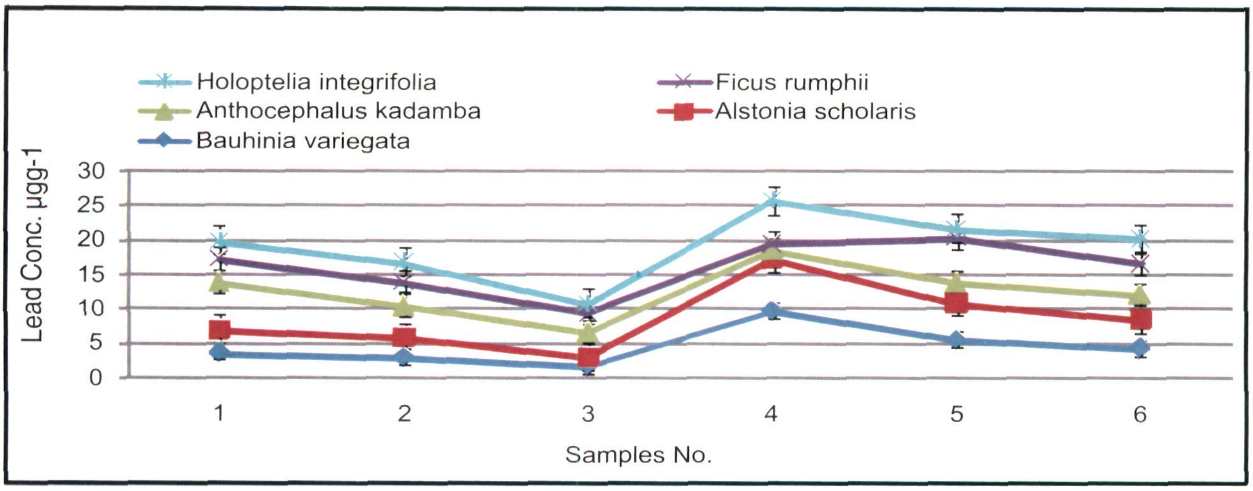

Fig. 1. Lead concentration at Old bus stand (SI) in different plants ±SE.

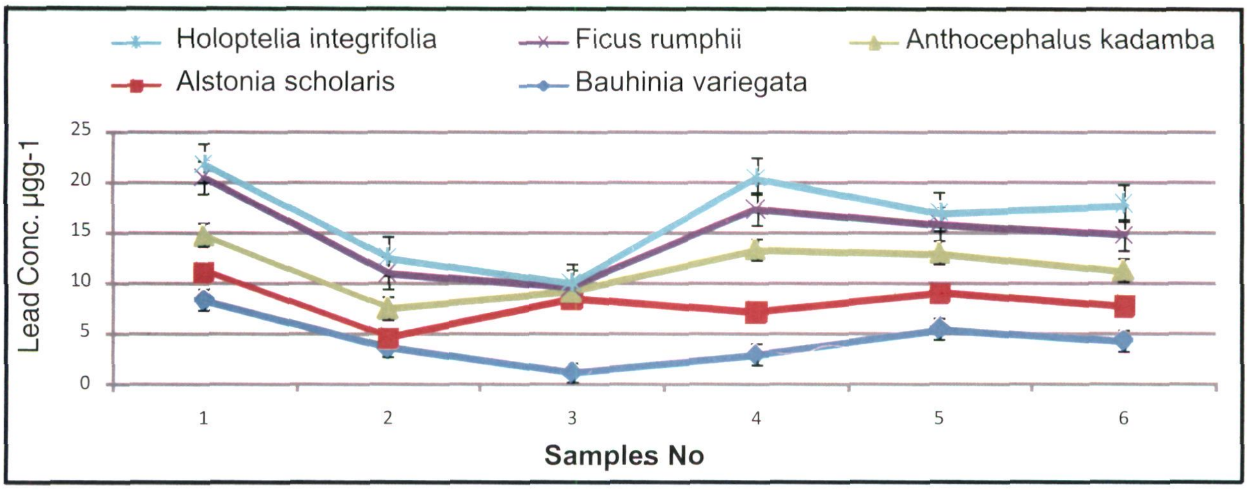

Fig. 2. Lead concentration at Kapoor Company (SII) in different plants ±SE.

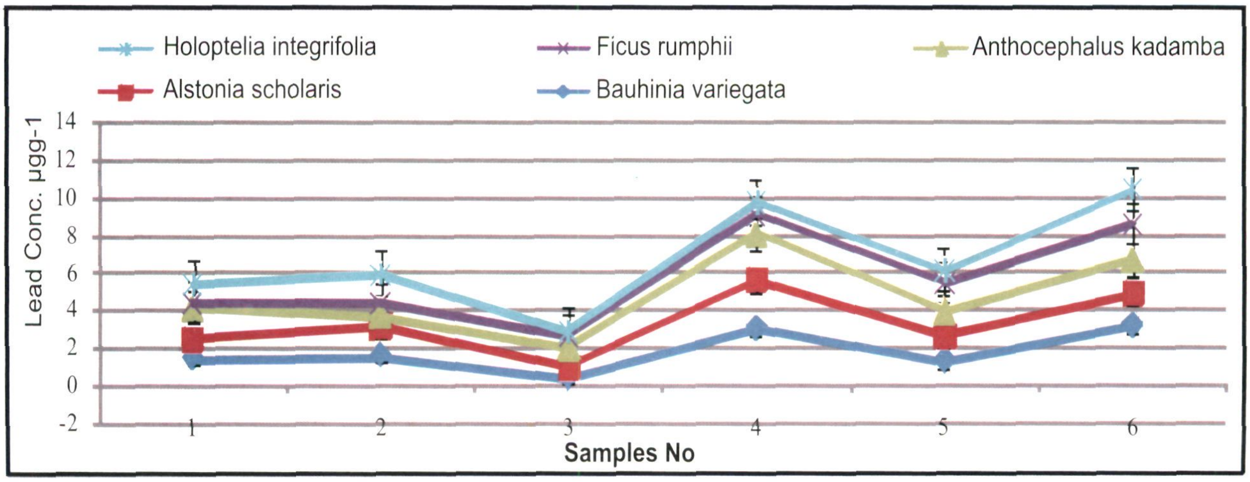

Fig. 3. Lead concentration. at Town hall (SIII) in different plants ±SE.

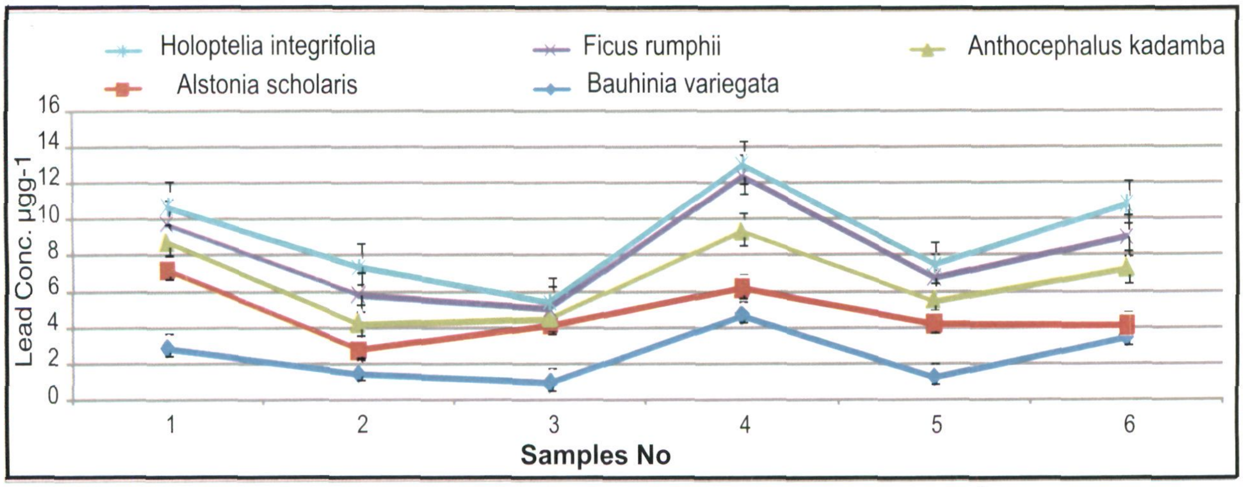

Fig. 4. Lead concentration at Mughalpura (SIV) in different plants ±SE.

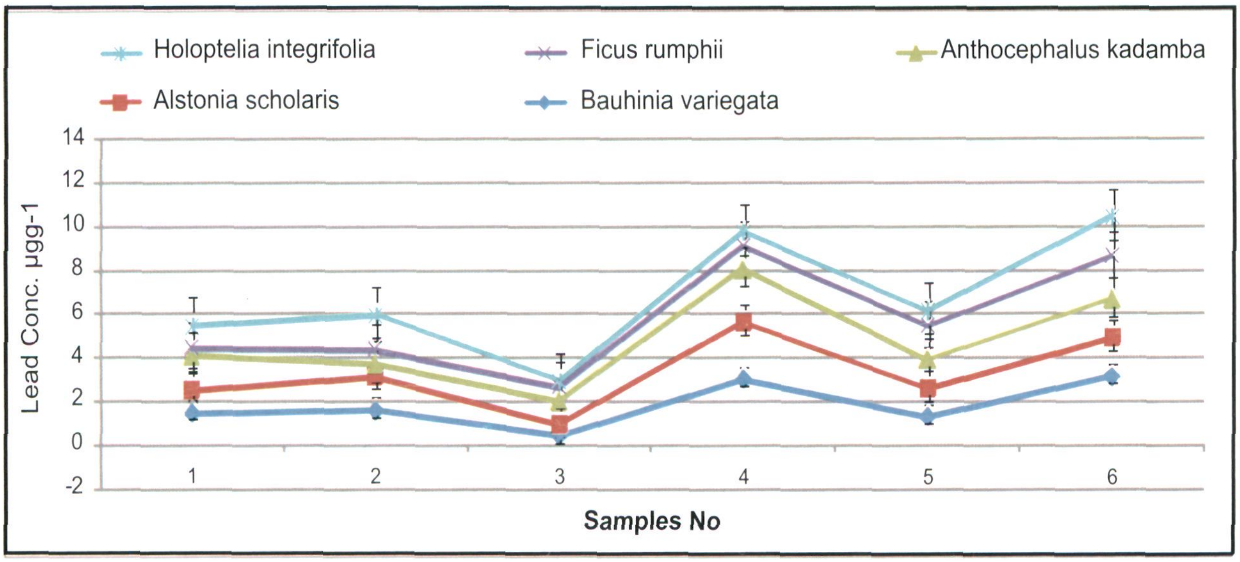

Fig. 5. Lead concentration at P.T.C. (SV) in different plants ±SE.

28.15 N and longitude 74.49 E .In this congested city, the vehicles are poorly maintained, roads are narrow and number of two wheeler is high thus increasing significance of motor vehicles as a source of pollutants . The study was carried out for the period of one year i.e. since 1August 2008 to 31July 2009 to study the effect of airborne lead pollution on the avenue trees located on both sides of the road at different locations of Moradabad city. The selected locations are as follows.

Old Bus Stand (SI):- This is the main bus station situated in the heart of city. The area of this bus station is very limited, and it is surrounded by narrow roads causing traffic jams and congestions and leading to slow movement of traffic. The contribution to air at this site is mainly due to the emissions from public and commercial transportation (buses, trucks, auto rickshaws, and two wheelers) (Table-1).

Kapoor Company (SII) : This is also a very busy crossing . All the buses of Delhi and Haridwar pass through this crossing with an extremely heavy traffic density.

site located in northern part of the city. A large number of shops, restaurants and workshop in addition to some government establishment such as Tehasil is situated near this site. The movement of the traffic is highly congested and slow due to high density of vehicles and encroachment on both sides of the road.

Mughalpura (SIV): *This is an industrial site of Moradabad city having a large number of* brassware industries. It is a very dense area with narrow street. The emission from the industries and automobiles are the major sources of air pollution in this region.

P.T.C (SI) (Police Training Center): This is a residential area having a very large open space and almost free from pollution so somewhere it is treated as a control area .

Atmospheric deposition was collected in the form of Suspended Particulate Matter (SPM) with the help of Respirable Dust Sampler at the rate of two to three samples per week on fiber glass filter paper- EPM 1000 for 24 hrs. with air flow rate of 1-1.15 m^3/min. The difference in initial and final weights of the filter paper gave the total quantity of SPM . A known portion of the fiber paper covered by particulates was cut and digested by nitric acid and perchloric acid on a 140°C hot plate. Residues were then redisolved by 0.1 m hydrochloric acid and a blank was also prepared using the same area of unexposed glass fiber filter paper and by treating the same procedure. These were cooled, filtered and made to 50 ml by distilled water. Concentration of lead was analyzed by Inductively Coupled Plasma-Optical Emission Spectrometer (ICP-OES; Spectro Analytical Instruments, West Midlands, UK) from samples collected for each site.

Five locally available avenue tree species such as *Holoptelea integrifolia, Ficus rumphii, Anthocephalus kadamba, Alstonia scholaris* and *Bauhinia variegata* in and around the different sites were selected for the study. All the species have very dense foliage, combined with the fact that it is leafy throughout the year resulting in a very high particulate capturing efficiency. The fresh leaf samples of selected trees from different sites were carried aseptically to the laboratory and airborne lead pollution was determined by following method .

The leaves were digested in concentrated nitric acid overnight .Then the samples were heated slowly until red fumes of NO_2 ceased. After cooling for few minutes, 70% perchloric acid was added and the samples were heated to reduce the small volume. These samples were filtered through Whatman number 42 filter paper and the filtrate was diluted to 50 ml. using deionised water and kept at room temperature for further analysis of heavy metals. The concentration of lead in filtered samples was analyzed with ICP-OES. Five Replicates of each sample were analyzed and average lead concentration was calculated.

All data were presented as mean, median, range and ± standard deviation were calculated using statistical package, SPSS 11.0 (SPSS USA).

Results and Discussion

Lead concentration in different plants at different locations are displayed in Fig.1-5. The values of experimental plants were examined and a great variation was found between concentration levels of individual plants within as well as between sites. Different lead pollution levels among plants were due to the different accumulation level of airborne lead at different sites and this fact is also supported by Yakupoglu *et al.*, (2008), Kumar *et al.*, (2009) and Singh *et al.*, (2010). The mean lead concentration in *Bauhinia variegata* (3.32 $\mu g g^{-1}$) and *Alstonia scholaris* (2.97 $\mu g g^{-1}$) were higher that the *Anthocephalus kadamba* (2.66 $\mu g g^{-1}$) and *Ficus rumphii* (2.44 $\mu g g^{-1}$) but it was significantly higher than the *Holoptelea integrifolia* (1.6 $\mu g g^{-1}$) at different sites (Table 2). The highest lead pollution levels were found in the samples of different plants taken from heavy traffic density area i.e. Old bus stand (Fig.1) and Kapoor Company (Fig.2) whereas high at Town hall (Fig.3) and Mughalpura (Fig.4) but the lowest lead concentration in samples of different plants at PTC site (Fig.5).

It was observed that all the plant species show maximum concentration at site I (SI) and minimum at site SV. Among all the plants *Bauhinia variegata* have highest concentration of lead at all the sites i.e. SI (4.56 µgg-1) SII (4.42 µgg^{-1}), SIII (3.56 µgg^{-1}), SIV (2.45 µgg^{-1}) and SV (1.81 µgg^{-1}) in comparison to other plant species whereas plant species *Holoptelea integrifolia* have lowest lead concentration at each site as SI (2.94 µgg^{-1}) ,SII(1.85 µgg^{-1}), SIII (1.16 µgg^{-1}), SIV (1.02 µgg^{-1}) and SV (1.01 µgg^{-1}) respectively (Table 2). The lead in each plant at different locations have been arranged in descending order as-

Lead at each location : Old bus stand > Kapoor company > Town hall > Mughalpura > PTC

Lead in Plants : *Bauhinia variegata > Alstonia scholaris > Anthocephalus kadamba > Ficus rumphii > Holoptelea integrifolia.*

According to Table-3 it was observed that all the selected five plant species have very much high lead concentration at polluted site (SI) in comparison to unpolluted site (SV). As it was found during the analysis that *Holoptelea integrifolia* is the most tolerant plant species having a concentration 2.94 µgg^{-1} at polluted site. *Ficus rumphii* and *Anthocephalus kadamba* are considered as moderate tolerant species and *Alstonia scholaris* and *Bauhinia variegata* (4.56 µgg^{-1}) are considered as sensitive species. This fact is also supported by Aydinalp and Marinova, (2004), Aksoy and Sahin, (1999) who made extensive studies on roadside plants. Air pollution may affect plant tissues but the plants which possess strong defense mechanism can survive in critical conditions (Chang *et al.*,2004; Shannigrahi *et al.*, 2004; Ishii *et al.*, 2007; Joshi and Swami , 2007).

Urban trees grown in area away from roads and motor traffic were not free of lead so the consumption of these plants could bring high amount of lead in the food chain (Yocupoglu *et al.*, 2008; Cirera *et al.*, 2009). The concentration of lead in *Holopıetea integrifolia , Ficus rumphii, Anthocephalus kadamba, Alstonia scholaris and Bauhinia variegata* are given in Table-2. Lead concentration determined in different plant species showed that the concentration have often exceeded the safe limit of Indian Standard (Awasthi, 2000) in *Bauhinia variegata, Alstonia scholaris* and *Anthocephalus kadamba* however, it did not exceed the safe limit in *Ficus rumphii* and *Holoptelea integrifolia (*Table 2). Thus this investigation clearly reveals that *Holoptelea integrifolia* and *Ficus rumphii* is the most resistant plant and doesn't respond to atmospheric lead levels. This study is also supported by the findings of Singh *et al.,* (1997) that the lead accumulation in various tissues of plants is related to atmospheric levels of lead. Among the plants *Bauhinia variegata, Alstonia scholaris* retain their leaves for more than two years so the concentration of lead within them may accumulate to significantly greater levels than rest plants reported here that are deciduous (Peachy *et al.,* 2009).

Vegetation growing near road sides in urban areas contaminated mainly due to lead pollution and ingestion is a possible rout of lead exposure and consuming plant grown near roadside is a way that lead reaches in human (Okuda *et al.*, 2008; Pacyna *et al.*, 2009). Hence, all these factors cumulatively contribute to the lead concentration in the range of 0.26 µgg^{-1} to 9.59 µgg^{-1} (Table 2) in different plant species at different sampling locations.

Western European countries introduced unleaded fuel in the late 1980s, and a number of countries now market only unleaded gasoline though there are many other countries including India, that have switched to unleaded gasoline without completely eliminating the sale of leaded gasoline. Therefore, lead pollution due to leaded gasoline still occurs in our cities. The major source of human lead accumulation in developing countries was found to be airborne lead and 90 percent of which comes from leaded gasoline (MECA, 2003).

Lead is highly toxic when present in excessive amount in environment and monitoring of lead is therefore, very essential to protect plants and human health hazard. Lead containing petrol is the major source of lead accumulation in plant leaves and the roadside ecosystem are the natural targets of such lead pollution. Therefore the evaluation of lead concentrations in different plants would prove very useful to control the airborne lead concentration. Present study reveals that plants growing near roadside showed the elevated concentration of lead and this lead accumulation has been correlated with the toxicity in plants. Among the plants studied *Holoptelea integrifolea, Ficus rumphii* and *Anthocephalus kadamba* are considered as tolerant plants and may be grown near highways as avenue trees.

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