Research Journal of Agriculture and Environmental Management. Vol. 5(1), pp. 032-036, January, 2016
Available online at http://www.apexjournal.org
ISSN 2315 - 8719© 2016 Apex Journal International

Full Length Research

A detailed study of heavy metal accumulation across highway plant species

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Accepted 14 January*, 2016; Published 22 January, 2016*

Heavy metal concentration in roadside dust is increasingly affected on roadside plants. Roadside plants leaves were collected from the site, NH-8 highway near Anand city, Gujarat, India, and analyzed for Cd, Cr, and Pb. Metal concentration in such leaves sample indicated that road side dust contained heavy metals. Here, four plants were selected which are commonly present in road side of highway and collected leaves of viz. *Alstonia scholaris, Ficus bengalensis, Polyalthia longifolia, Azadirachta indica.* The sources of contaminated dust which is deposited on leaves are vehicle emission and other anthropogenic activity. Analysis suggested that heavy metals are present in elevated level in roadside plants leaves and dust.

Key words: Heavy metal, Leaves deposited dust, NH-8 highway, road traffic

INTRODUCTION

Heavy metals at trace levels are ubiquitous in natural water, air, dust, soil and sediment (Brown et al., 1990). Many of these heavy metals are considered toxic to living organism and even trace metals considered essential for life can be toxic when present at excessive levels that impair important biological processes and pose a threat to flora and fauna (Morrison et al., 1990). Consequently, in recent years, public and scientific attention has increasingly focused on heavy metal contamination and its negative effect on humans and other living creatures (Wang et al., 2005). In the urban environment, such pollutants are commonly found in highway dust which can be potentially harmful to roadside vegetation, wildlife, and neighboring human settlements (Turer et al., 2001). The source of these major pollutants was supposed to be due to road surface wear, road paint degradation, vehicle wear debris of tyre, body, brake lining etc. These pollutants are migrates via dust and get deposited on various sites of plants.

Road deposited dust does not remain deposited for long (Lu et al., 2009). It is easily re-suspended back into the atmosphere, where they contribute a significant amount of trace element (Faiz et al., 2009). In general, influences between air and soil pollution are mutual. Just as the atmosphere can transfer a large amount of heavy metals into urban soils through precipitation (Ritter et al., 1983) soil dust can also contribute to the concentration of heavy metals in the air (Chen et al., 1997)

Vehicular transportation is now a cause of major concern. Pollution of the natural environment by heavy metals is a worldwide problem because these metals are indestructible and most some of these elements are essential for humans, at high levels they can also mean toxicological risks (Domingo and J. L, 1994).

Sakagami et al. (1982) study has confirmed the mutuality of the close relationship between heavy metal concentration in topsoil and in the dust falls. Therefore, heavy metals in highway dust can generate airborne particles and dust which may affect air environmental quality.

Environmental pollution of heavy metals from road traffics emission has attained much attention in the recent past due to their long-term accumulation. Several studies have proved that roadside environments are polluted by heavy metals released during different operations of the road transport. Heavy metals such as Pb, Cd, Cu, and Zn have been reported to be released into the atmosphere during different operations of the road transport (Zhang et al., 2012; Akbar et al., 2006; Sharma and Prasade, 2010; Atayese et al., 2008).

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The use of leaded gasoline in cars is one of the major sources of Pb pollution in cities around the world. According to (Irami et al., 2009) road traffic is responsible for over a thousand tones of Pb each year, as a result of lead additives in petrol. Soils, plants and food are major receptacles for this atmospheric emission.

The pollution of an agricultural soil by heavy metals from automobile sources is a serious environmental issue due to their potential accumulation in bio system. Heavy metals van the body through soil and dust, dermal contact, breathing and food chain. Total heavy metal content of soils is useful for many geochemical applications but often the speciation of these metals is more of an interest agriculturally.

Heavy metal toxicity has negatively effect on plant such as growth, enzymatic activity, stoma function, photosynthesis activity and so on (Onder et al., 2007; Akber et al., 2006; Ayodede and Olyomi, 2011).

Metals accumulate in highway dust and in the leaves of roadside plant through atmospheric deposition involving sedimentation, impaction and interception. Although there have been a considerable number of studies of heavy metals concentration in roadside soil and plants, the vast majority of these have been carried out in developed countries with long histories of industrialization and extension use of leaded gasoline and very few studies have been carried out in developing countries such as India where data on the concentration and distribution of metals in highway dust is scarce. Therefore, this study examines heavy metal levels highway dust and dust deposited on plant along a major traffic highway in National highway 8(NH-8) near Anand city, Gujarat, India.

In view of the increasing evidence of the adverse effects of road deposited dust on the human health and environment, not much data on road dust, one of the major pre-requisite for health studies, is available major cities and districts Gujarat, although a large population live in those places. In the present study, an attempt has been made to generate evaluate levels of trace heavy metals, Cd, Cr, and Pb in road side deposited dust in the NH-8 highway near Anand city, Gujarat, India.

MATERIALS AND METHODS

Study area [National highway-8 near Anand City, Gujarat, India]

National Highway 8 (NH 8) is a 4- lane (6-lane between Delhi-Jaipur) National Highway in India. According to estimates, it is the busiest highway in the subcontinent, as it connects the national capital Delhi to the financial capital Mumbai, as well as important cities Gourgaon, Ajmer, Udaipur, Ahmedabad, Surat, Jaipur, Kotputli and Vadodara.The total length isn 1,428 km (887 m) (Figure 1).

Sampling

Roadways were selected on the basis of traffic load and anthropogenic activities. A detailed description of the selected site is given in Table 1. Description of the traffic load and site related information was collected from the road transport office, Anand and urban planning department Anand. People surrounding the study area use their vehicles for going to work nearby cities like Anand and vadodara. Heavy duty vehicles and 4-wheeler are continuously use NH-8 for transportation.

Bioaccumulation of heavy metals by selected plant species

Leaf samples were of four different plant species growing along the roads viz. *Alstonia scholaris, Ficus bengalensis, Polyalthia longifolia, Azadirachta indica* were picked at a height of 2 m which contained dust particles. These four species were selected because they were commonly found throughout roadway. The leaves were dissolves in 200 ml de-ionized water and settle down dust particles and collected after removing supernatant. Each leaf of plant species and dust was dried at 80°C in hot air oven for 48 h. All the samples were chemically analyzed for detection of Cd, Cr, and Pb. Accurately 1 g of dry powder of each sample was weighed with the help of electronic Balance, and digested with HNO_3 and H_2O_2 as prescribed by (Saison et al., 2004). Later, the digested samples were diluted with 25 ml of distilled water. The blank were run with set, and the samples were analyzed in Inductive Coupled Plasma Spectroscopy (ICP), Perkin Elmer, and Optima 3300 RL. The concentration of metals was represented in ppm.

RESULT AND DISCUSSION

Biomonitoring

The results of metal accumulation on roadside *polyalthia longifolia* are tabulated in Table 2. From the results found that accumulation of Pb was comparatively higher than other Cd and Cr respectively.

A close observation at Table 2 specified that Pb have gained more prominance in roadside dust studies as against Cr and cd (Addo *et al.,* 2012)

The results of metal accumulation on roadside *Alstonia scholaris* are tabulated in Table 3. From the results found that accumulation of Cr was comparatively higher than other Pb and Cd respectively.

The results of metal accumulation on roadside *Ficus bengalensis* are tabulated in Table 4. From the results found that accumulation of Cr was comparatively higher than other Pb and Cd respectively.

The results of metal accumulation on roadside

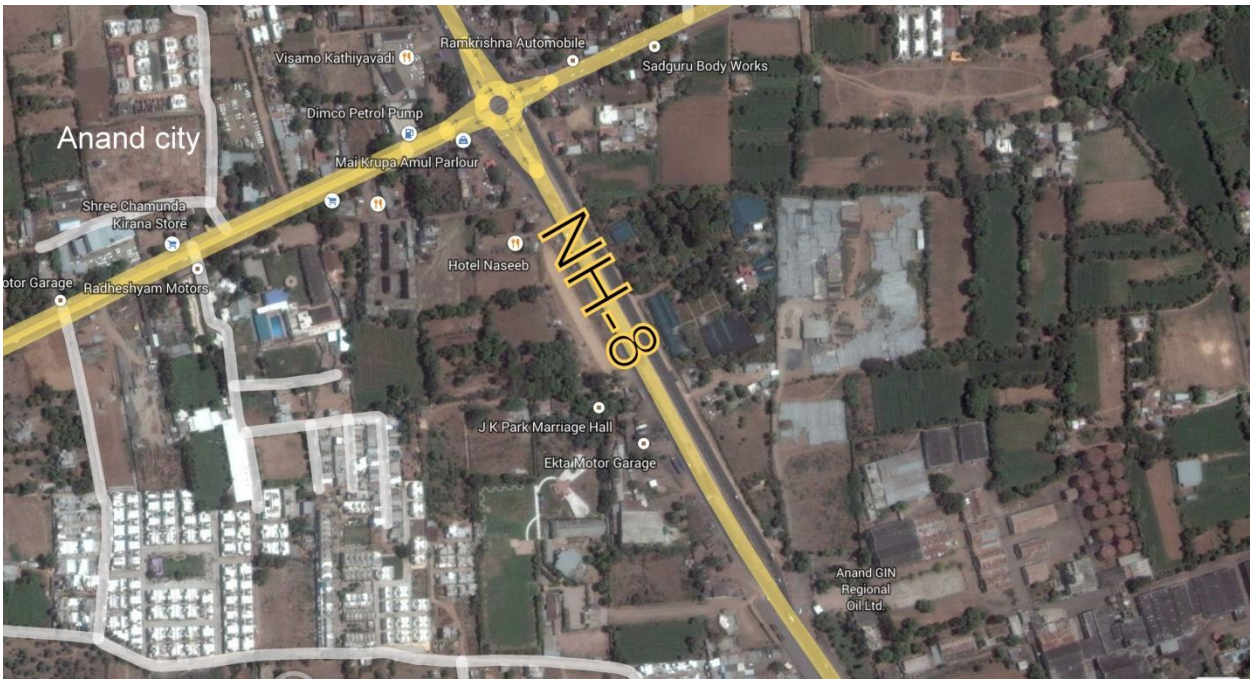

Figure 1. Study area- National Highway-8 (NH-8) (Satellite image).

Table 1. Description of sampling site.

Type of vehicles	Numbers of vehicles/hour	Site description
2-Wheeler	2376	
Car,3- wheeler, jeep	1975	
uses	265	Heavy traffic, semi urban area, agricultural field
Heavy duty vehicles	1056	Industrial area
Tractors	84	
Total	5756	

Table 2. Bioaccumulation of heavy metals by *Polyalthia longifolia* plant leaves

Polyalthia longifolia	
Element	**Metal accumulation in leaves (ppm)**
Chromium	0.504
Cadmium	0.987
Lead	3.259

Azadirachta indica are tabulated in Table 5. From the results found that accumulation of Pb was comparatively higher than other Cr and Cd respectively.

Conclusion

While highway dust and dust deposited on leaf surface in surrounding of NH-8 highway contained elevated levels of heavy metals, metal contamination was much lower to other studies of metal in dust from around the world. Among the site studied, the extent of metal pollution in highway dust was influenced more by heavy traffic than by industrial activities.

Among all the metals considered Cd, Cr and Pb concentration were most elevated. The result of analysis also suggested that vehicular traffic represent the most important sources of toxic heavy metals. Plant capture dust and accumulate in their leaves of *Polyalthia longifolia, Alstonia scholaris, Ficus bengalensis* and

Table 3. Bioaccumulation of heavy metals by *Alstonia scholaris* plant species.

Alstonia scholaris	
Element	**Metal accumulation in leaves (ppm)**
Chromium	2.746
Cadmium	0.065
Lead	0.467

Table 4. Bioaccumulation of heavy metals by *Ficus bengalensis* plant species.

Ficus bengalensis	
Element	**Metal accumulation in leaves (ppm)**
Chromium	2.305
Cadmium	0.008
Lead	0.539

Table 5. Bioaccumulation of heavy metals by *Azadirachta indica* plant leaf

Azadirachta indica	
Element	**Metal accumulation in leaves (ppm)**
Chromium	1.799
Cadmium	0.768
Lead	3.389

Azadirachta indica exhibited maximaum dust collection and accumulate heavy metals efficiency among all the plant species.

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