RESEARCH ARTICLE

HEAVY METALS CONCENTRATION IN DUST ACCUMULATED ON LEAVES OF CERTAIN PLANT SPECIES GROWN ALONGSIDE NATIONAL HIGHWAY- 22, INDIA

Navjot Singh Kaler*[1], S.K. Bhardwaj[1] and Prabhat Tiwari[1]

[1]Dr Y.S. Parmar UHF Nauni, Solan- 173230 (H.P.), India
Email: kalernavjot8888@gmail.com

Received-04.02.2017, Revised-16.02.2017

Absract: Heavy metals contamination in plants due to air pollution is one of the major issues to be faced throughout the world and requires attention because heavy metals above their normal ranges are extremely threatened to both plant and animal life. Now a day's increase in vehicular traffic on highways is a major threat to air quality as the pollution released from vehicles consisting high concentrations of heavy metals which seriously affects the nearby vegetation. As biomonitoring with plants is low-cost and valuable method for knowing the effect of different air and environment pollutants so the present study was carried to estimate levels of heavy metals in dust accumulated on leaves of selected plant species from Parwanoo to Solan on National Highway-22 falling in Solan district of Himachal Pradesh. The four species namely *Grewia optiva*, *Toona ciliata*, *Melia azedarach* and *Woodfordia floribunda* of uniform size, age, spread and common in occurrence on both sides of the highway were selected for the study. Concentrations of heavy metals (As, Cd, Cr, Cu, Mn, Ni, Pb and Zn) were estimate in dust accumulated on leaves of selected plants and compare them with their normal permissible limit prescribed for soil. The dust accumulated on leaves had heavy metals, Cu (29.15 mg kg^{-1}) and Zn (1219.92 mg kg^{-1}) above permissible limit of the soil. The study provided a reliable method for screening heavy metals concentration in dust deposited on leaves of plants nearby roads where the air-shed is contaminated by a variety of pollutants due to vehicular emissions.

Keywords: National highway-22, Leaf dust, Heavy Metals, Solan

INTRODUCTION

Air pollution has become one of the major problems around the globe. It is the introduction of chemicals, particulate matter or biological materials in to the atmosphere by human activities that cause harm or discomfort to humans or other living organism or damage the environment. Rapid development of human civilization, industrialization along with the expansion of cities, increasing demand of energy and rapid economic development resulted in the increased number of automobiles and recognized as the major source of air pollution (Oliva *et al*., 2010). It is known fact that 60 % of air pollution is caused by automobiles only (Gaikwad *et al*., 2004).

Plants have ability to remove air pollutants, collect heavy metals from air (Lin *et al*., 1976) and act as a sink (Sunita *et al*., 1997, Dwivedi *et al*., 2007 and Tripathi *et al*., 2007) to minimize air pollution by absorption, adsorption, accumulation and metabolization without sustaining serious foliar damage or decline in growth and ultimately improve the air quality by providing oxygen to the atmosphere (Beckett *et al*., 1998 and Sharma *et al*., 1994). The interactions between plant and different types of pollutants and the influence of environmental pollution on physiological and ultrastructural aspects were investigated by various researchers (Heumann *et al.*, 2002 and Velikova *et al.*, 2000). Lots of work has been done to study the response of traffic load on plants (Angold, 1997).

Heavy metal concentrations in roadside dust are increasingly becoming a problem for the trees growing alongside the road and have posed a threat to the human and animal life as they transported with gases and aerosols on long distances (Nriagu *et al.*, 1988 and Pacyna *et al*., 1988). Heavy metals are considered toxic to living organisms and even trace metal considered essential for life can be toxic when present at excessive level, that impair important biochemical processes and pose a threat to human health, plant growth and animal life (Morrison *et al.*, 1990). These metals accumulate in street dust and in the leaves of roadside plants through atmospheric deposition involving sedimentation, impaction and interception. Consequently, in recent years, public and scientists attention has increasingly focused on heavy metal contamination as monitoring of certain heavy metals was important for safety assessment of the environment. In the urban and roadside environment, such pollutants are commonly found in the dust which can be potentially harmful to roadside vegetation, wildlife and neighbouring human settlements. So the present monitoring work was undertaken to determine the heavy metals (As, Cd, Cr, Cu, Mn, Ni, Pb and Zn) concentration in dust accumulated on leaves of selected plant species and compare them with their permissible limits prescribed for soil.

MATERIAL AND METHOD

Study area

The entire study area extended from Parwanoo to

*Corresponding Author

Solan, geographically located in Solan district which lies between 30°44'53" and 31°22'01" N and between 76°36'10" and 77°15'14"E. The total distance of National Highway between Parwanoo and Solan is 41 km (Fig.1). The National Highway on the way to Shimla, a famous tourist place is subjected to heavy traffic load. Besides, district being an education hub and gateway to horticulture produce outside the state highway is subjected to continuous heavy traffic load. The climate of the district is sub-tropical in the valley and tends to be temperate in the hilltops. Average annual rainfall in the district is about 1100 mm with average of 64 rainy days and Mean maximum and minimum temperature ranges between 34°C and 4°C. The Parwanoo- Solan national highway falling in Solan district of Himachal Pradesh is on the hilly terrain having loose strata and generally moderately to steeply sloped with number of curves with altitude ranging from 350 to 1800 meter above mean sea level.

Study method

Dust samples from leaves to determine heavy metal concentration were collected by randomly selecting twenty one plants of each selected species (*Woodfordia floribunda, Toona ciliata, Melia azedarach* and *Grewia optiva*) growing alongside the Parwanoo- Solan National Highway 22 at a distance of 0-10 m. The samples were replicated thrice and each replication consisting of seven plants. The plants selected for study were uniform with respect to their diameter at breast height (1.37m), crown spread and were common in their occurrence on both sides of the highway. The relevant characteristic of these plants are shown in Table 1. To analyze the heavy metals in the dust 0.5 g of sample was digested with concentrated HNO_3, H_2SO_4 and H_2O_2 in the ratio of 2:6:6 as per procedure prescribed by (Saison *et al.*, 2004). The concentration of heavy metals (mg kg^{-1}) was estimated by using ICP Spectrometer (Model- iCAP 6300 duo) of thermo scientific make.

RESULT AND DISCUSSION

The vegetation nearby national highway is exposed to dust pollution and chronic concentration of gaseous pollutants, which may affect the biochemical make up, and tolerance capability of plants to the air pollution. The data pertaining to heavy metals in dust collected from the leaves is presented in table 2. The concentration for As ranged from 0.33 to 0.93 mg kg^{-1} with a average value of 0.66 ± 0.05mg kg^{-1}, for Cd from 0.79 to 0.99 mg kg^{-1} with average value of 0.89 ± 0.02 mg kg^{-1}, for Cr from 23.61 to 44.11 mg kg^{-1} with average value of 32.35 ± 2.20 mg kg^{-1}, for Cu from 23.04 to 36.78 mg kg^{-1} with average value of 29.15 ± 1.46 mg kg^{-1}, for Mn from 194.80 to 302.60 mg kg^{-1} with average value of 248.39 ± 12.91 mg kg^{-1}, for Ni from 21.50 to 12.67 mg kg^{-1} with average value of 17.18 ± 1.04 mg kg^{-1}, for Pb from 26.66 to 41.89 mg kg^{-1} with average value of 36.02 ± 1.79 mg kg^{-1} and for Zn from 1101.00 to 1394.00 mg kg^{-1} with average value of 1219.92 ± 30.33 mg kg^{-1} in dust collected from the leaves of plants alongside the road.

The concentration of Cu (29.15 mg kg^{-1}) and Zn (1219.92 mg kg^{-1}) in dust accumulated on leaves of selected plant species was above the normal permissible limit prescribed for soil. These results were supported by the findings of Allaway (1990), Pendias and Pendias (1992) who reported that the normal permissible limit of Cu was 2 to 25 mg kg^{-1} and for Zn 1 to 900 mg kg^{-1} in normal soil. The vehicular emission, road paint degradation, vehicle wears be the reason for increased concentration of Cu and Zn above their permissible limits in soil. These results are also supported by Al-Khashman (2004) who revealed that dust is typically derived from anthropogenic sources via the interaction of natural solid, liquid or gaseous materials with pollutant sources such as water transported material from surrounding soils and slopes, dry and wet atmospheric deposition, biological inputs, road surface wear, road paint degradation, vehicle wear (tyres, body, brake lining, etc.) and vehicular fluid and particulate emissions and emissions and discharge from metal processing industries.

Table 1. Characteristics of selected plants at study site

Name of Plant	Family	Common name	Habit	Leaf shape	Average Plant height approx. (m)
Woodfordia floribunda	Lythraceae	*Dhatki, Dhawai*	Shrub	Elliptical	3
Toona ciliata	Meliaceae	*Toon, Indian mahogany*	Tree	Elliptical (Leaflet-Imparipinnate)	25
Melia azedarach	Meliaceae	*Drek, Bead tree*	Tree	Elliptical (Leaflet-Tripinnate)	18
Grewia optiva	Tiliaceae	*Dhaman, Biul*	Tree	Ovate	12

Table 2. Heavy metals concentration (mg kg^{-1}) in leaf deposited dust

Heavy metals	Range	Mean ± SD	Coefficient of variation
As	0.33 - 0.93	0.66 ± 0.05	30.64
Cd	0.79 - 0.99	0.89 ± 0.02	8.08
Cr	23.61 - 44.11	32.35 ± 2.20	23.58
Cu	23.04 - 36.78	29.15 ± 1.46	17.36
Mn	194.80 - 302.60	248.39 ± 12.91	12.91
Ni	12.67 - 21.50	17.18 ± 1.04	21.15
Pb	26.66 - 41.89	36.02 ± 1.79	17.21
Zn	1101.00 - 1394.00	1219.92 ± 30.33	8.61

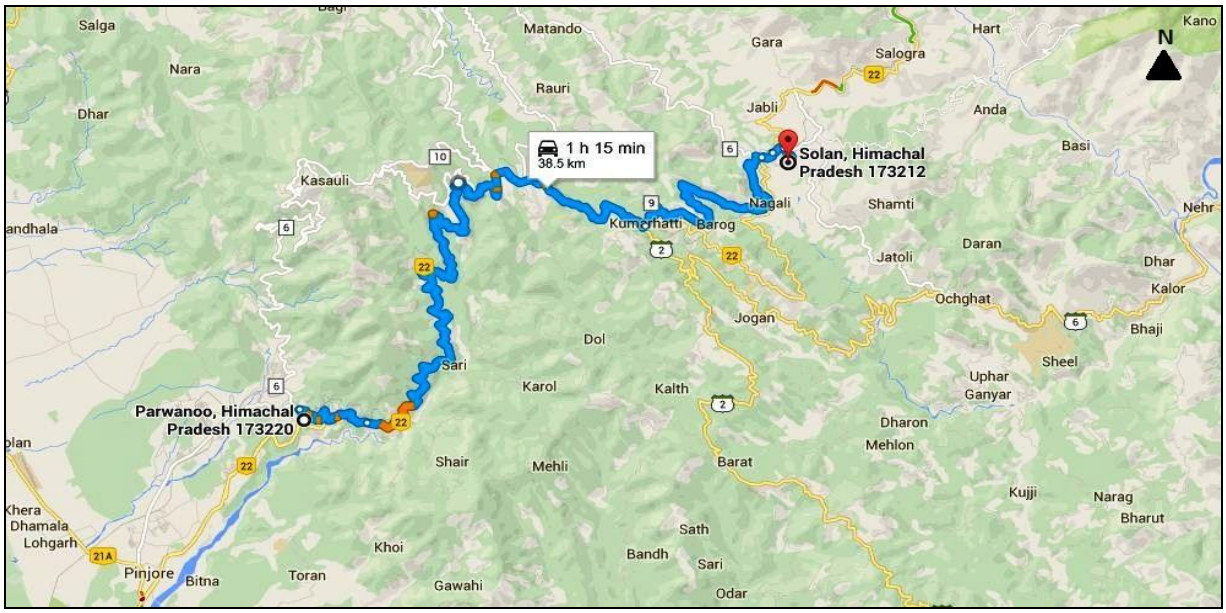

Figure 1. Map showing the study area

CONCLUSION

The dust samples collected at the study area exhibited different concentrations of heavy metals (As, Cd, Cr, Cu, Mn, Ni, Pb and Zn). The Cu and Zn concentrations in leaf deposited dust were found to be above their permissible limits whereas, As, Cd, Cr, Mn, Ni and Pb concentrations were below the permissible limit prescribed for soil. The results of such studies are therefore handy for future planning and may be helpful to bring out possible control measures.

ACKNOWLEDGEMENT

Authors are thankful to the Prof. G.S. Samet, Dean, College of Forestry, Department of Environmental Sciences, Dr. YS Parmar University of Horticulture and Forestry Nauni (Solan) for providing laboratory and library facility and their kind encouragement.

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