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Lead in the Soil and Grasses along Roadsides of Delhi

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Lead content of soil and grasses in roadsides of Delhi were estimated. A good correlation was found to exist between traffic volume, total and extractable soil Pb and the Pb content of roots and shoots of the grass *Cynodon*. There existed a 'threshold value' of soil Pb before any Pb was accumulated by grasses.

Key words: Lead, Soil, Grasses, Delhi roadsides

Introduction

Automobiles contribute significantly to the man-made pollutants released into the atmosphere. The exhaust fume comprises mainly of carbon monoxide, unburnt hydrocarbons, oxides of nitrogen and particulate matter including Pb. Among these, carbon monoxide is most abundant of the pollutants and Pb is the most persistent. The compounds added to gasoline include tetraethyl Pb (TEL) as anti-knock—62%, ethylene chloride—18%, ethylene bromide—18%, miscellaneous additives—2% (Coello et al. 1974). About 70-80% of added Pb in gasolines is released with exhausts and rest is retained (Davies 1973, Huntzicker et al. 1975). Under average conditions automobiles release up to 130 mg Pb/mile (81 mg Pb/km) into the roadside environment (Smith 1976). The Pb contamination of the atmosphere is also affected by the local meteorology, traffic pattern, vehicular condition, driving habits apart from the traffic volume, of that area.

Lead accumulation studies along roadsides have recently been quite numerous because it has been observed that Pb fallout from the motor vehicle exhaust pollutes roadside vegetation and nearby agricultural crops which in long run may constitute a health hazard to man and his domestic animals (Laaksovirta et al. 1976). Estimation of Pb content in roadside soil and vegetation is important to ascertain the extent of lead pollution in roadside communities. In India, reports on such surveys are extremely scarce.

Materials and Methods

Metal accumulation in plants is a species specific property. Meaningful comparisons of metal accumulation by plants with that of metal content of soil or traffic volume in roads, can be made only when comparison is among the members of the same species. It was found that grasses of species *Cynodon dactylon* was of cosmopolitan occurrence in Delhi roadsides, and was growing in all seasons, so this material was selected.

The data on traffic volumes on different roads were obtained from the Central Road Research Institute (CRRI), Delhi. Eleven roads representing low, moderate and high traffic density were selected and samples were collected from all these on the same day (7th June 1977). Soil and grasses were collected within a distance of 10 ± 2 cm from the road margin. The soil was collected from a depth of 2 ± 0.5 cm from the surface.

The soil was air-dried for 3–4 days to a constant weight and powdered. Grass samples were washed by dipping in distilled water and then oven-dried at 85°C for 48 hr. 0.5 g of dried root/shoot was dry-ashed. The ash was digested with 2 ml of conc. HCl and evaporated to semi-dryness. The residue was taken up in 10 ml of 1N HCl. The insoluble materials were filtered and the final volume made up to 15 ml with 1N HCl.

The total Pb content of soil was determined by digesting 0.5 g soil with 60% perchloric acid (PCA) to semi-dryness. The residue was taken up in 10 ml of 10% PCA, and filtered. The final volume was adjusted to 25 ml with 10% PCA. The extractable Pb content of soil was found by digesting 0.5 g of fine, powdered soil with 0.1N Ammonium lactate and 0.4N acetic acid at a *p*H of 3.7. Final volume was adjusted to 15 ml.

The Pb content of the final solutions in all cases was determined by atomic absorption spectrophotometry (Hitachi-207) using an air-acetylene flame. Absorption measurements were made at a wavelength of 283.5 nm.

Results and Discussion

The average values of traffic density on different roads of Delhi, representing fairly graded increase, in sequence is shown in table 1. The corresponding value of total and extractable lead in these 11 sites, together with the Pb content of the roots and shoots of *Cynodon* found in these areas are shown in table 2.

The difference between the total and extractable Pb content of all the sites vary from 12–34 ppm, (except site III which may be due to a local high input). This is fairly constant, showing that increases are in extractable Pb and not in bound Pb. Or in other words the original Pb content must

Table 1 *Traffic density on Delhi roads*
Vehicles/16 hr

Site No	Name of Road/location	Traffic density
1	R K Puram (Sector I)	8,700
2	Bangla Sahib Road	10,140
3	Alipur Road (Maiden's Hotel)	12,050
4	Mall Road (Delhi University)	15,000
5	Ring Road (I.P. Power Station)	17,000
6	Inter-State Bus Terminal (Kashmiri Gate)	20,000
7	Janpath (Eastern Court)	24,300
8	Panchkuin Road	29,030
9	Zakira (Railway Crossing)	35,000
10	Netaji Subhash Marg (Darya Ganj)	40,800
11	Minto Road (Minto Bridge)	42,100

Table 2 *Lead Content of Soil and Grasses Along the Roadsides of Delhi*

Site No.	Total Pb of soil	Extractable Pb of soil	Pb content of root	Pb content of shoot
1	110.0 ± 1.2	98.0 ± 1.3	42.5 ± 0.5	7.9 ± 0.2
2	112.0 ± 1.2	90.5 ± 1.1	53.0 ± 0.8	11.0 ± 0.5
3	210.0 ± 1.8	99.8 ± 1.2	73.0 ± 1.0	15.8 ± 0.3
4	145.7 ± 2.0	128.4 ± 1.3	72.0 ± 1.4	15.2 ± 0.25
5	146.0 ± 1.5	120.2 ± 1.3	74.5 ± 1.2	14·9 ± 0.4
6	195.8 ± 2.4	165.3 ± 1.6	92.8 ± 0.5	18.6 ± 0.4
7	235.5 ± 3.6	201.4 ± 1.2	107.2 ± 0.8	22.5 ± 0.6
8	306.0 ± 2.9	282.6 ± 2.4	120.0 ± 1.1	23.8 ± 1.0
9	300.0 ± 2.7	281.6 ± 1.5	180.0 ± 1.6	37.5 ± 0·8
10	326.0 ± 4.0	312.7 ± 1.8	198.0 ± 1.2	38.9 ± 0.4
11	341.0 ± 3.2	310.2 ± 1.6	217.6 ± 1.1	40.5 ± 0.5

All Pb concentrations are expressed in ppm

Table 3 *Coefficients of Correlation* (*r*) *and Linear Regression* (*a, b*)

	x	y	r	a	b
1	Traffic density 1000 vehicles/16 hrs $\bar{x}$=23.10	Total soil lead (ppm) $\bar{y}$=220.66	0.94119	64.5359	6.7586
2	Total soil Pb (ppm) $\bar{x}$=220.6636	Extractable soil Pb (ppm) $\bar{y}$=190.0	0.9997	—30.0898	0.9974
3	Extract. soil Pb (ppm) $\bar{x}$=190.0	Pb content of root (ppm) $\bar{y}$=111.872	0.9853	—18.5642	0.6865
4	Pb in root (ppm) $\bar{x}$=111.872	Pb in shoot (ppm) $\bar{y}$=22.4	0.9952	1.0158	0.1911
5	Traffic vol. 1000/16 hrs $\bar{x}$=23.10	Pb in root (ppm) $\bar{y}$=111.872	0.9844	—1.6826	4.9160
6	Traffic volume 1000 vehicles/16 hrs $\bar{x}$=23.10	Pb in shoot (ppm) $\bar{y}$=22.4	0.9221	0.6947	0.9396

Linear regression $\bar{y}=a+b\bar{x}$
Correlation coefficient$=r$

have been very similar before the traffic started or roads were built. And the increases are mainly due to external input.

The relation between traffic volume and total soil Pb, shows that they are fairly correlated (r=0.94119). The regression analysis and graph (figure 1) indicates that even in absence of any traffic there exists some total Pb content of soil. This is very true for 'natural' conditions or comparative uncontaminated areas. Presently we found even if value for x (traffic volume) is zero, the Pb content of soil (y) is about 64 ppm.

In the areas under study the total Pb content of soil (x) and extractable Pb content of soil (y) are very strongly correlated (r=0.9997). Increase in total Pb has also produced an increase in extractable Pb content of soil, under the range of $0 \leqslant x \leqslant 341$ ppm. The regression analysis and graph (figure 2) shows that even at absence

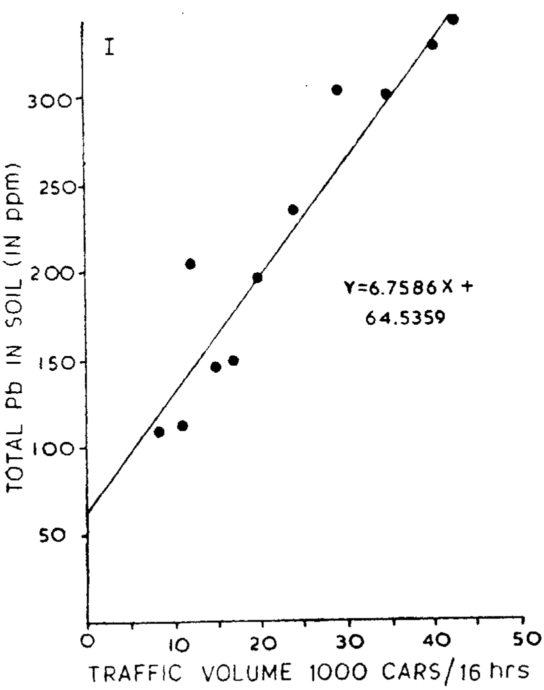

Figure 1 Regression line between traffic volume in roads (x) and total soil Pb (y)

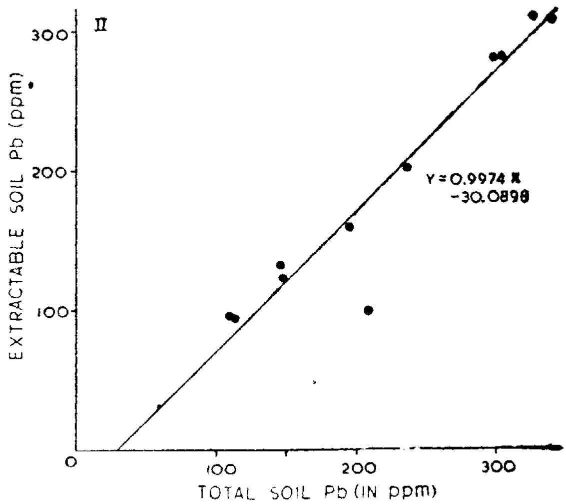

Figure 2 Regression line between total soil Pb (x) and extractable soil Pb (y)

of any extractable Pb, there exists some total Pb in soil. The value of total Pb at which no extractable Pb exists is about 30 ppm. This Pb is bound and not available to plants for uptake. So, we can say that at soils with Pb content of 30 ppm plants do not take up any Pb.

The extractable Pb content of soil and Pb content of the root was indicating a proportional increase or decrease in their concentrations (r=0.9853). The regression analysis and graph (figure 3) show that at a particular level of extractable lead in soil (27 ppm) no Pb is traceable in root. So, we can say that this is a threshold (27 ppm) at which no Pb is taken up by the root, or this is a 'safe limit'.

The Pb content of the root and shoot shows a direct relation (r=0.9952). So the Pb content of shoot depends on the Pb accumulation by root. However, the regression analysis and graph (figure 4) show that regression line passes almost through the origin. The slightly higher value may be due to foliar uptake of Pb. Foliar uptake has been shown to occur for Pb (Hemphill

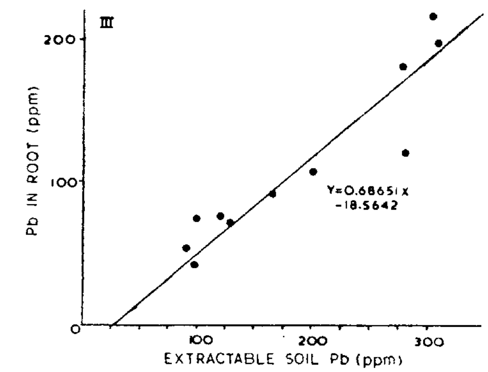

Figure 3 Regression line between extractable soil Pb (x) and Pb content of grass root (y)

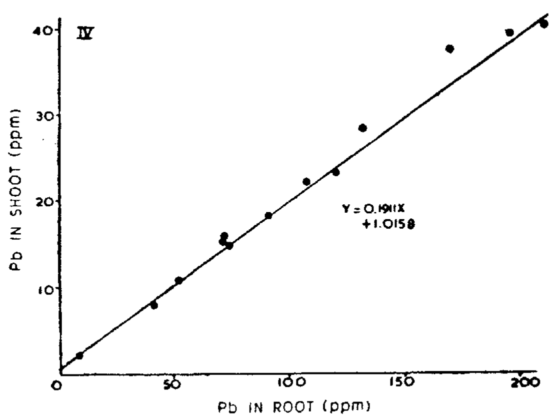

Figure 4 Regression line between Pb content of grass root (x) and Pb content of grass shoot (y)

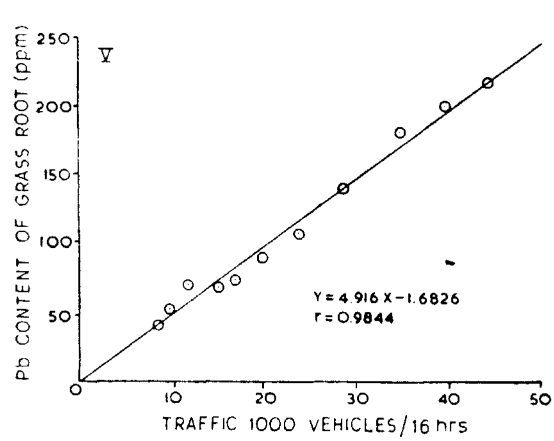

Figure 5 Regression line between traffic volume (x) and Pb content of grass root (y)

& Rule 1975, Rabinowitz 1 72). However, the problem of distinguishing between external and internal Pb is very difficult. The particulates of heavy metal get embedded in surface cuticle and are extremely difficult to remove by washing. This might account for nonzero (+ve) level of Pb in shoot for a zero value of Pb in root.

The relation between traffic volume and Pb in grass root is also well correlated (r=0.9844). The regression analysis and graph show that up to a non-zero+ve value of traffic volume the Pb content of grass root remains zero, i.e., the lead accumulation by root starts only when the traffic volume has build up to a certain level.

Surface soils are in direct contact with contemporary environment and aquire lead from emitting sources and from pollution by man. The estimation of Pb levels are important from epidemiological studies' point of view to ascertain the risk of health hazard to man and his domestic animals. Grasses can serve as useful biological monitors, as they are cosmopolitan in occurrence and have propensity to accumulate throughout the season apart from being quite inexpensive.

Conclusios

Increase in the traffic volume on the roads produce a proportional increase in the Pb content of soil and grasses along the roadsides. It is observed that grass roots accumulate Pb only after a particular level of total and extractable lead builds up in the soil. Roots were found to have a higher Pb content than shoots though data indicate that foliar absorption is also possible.

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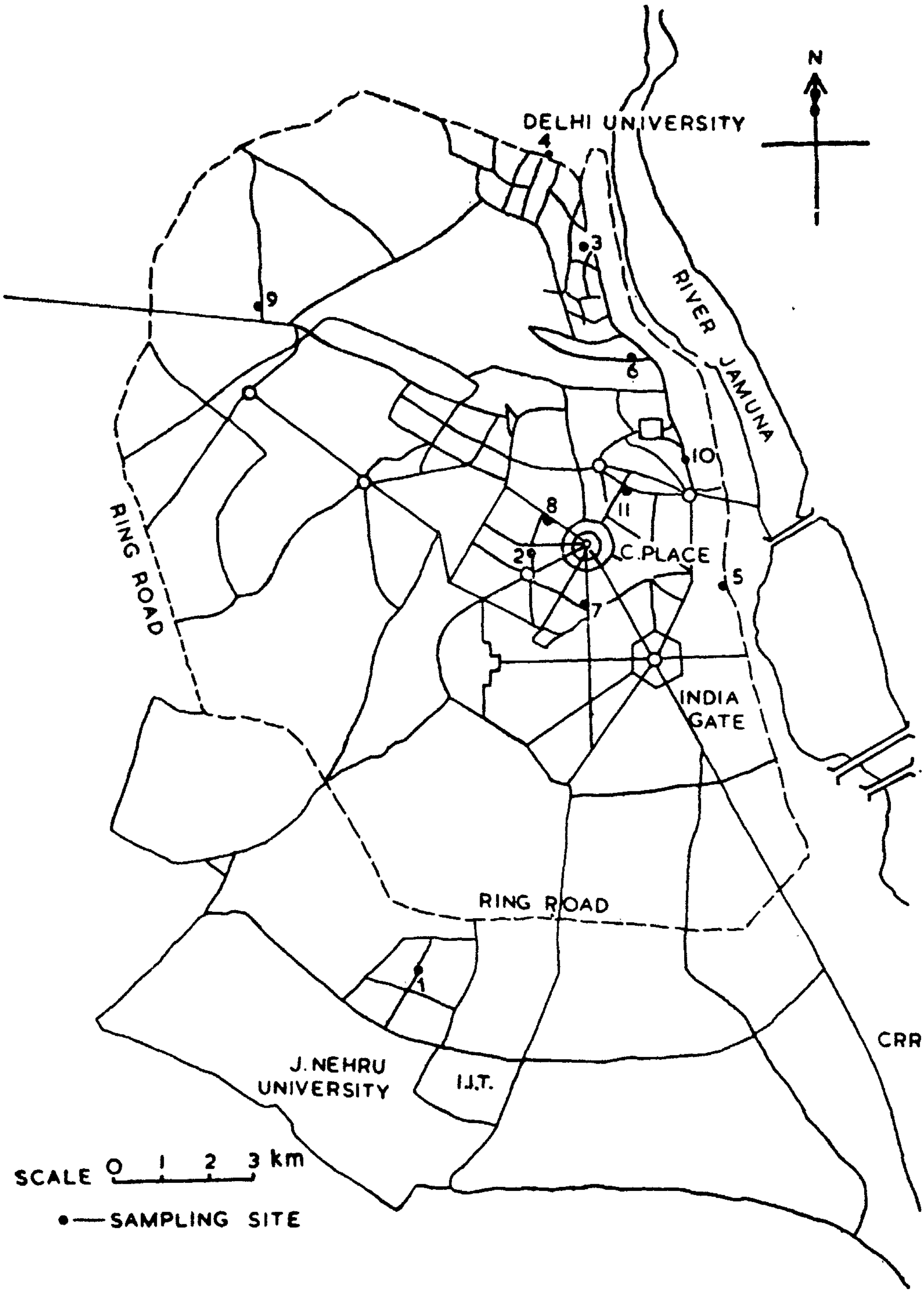

Figure 6 Road Map of Delhi showing sampling sites (1–11). (All roads of Delhi are not shown in the map)

data on traffic density of different roads of Delhi. One of us (I.D.) thanks UGC for awarding a research fellowship, through the University during this work.

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