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Heavy Metal Contamination in Farm and Urban Soil in Mymensingh

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Abstract

A study was carried out to determine the status of heavy metals in farm and urban soils from intensively growing areas of Mymensingh. Sixty three soil samples were collected from 11 upazillas of Mymensingh. From these samples total amount of heavy metals like Pb, Cd, Ni, Cr, Fe and Mn were tested. The soils were also analyzed for texture, pH and organic matter content. The mean concentrations of Pb, Cd, Ni, Cr, Fe and Mn in farm soils were 19.64, 0.32, 39.80, 14.10, 1800.40, 135.66 µg g^{-1}, respectively and the mean concentrations of above metals in urban soils were 20.93, 0.37, 36.90, 28.85, 1810.08, 127.05 µg g^{-1}, respectively. The heavy metal concentrations in farm soils were within the limit allowed for maximum acceptable concentration for satisfactory crop production. Heavy metals in urban soils were also below the limit considered as contaminated soil. Most of the heavy metals in both farm and urban soils were negatively correlated with sand and positively correlated with silt. There was no significant correlation between heavy metal content and soil pH or organic matter in both farm and urban soils with very few exceptions. Most of the heavy metals did not show any significant correlation with each other expect Fe which showed significant correlation with Pb, Ni, Cr, Mn and Cd for both farm and urban soils.

Key words: Contamination, Correlation, Farm and urban soil, Heavy metals

Introduction

Heavy metals possess a great concern for contamination of soil and water because they are persistent and may affect vegetables, plant and human health. The "heavy metal" is generally a collective term, which applies to the group of metals and metalloids with atomic density greater than 4 gcm^{-3} or 5 times or more greater than water (Huton and Symon, 1986; Hawkes, 1997). The heavy metals are widely distributed throughout the environment. Industrial discharge, fertilizer, manure, pesticide, fossil fuel, municipal waste, sewage-sludge, mining waste, animal waste, contaminated water etc. might be some of the major sources of heavy metal contamination in soil and water (Alloyway *et al.*, 1988). When an element enters into the environment, it follows some biochemical cycles being transported by air, water and gravity until they reach a geo-chemical sink. Soil is the ultimate sink for all elements where heavy metals may accumulate in soil with a short span of time (Kabata and Pendias, 1992). The use of chemical fertilizers is now widespread for supplementing nutrients. Some phosphatic fertilizers and pesticides are also adding various types of heavy metals like Cd, Pb and Zn as impurities (Alloway *et al.*, 1988), which after application may significantly increase their content in the soil. It is reported that the major source of Pb intake for human being is food where the major absorption takes place in gastrointestinal tract (WHO, 1972). It is obvious that heavy metals at contamination level can cause detrimental effect on crop production and health. The present study was therefore undertaken with the objectives to determine Pb, Cd, Ni, Cr, Fe and Mn contaminations in 11 upazillas of Mymensingh to assess the existing heavy metal contamination status.

Materials and Methods

A study was conducted during January to March 2012 to determine the status of heavy metals in farm and urban soils of intensively growing areas of Mymensingh. Farm soil samples were collected from 11 upazillas of Mymensingh namely Trishal, Gouripur, Bhaluka, Tarakanda, Ishwargonj, Phulpur, Haluaghat, Muktagacha, Goforgaon, Nandail, Mymensingh Sadar. Urban soil samples were collected from 9 locations namely Kalibari drain soil, Ganginarpar drain soil, Town Hall drain soil, Kalibari roadside soil, Ganginarpar roadside soil,Town Hall roadside soil, Tangail busstand soil, Maskanda busstand soil and Bridge busstand soil of Mymensingh town. Farm soils were collected at a depth of 0-15 cm from paddy fields of each location. Plant roots and other extraneous materials were removed from the collected soil samples, air-dried, ground and passed through 2mm-mesh sieve. The samples were kept in plastic container. Collected samples were further analyzed for physical characteristics namely percentage of sand, silt, clay, and textural class and chemical characteristics such as soil P^H and organic carbon. To determine the total Pb, Cd, Ni, Cr, Fe and Mn the soil samples were then

digested with di-acid mixture (HNO_3 and H_2O_2) at digestion laboratory, Dept. of Soil Science, Bangladesh Agricultural University, Mymensingh. The total concentration of Pb, Cd, Ni, Cr, Fe and Mn were determined at the laboratory of soil science of Bangladesh Rice Research Institute, Gazipur by using the Atomic Absorbtion Spectrophotometer (AAS). Therefore, the range, mean and standard deviation of the contents of heavy metals of soils were calculated. Correlation statistics was done to examine the interrelationship among the heavy metals with soil pH, organic matter and texture.

Results and discussion

Heavy metal status

A. Farm soils

All the soils contain below or within the limit of Maximum Allowable Concentrations (MAC) for Pb (20 - 300 mg kg^{-1}), Cd (1 to 5 mg kg^{-1}), Ni (20 – 60 mg kg^{-1}), Cr (50 - 200 mg kg^{-1}) and Mn (1500 – 3000) mg kg^{-1} in agricultural soils (Table 1.). The concentrations of the elements were also within typical values for uncontaminated soil range such as Pb (0 - 500 mg kg^{-1}), Cd (0 to 1 mg kg^{-1}), Ni (20 -50 mg kg^{-1}), Cr (0 - 100 mg kg^{-1}) and Mn (0 - 500 mg kg^{-1}) (Table 1.).

Table 1. Total Pb, Cd, Ni, Cr, Fe and Mn concentrations in farm soils of Mymensingh

SL. No.	Sample site	Pb	Cd	Ni	Cr	Fe	Mn
		Concentration (µg g^{-1})					
1	Trishal	18.40	0.20	**12.40**	**3.90**	1811.10	**173.70**
2	Gouripur	**26.40**	0.27	32.20	14.60	1793.20	134.50
3	Bhaluka	**16.80**	**0.17**	22.40	**41.10**	1866.20	140.60
4	Tarakanda	18.40	0.32	24.60	18.60	1859.70	123.80
5	Ishwargonj	17.70	0.38	30.60	8.60	1748.00	143.10
6	Phulpur	17.00	0.34	**42.70**	10.30	**1721.80**	137.60
7	Haluaghat	16.80	0.18	27.20	10.00	1777.00	**114.20**
8	Muktagacha	19.00	0.42	31.40	12.00	1773.70	125.10
9	Goforgaon	21.90	0.19	38.80	11.40	**1890.50**	136.10
10	Nandail	24.20	0.32	19.50	14.00	1798.00	123.60
11	Mymensingh Sadar	19.50	**0.68**	36.00	10.60	1765.60	140.00
Mean		**19.64**	**0.32**	**28.89**	**14.10**	**1800.40**	**135.66**
Standard deviation		3.19	0.15	9.90	9.69	52.47	15.52
MAC[1]		**20–300**	**1–5**	**20–60**	**50-200**	**-**	**1500-3000**
Typical values for uncontaminated soil[2]		**0-500**	**0-1**	**0-20**	**0-100**	**-**	**0-500**

[1]Kabata-Pendias, 2001 ; Sadurski, 2004, [2]Sattar, 1996

B. Urban soils

All the soils contain below or within typical values for uncontaminated soil range such as Pb (0 - 500 mg kg^{-1}), Cd (0 to 1 mg kg^{-1}), Ni (20 -50 mg kg^{-1}), Cr (0 - 100 mg kg^{-1}) and Mn (0 - 500 mg kg^{-1}) (Table 2.)

Table 2. Total Pb, Cd, Ni, Cr, Fe and Mn concentrations in urban soils of Mymensingh

SL. No.	Sample site	Soil Types	Pb	Cd	Ni	Cr	Fe	Mn
			Concentration (µg g^{-1})					
1	Kalibari	DS[1]	23.13	0.26	39.80	3.10	1822.40	128.00
2	Ganginarpar	DS	22.93	0.35	42.70	12.90	1867.30	128.98
3	Town Hall	DS	25.65	**0.17**	**95.70**	**95.60**	1853.20	125.08
4	Kalibari	RSS[2]	17.17	0.28	36.30	67.00	1736.40	**152.30**
5	Ganginarpar	RSS	14.30	0.46	**10.70**	17.80	1772.10	121.78
6	Town Hall	RSS	**14.18**	**0.58**	34.30	14.90	1765.60	125.08
7	Tangail	BSS[3]	**25.33**	0.48	13.10	28.40	**1729.40**	127.70
8	Maskanda	BSS	23.92	0.52	21.0	**10.00**	1854.30	120.65
9	Bridge	BSS	21.80	0.24	38.5	10.00	**1896.50**	**113.90**
Mean			**20.93**	**0.37**	**36.90**	**28.85**	**1810.80**	**127.05**
Standard deviation			4.52	0.14	25.03	31.33	61.30	10.56
Typical values for uncontaminated soil[4]			**0-500**	**0-1**	**0-20**	**0-100**	**-**	**0-500**

[1]DS = Drain soils, [2]RSS = Roadside Soils, [3]BSS = Bus Stand Soil, [4]Sattar, 1996

Interrelationships among heavy metals of soils

A. Farm soils:

Table 3. Correlation among heavy metals of farm soils

Elements	Pb	Cd	Ni	Cr	Fe	Mn
Pb	-	0.01	-0.03	-0.12	0.16	-0.12
Cd	-	-	-0.29	-0.27	-0.50	-0.05
Ni	-	-	-	0.51	0.57	-0.02
Cr	-	-	-	-	0.50	-0.17
Fe	-	-	-	-	-	0.02
Mn	-	-	-	-	-	-

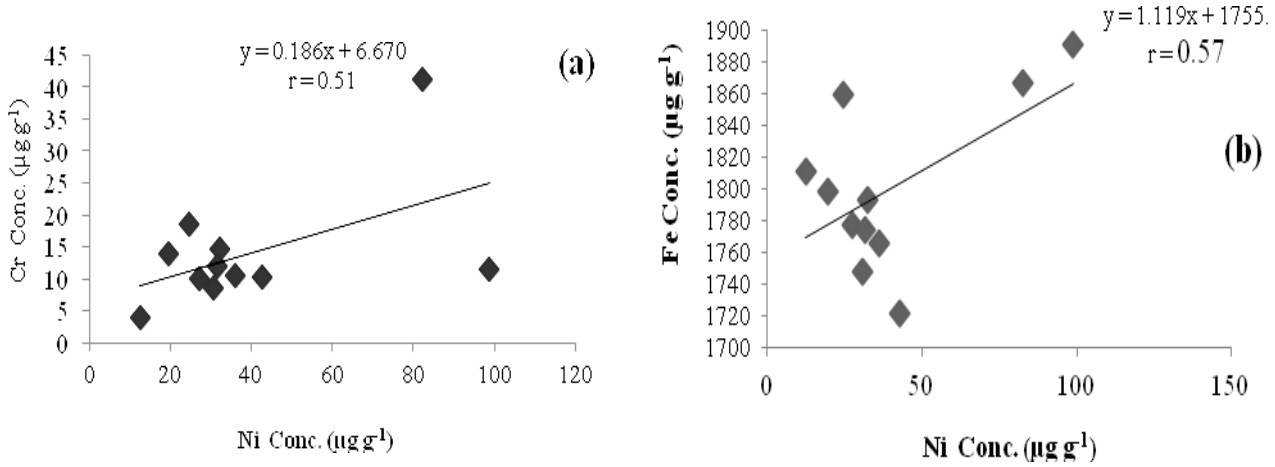

Fig. Correlation between Cr and Ni(a) and Ni and Cd (b) in urban soils

B. Urban Soils

Table 4. Correlation among heavy metals of urban soils

Elements	Pb	Cd	Ni	Cr	Fe	Mn
Pb	-	-0.40	0.38	0.15	0.46	-0.20
Cd	-	-	-0.71	-0.50	-0.43	-0.17
Ni	-	-	-	0.70	0.44	0.04
Cr	-	-	-	-	-0.16	0.47
Fe	-	-	-	-	-	-0.59
Mn	-	-	-	-	-	-

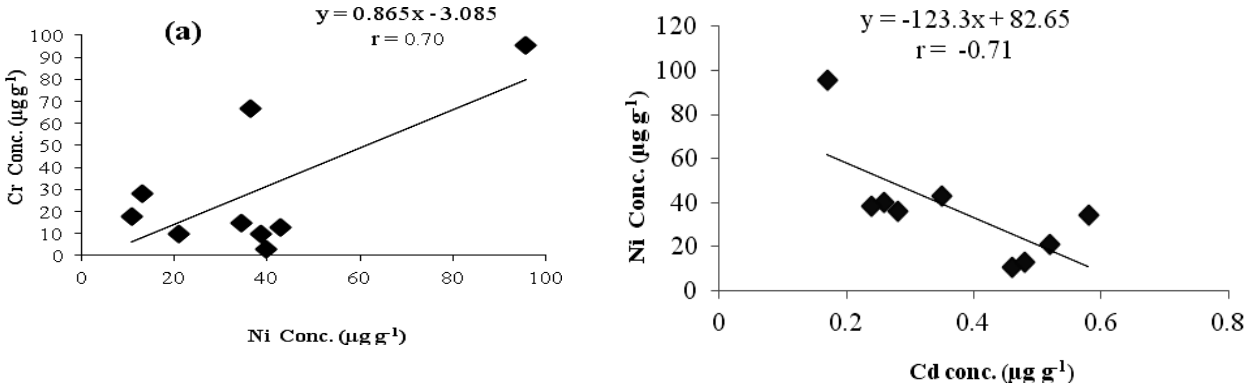

Fig. Correlation between Cr and Ni(a) and Ni and Cd (b) in urban soils

The negative correlation occurs because combined physiological effect of two or more elements is less than the sum of their independent effects, and positive correlation occurs because the combined effect of these elements is greater. (Olsen, 1972; Foy *et al.*, 1978).

Conclusions

Heavy metals and its contamination is not a familiar term among the farmers of Bangladesh, even they actually don't aware of any kinds of contaminations or pollutions that can reduce their crop production and cause detrimental effect on health. So how they can protect these contaminations, while they don't know about it? At first they are to inform about these contaminations, especially how they take place. Awareness should build up about these contaminations so that they themselves can protect this hazard. Department of Agricultural Extension (DAE) and Department of Environmental Science can play very crucial role in this regard. Integrated Pest Management (IPM) can be another vital alternative to chemical fertilizers and pesticides to minimize the rate of contamination. Organic farming should be popularizing among the farmers. Dumping of municipal waste, sewage sludge, industrial sludge and effluents, chemicals from the laboratories shouldn't be disposed near to crop land.

However, findings of this study indicate that no element exceeded the maximum acceptable concentration (MAC) for crop production or below the contamination level for soils and for crop production.

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