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Original Article

Trace Elements in the Soils of Ropar and Garhshankar Forest division of Punjab

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Abstract

The main objective of the study is to determine the availability of trace elements in soils of Ropar and Garhshankar Forest division of Punjab. For analysis of the soils, 34 soil samples were collected from different nursery plantation of Ropar and Garhshankar Forest division in Punjab. The available trace elements can be determined in DTPA extract using AAS. The trace elements consider in this soils were Zn, Mn, Cr, Cu, Fe and Co. After analyses, the result found to be highly contaminated with heavy metals in the soils of this region. The ranges of available trace elements are Zn(0.003-8.084)ppm, Mn(1-5)ppm, Cr(0-9.5)ppm, Cu(0-1.7)ppm, Fe(0-8)ppm, Co(0-1.5)ppm. The increasing order of the trace elements of this soils were Co<Cu<Mn<Fe<Zn<Cr. The pH of Punjab soil is slightly alkaline which ranges from 7 to 8.9. The bulk density and porosity are dependent on soil texture and the densities of soil mineral (sand, silt, and clay) and organic matter particles, as well as their packing arrangement. The bulk density and porosity in soil of Punjab shows that the soils in this region are loosely arranged and less compact.

Keywords

Trace Elements; Ropar; Garhshankar; Punjab; Bulk density; Porosity.

Introduction

Chemical elements in soil are referred to as trace elements (TEs) because of their occurrence at concentrations less than 100 mg kg-1. As a matter of fact, many of these elements are present at concentrations lower than this. Most of the trace elements of environmental and human/animal health significance are metals, for example cadmium, chromium, cobalt, copper, gold, lead, mercury, molybdenum, nickel, palladium, platinum, rhodium, silver, thallium, tin, vanadium, and zinc. Trace elements have also been termed 'toxic metals', 'trace metals' or 'heavy metals'. 'Heavy metals' is the most popularly use and widely recognized term for large groups of elements with density greater than 6 g cm-1 but not at all TEs are metals.

The term 'trace elements' is useful as it embraces metals, metalloids, non-metals and other elements in the soil-plant-animal system, but it is vague because it can include any element regardless of its function. Trace elements occur naturally in soils. However, production-oriented policies in the twentieth century, which exploited land for mineral extraction, manufacturing industry and waste disposal have resulted in the input and accumulation of large quantities of TEs in the soils. There are variety of both natural and anthropogenic input sources of trace elements in soils. The major natural sources include weathering (including erosion and deposition of wind-blown particles), volcanic eruptions, forest fires and biogenic sources1.The major anthropogenic sources of trace elements input to soils are: Atmospheric deposition, arising from coal and gasoline combustion, nonferrous and ferrous metal mining, smelting, and manufacturing, waste incineration, production of phosphate fertilizers and cement, and wood combustion; Land application of sewage sludge, animal manure and other organic wastes and co-products from agriculture and food industries; Land disposal of industrial co-products and waste, including

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paper industry sludge, coal fly ash, bottom fly ash and wood ash; Fertilizers, lime and agrochemicals (pesticides) use in agriculture.

The soil is the primary source of trace elements for plants, animals and humans. Elevated levels of TEs in the soil as a consequence of human activities therefore pose a range of environmental and health risks. Trace elements, unlike organic contaminants, are required in soils essentially indefinitely because they are not degradable. Consequently, soils contaminated with TEs pose a long-term risk of increased plant uptake and leaching, with potentially adverse implications for the wider environment, including human health. Arsenic, Cd, Hg, Pb, and Se are the most important in terms of the food chain contamination and ecotoxicity viewpoints 5. When the concentration of trace elements excess it critical level then the soil become polluted or contaminated. At elevated levels, trace elements are harmful to humans. For example, Pb, which is added to gasoline to reduce automobile engine knock, has become widespread in soils. Other additions of Pb to the environment include contamination from Pb paint, smelters, and Pb arsenate, an insecticide. Lead is toxic to humans, especially children, and damages the central nervous system, causing retardation and even death in extreme cases.

Trace elements are also of concern in the environment because of their potential to bioaccumulate in the food chain. The well-known Minamata disease, which occurred in Japan, was caused by bioaccumulation of methyl mercury in the fish of Minamata Bay. The local people consumed fish that had bioaccumulated the compound. Also in Japan, Itai-Itai disease, a form of Cd poisoning, caused many Japanese to fall ill when they ingested Cd contaminated rice.

Materials and Methods

Punjab is located in the northwest of India surrounded by Pakistan on the west, the Indian states of Jammu and Kashmir on the north, Himachal Pradesh on its northeast and Haryana and Rajasthan to its south. It covers a geographical area of 50,362 sq. km which is 1.54 % of country’s total geographical area. Punjab state is located between 29° 30' N to 32° 32' N latitude and between 73° 55' E to 76° 50' E longitude. Its average elevation is 300 m from the sea level. A belt of swelling hills extends along the northeast at the foot of the Himalayas. Punjab state is situated between the great systems of the Indus and Ganges rivers. Most of the state is an alluvial plain, irrigated by canals; Punjab’s arid southern border edges on the Thar, or Great Indian, Desert. The Siwalik Range rises sharply in the north of the state. In Punjab, the soil characteristics are influenced to a very limited extent by the topography, vegetation and parent rock. The variation in soil profile characteristics are much more pronounced because of the regional climatic differences. Punjab is divided into three distinct regions on the basis of soil types. The regions are: South-Western Punjab, Central Punjab and Eastern Punjab. Rupnagar district is one of the twenty districts in the state of Punjab in North-West Republic of India. Rupnagar (formerly known as Ropar or Rupar) district, included in the Patiala Division of Punjab falls between north latitude 30°-32' and 31°-24' and east longitude 76°-18' and 76°-55'.

The experimental sites from where the soil samples were collected from Ropar and Garhshankar Forest Division were as follow:

Sampling and Analytical Procedure

Soils sampleswere collected from the above 11 sites , the term parent soil , planted soil and pot mixture soil. So, 33 soil samples were collected from different sites of Ropar and Garhshankar Forest division of Punjab. Collected soil samples were air dried for several days and ground to pass a 2 mm sieve and analysed for physical and Chemical attributes. The porosity was determined by the method described by Brady 2.The pH was estimated in soil: distilled water (1:2.5) suspension using a digital pH meter (Elico Model LI-10T) and Digital Conductivity Meter (CC-601), respectively 4 .The available trace elements were determined by making a DTPA extract of the soil samples and fitted it to the Atomic Absorption Spectophotometer (AA-6401 F, Shimadzu, Japan). The working standard solutions for each metal were prepared before every analysis. Concentrations of Fe, Mn, Cu, Co, Zn and Cr were measured by an air acetylene flame AAS.

Result and Discussion

The soil samples collected from Ropar and Garhshankar Forest Division of Punjab shows that The region of Balachur (parent soils) and Lamheri (parent soils) shows the minimum or least concentration of Zn i.e 0.003 ppm (table-1) the concentration of Zinc is highest in Lamheri (planted soil) region i.e. 8.084 ppm followed by Mait Majra (planted soils)(table-2) and Kathgarh (pot mixture soils) i.e 3.046 pm and 0.322 ppm (table-3). From the above results, we know that the Zn concentration

Map of the Study area

Experimental sites	Latitude	Longitude	Forest Range
Mait Mojra	N 300 57'03.3"	E 760 36' 49.2"	Ropar
Loghut	N 300 59' 16.3"	E 760 31' 29.1"	Ropar
Batarala	N 310 04' 34.2"	E 760 32'01.2"	Nurpurbadi
Raessira	N 310 400' .9"	E 760 22' 25.4"	Nurpurbadi
Kalyanpur	N 310 10' 39.2"	E 760 34' 09.3"	Ananpur sahib
Lamheri	N 310 15' 30.5"	E 760 30' 08.6"	Ananpur Saheb
Tonsa	N 310 00' 06.6"	E 760 26' 31.9"	Kathgarh
Fathepur	N 310 00' 15.9"	E 760 25' 31.1"	Kathgarh
Bacchola	N 310 27' 58.5"	E 760 03' 07.8"	Mahilpur
Sahapur	N 310 13' 45.9"	E 760 10' 53.1"	Garhsankar
Balachur	N 310 04' 09.0"	E 760 16' 48.4"	Balachur

Fig. 1 (a) : Garhshankar Forest division

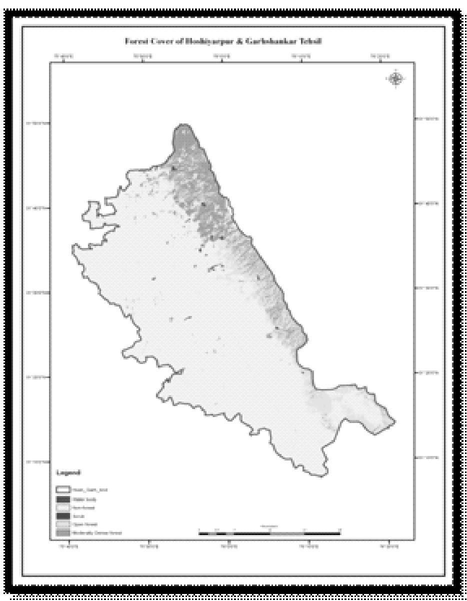
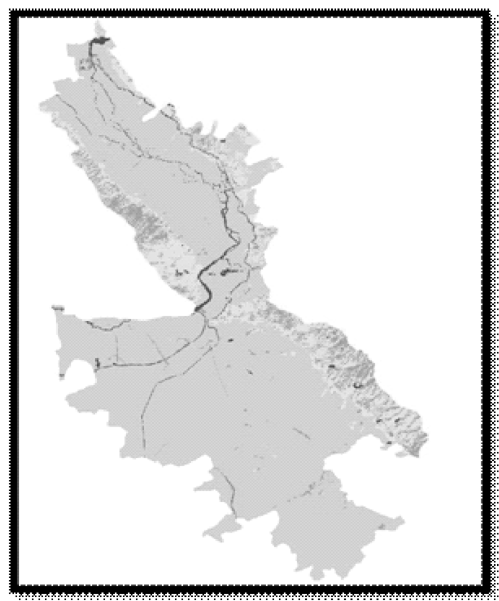


Fig. 1 (b) : Ropar Forest division



range from 0.003 to 8.084 ppm and it also shows that the concentration is highest in planted and pot mixture soils as compared to Parent soils. The manganese concentration range from 1 to 5 ppm. The Mn concentration is highest in Mait Majra nursery (pot mixture soils) i.e 5.937 ppm followed by Balachur (planted soil) i.e 4.481 ppm. The region of Loghut, Kathgarh and Baccholi has the least concentration of Mn i.e 1.011, 1.515ppm. The soils of these three regions are mainly of parent soil. Here also shows that the planted and pot mixture soils has highest concentration of Mn and the parent soil shows the least concentration.The soil of this two district i.e Ropar and Garhshankar has highest concentration of Chromium (Cr). It ranges from 0 to 9.5 ppm. The region of Loghut (planted soil) and Batrala (planted soil) has the highest concentration i.e 9.525 ppm followed by Batrala (planted soil) and Lamheri (planted soil) i.e 7.885 ppm. The region of Kalyanpur, Baccholi and Batrala (pot mixture soil) has the minimum value of Cr concentration i.e 0.24 ppm. Copper (Cu) concentration is highest in Fathepur (parent soil) region i.e 1.704 ppm followed by Loghut (planted, clonal, Eu soil) i.e 0.943 ppm and least in Log hut (parent soil) i.e 0.453 ppm. All the parent soil sample has least concentration of copper except in Fathepur region as compared to pot mixture soil and planted soil. The concentration of Cu range from 0 to 1.7 ppm.The concentration of Iron (Fe) range from 0 to 8 ppm. The region of Mait Majra (planted soil) shows

Table 1 : Concentration of trace elements in Parent soil of Ropar and Garhshankar Forest division of Punjab

Table 2 : Concentration of trace elements in planted soil of Ropar and Garhshankar Forest division of Punjab

Table 3 : Concentration of trace elements in Pot mixture soil of Ropar and Garhshankar Forest division of Punjab

Site (Nursery)	Concentration of Heavy Metals/ Trace Elements					
	Zn (ppm)	Mn(ppm)	Cr(ppm)	Cu(ppm)	Fe(ppm)	Co (ppm)
Sahapur (pot mixture soil)	0.368	3.306	1.223	0.742	0.800	0.121
Balachur(pot mixture soil)	0.292	2.522	0.721	0.818	3.633	1.136
Bachholi(pot mixture soil)	0.094	2.345	0.125	0.562	1.300	0.502
Fathepur (pot mixture)	0.009	1.907	0.492	0.643	0.967	0.375
Kathgarh(pot mixture soil)	0.322	3.082	1.223	0.629	1.300	0.121
Raessira (pot mixture soil)	0.048	3.25	4.941	0.855	1.800	0.882
Lamheri (pot mixture soil)	0.069	1.515	2.305	0.516	2.967	0.375
Kalyanpur (pot mixture soil)	0.182	2.354	3.521	0.704	0.633	0.121
Mait majra (pot mixture soil)	0.319	5.937	4.941	0.818	2.633	0.502
Log hut (planted, clonal,EU, soil)	0.009	2.690	3.521	0.943	3.967	0.882
Batrala(pot mixture soil)	0.090	3.082	0.240	0.906	0.633	0.375

the highest concentration of Fe i.e 8.3 ppm followed by Log hut (planted, clonal, Eu soil) and Balachur (pot mixture soil) i.e 3.967 ppm and 3.633 ppm. The region of Sahapur (pot mixture soil) and Kalyanpur (planted/ forest soil) has the least concentration of Fe i.e 0.8ppm. The Cobalt (Co) concentration range from 0 to 1.5 ppm. Batrala (planted soil) region shows the maximum concentration of Co i.e 1.517 ppm and the region of Sahapur (pot mixture soil), Fathepur (planted soil), Kathgarh (pot mixture soil) and Lamheri (parent soil) shows the minimum concentration of Co i.e 0.121 ppm. From the above result, the increasing order of trace elements or heavy metals of Punjab are arranged as follows:

Co<Cu<Mn<Fe<Zn<Cr

Increasing order of heavy metals in soil of Punjab

This result shows that concentration of Cr is highest and Co is least in soil of Punjab. Although the soil sample collected from Planted and Pot mixture soils shows higher amount of trace element as compared to Parent soil sample. This is due to the application of fertilization in pot mixture soil which changes their concentration.

Conclusion

The data presented above brings out that the soils of Ropar and Garhshankar forest Division of Punjab is highly contaminated with heavy metals. The soil where drain water is used for irrigation has higher DTPA-extractable metals contents as compared to the canal irrigated area. The vegetables grown using this polluted water also have much higher concentration of heavy metals. From the above result, we know that the concentration of heavy metal is higher in planted and pot mixture soils as compared to Parent soil due to the application of fertilization which altered it concentration. The concentration of Chromium (Cr) is highest followed by Zinc (Zn) and Iron (Fe) in the Ropar and Garhshankar forest division of Punjab. The toxicity of soil and interaction between soil particles and nutrient is depends upon the form in which they exist in the environment 3. The most adverse effect of heavy metals is that they can be introduced into the food chain and threaten human health. Agricultural products growing on soils with high metal concentrations are represented by metal accumulations at levels harmful to human and animal health as well as to the bio-environment. High concentrations of heavy metals in soils around industrial facilities originate from an anthropogenic source which is associated with unrestrained solid release and untreated or poorly treated fluid wastes from these industrial facilities.

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