Post irrigation impact of textile industrial effluent on the composition of agricultural soil system at Panipat (Haryana), India

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Abstract

Textile industries of Panipat city are famous for handloom business in abroad as well as in India. The monitoring of agricultural soil quality was carried out for the assessment of effects of textile effluents on some environmental components. Samples of soils and crop plants have been analyzed for seven heavy metals, viz. Cadmium, Copper, Iron, Lead, Manganese, Nickel and Zinc using AAS. The results show the presence of some of the heavy metals in agricultural soil comparatively higher than the soil from 10 km far from industrial area. Metal transfer factor from soil to vegetation was calculated for all heavy metals. Transfer factor was found maximum 3.27 for Zn, while for manganese transfer factor was evaluated 0.78. The present paper deals with the distribution of heavy metals in irrigated agricultural soil and crop plant tissues in the territory of Panipat textile industrial area.

Key words: Heavy metals, agriculture soil, accumulation, transfer factor, crop plants

Introduction

In the last two decades, the rapid growth of industrialization, urbanization and development have created negative impacts on lithosphere, atmosphere and hydrosphere of the environment. In most parts of India, textile handloom business including cotton, woolen, dying, printing, weaving, etc. are the main source of economy and employments for a major low income group. Textile industries consume a large quantity of water and generate a huge amount of wastewater, which generally discharged into a common effluent drain of industrial area. The composite effluents from textile industries in Panipat city consisting high concentrations of heavy metals, organic pollutants and toxic colours, which may affect the quality of surface water, soil, ground water and plant tissues of the region.

Textile effluent when discharged into the pond and through pond they percolated to the ground water (Malik *et al.*, 2006). When this water is used for irrigation purpose affects our crop health. The textile effluent had consisting high concentration of trace heavy metals and through its accumulation in different trophic levels in food chains of ecosystem ultimately cause the health hazards among livestock and human beings (Malik *et al.,* 2004). Ground water contaminated by textile effluents, has deteriorated immensely the post agriculture irrigation, drinking utilities and impacts on agricultural soil systems and crop plant vegetation.

The sediments existing as the bottom of the water column play a major role in the pollution scheme of an aquatic system by heavy metals (Forstner, 1985). They reflect the current quality of the water system and can be used in detecting the presence of contaminants that do not remain soluble after discharge into surface water. As a result of complex physical, chemical and biological processes a major fraction of heavy metals (contributed naturally as well as through various anthropogenic activities) is found to be associated with bottom sediments (Baruah *et al.*, 1996). Bed sediments in surface water systems thus act both as a sink and source of metals. Metal accumulation in sediments provides a record of the spatial and temporal history of pollution (Martin and Whitfield, 1983). Hence, sediment monitoring can provide important information on various pollution events.

Discharges of textile waste on land and used for agricultural purpose have also affected the crop and soil productivity due to high dissolved salts. The suspended solids, which are present in the waste, may carry out clogging of soil pores. The sodium, which is present in the waste, may lead to hardening of texture of soil, thereby preventing penetration of roots in soil (Malik and Bharti, 2010).

Textile effluent pollution may also alter the characteristics of sediment and soil of industrial area directly or indirectly. Composite effluents from textile industries and dye houses of Panipat industrial area normally discharged openly into a common effluent drain without any adequate treatment and commences in a large pond near Binjhole village near to industrial area, which may change the quality of bottom sediments of drain , pond sediment quality and also the physico-chemical characteristics of surrounding agricultural soil (Bharti, 2007).

Material and methods

Panipat is situated on the bank of river Yamuna, it lies between 29' 09' 50" and 29' 50' North latitude and 76° 31' 15" and 77° 12' 45" East longitude with a height of 255 masl. Panipat town is located on the national highway no.1 about 90 km toward north of Delhi has a population of about 0.27 million. Average population density of the urban area of Panipat city is 25,278 per Sq. Km., while the area of town is 10.8 Sq. Km. Study points in Panipat city is situated on Jatal road in industrial area near GT Road. Soil samples were collected in polythene bags from the agricultural fields of the area, and 10 km far from industrial area on Jatal road. Root and shoot samples of Radish (*Raphanus sativus)* were also picked up for heavy metals analysis. Ground water samples were also collected for heavy metals analysis. All samples were analyzed by the standard methods (APHA, 1995) and Trivedi and Goel (1984). Transfer factor between plants and soil was calculated for each metal according to the following formula: TF = *Ps* (□g g–1 dry wt)/*St* (□g g–1 dry wt), Where, *Ps* is the plant metal content originating from the soil and *St* is the total metal content in the soil.

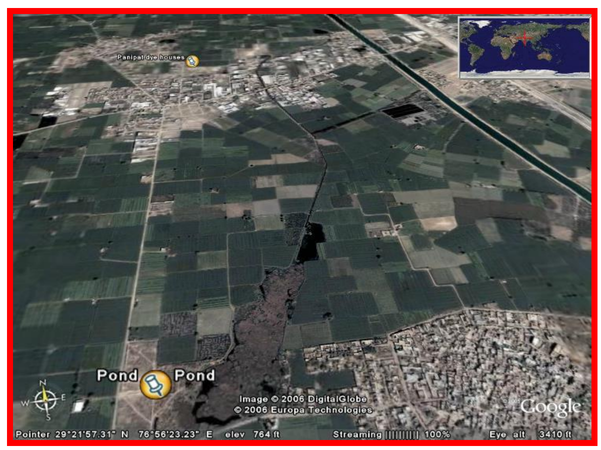

Fig: 1. Satellite imagery showing industrial area and affected pond

Results and discussion

As the major source of heavy metals pollution are dye houses of textile industries in Panipat region. Metal reach in pond water and percolate down to ground water (Malik *et al.*, 2006). Because the ground water is mostly used for irrigation of agricultural fields in most part of Haryana state, so, due to the repeated irrigation practices, agricultural soil quality may be altered. Some heavy metals may accumulate in the tissues of agricultural crop vegetations from these contaminate soils. Agricultural soil is indirectly in touch of point source of metal pollution, because no one is irrigating the agricultural fields directly with textile effluents. Soil samples of irrigated land used for growing crops and vegetables showed the presence of all seven metals considered in the study. Concentration of Mn, Fe, Zn, Cu, Ni, Cr, Pb and Cd (□g g^{-1}) is depicted in table-1. These values are higher in soil samples compared to vegetable samples, except for Zn. The reason might be due to its weak adsorptive nature in the soil (Lokeshwari and Chandrappa, 2006). Plants can absorb the higher quantity of zinc. The average total concentration of all metals in soil samples was lower than the concentrations in ground water. However, in some agricultural soils heavy metals present in trace amount naturally (Nongkynrih *et al.*, 1996).

It was found that the average concentrations of heavy metals in surface soils, i.e. Mn, Ni, Fe, Cu, Cd, Pb and Zn were 0.08, 0.06, 0.48, 0.25, 0.016, 0.36 and 0.12 mg g^{-1} respectively, in which Fe, Pb, Cu were found in excess level due to their cumulative and adsorptive nature in soil after repeated irrigation by contaminated ground water. Cd and Zn were found minimum due to their weak adsorptive nature in soil (Mido and Satake, 2003). Soils near textile industries having comparatively high concentrations of Mn and Zn, while cadmium minimum (Kasem and Singh, 1999). Due to the soil and plant interactions some toxic metals may accumulate in the tissues of crop plants (Henning *et al.*, 2001). Most of the laboratory research on biosorption of heavy metals indicates that no single mechanism is responsible for metal uptake. In general, two mechanisms are known to occur, viz. 'adsorption', which refers to binding of materials onto the surface and 'absorption', which implies penetration of metals into the inner matrix (Ramraj *et al.*, 2000). Either one of these or both the mechanisms might take place in the transportation of metals into the body tissues of crop plant vegetations. Roots and shoots of radish were analysed for total metal content. The order of toxic heavy metal contamination in crop plants is as follows: Zn > Fe, > Mn > Ni > Pb> Cu > Cd. Cadmium was not found in the samples of plant parts. Accumulation of these heavy metals in vegetable plant might be due to the use of contaminated ground water for their cultivation. Zn was present in appreciable amounts in the shoots part of the vegetable.

Heavy metals in plant tissues were found to be lower in comparison to irrigated soil. Fe, Zn, Pb and Mn were found 0.148, 0.143, 0.019 and 0.043 µg g^{-1} respectively maximum in plant roots, while in plants shoots only Zn and Fe were found 0.25 and 0.128 µg g^{-1}. Cd was almost absent in plant tissues, however shoots may contain comparatively high concentrations of Cd in few plant species (Olaniya et al., 1998). The concentrations of Zn and Cd in crops increased with the degree of contamination of the soil. Different vegetable species accumulate different metals depending on environmental conditions, metal species and plant available forms of heavy metals. Studies have shown that uptake and accumulation of metals by plant species depend on several factors, and various researchers have identified several reasons (Bingham et al., 1975; Dowdy et al., 1978). Transfer factor was found to be more for Zn, Mn, Fe and Ni 3.27, 0.78, 0.57 and 0.28 respectively from agricultural soils to vegetation. It is found that the average total concentration of metals in plant shoots is higher than the plant roots. Overall results on comparison reveal that metals in water had impact on soil quality and crop plant vegetations also.

Soil quality and composition may also alter in irrigated agricultural crop fields and thus metals accumulated in plants body, which may seriously caused health hazards to livestock and ultimately to human beings by direct consumption or by uptake the food products originated by cattle (De, 2002). Irrigation with contaminated ground water containing variable amounts of heavy metals leads to increase in concentration of metals in the soil and vegetation. Concentration of metals in vegetation will provide baseline data and there is a need for intensive sampling of the same for quantification of the results.

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TABLE1: ***Heavy metals in agricultural soil in industrial area.***

Metals	**Agricultural soil**					**Control soil**	**Ground water**
(in µg/g)	Soil 1	Soil 2	Soil 3	Mean	SD	(in µg/g)	(in mg/l)
Cd	0.001	0.007	0.04	0.016	0.0210	BDL	0.006
Cu	0.05	0.28	0.42	0.25	0.1868	0.155	0.303

Fe	0.14	0.39	0.92	0.483	0.3983	0.357	2.767
Mn	0.02	0.08	0.15	0.083	0.0650	0.065	0.26
Ni	0.04	0.05	0.11	0.067	0.0378	0.045	0.072
Pb	0.16	0.21	0.73	0.367	0.3156	0.258	0.74
Zn	0.04	0.09	0.23	0.12	0.0985	0.089	0.101

TABLE 2: ***Mean values of heavy metals in vegetation tissues (in µg/g).***

Plants parts	**Cd**	**Cu**	**Fe**	**Mn**	**Ni**	**Pb**	**Zn**
Radish root	BDL	0.012	0.148	0.043	BDL	0.019	0.143
Radish shoot	BDL	0.0005	0.128	0.022	0.019	BDL	0.249
Transfer factor	0	0.05	0.57	0.78	0.28	0.05	3.27

BDL= Below Detection Limit