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Spatial Effects of Industrial Effluent on Soil Quality around the Textile Industrial Area of Bhaluka Upazila, Mymensingh

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Abstract

The study was carried out to investigate the spatial effects of industrial effluent on physico-chemical properties of soil around the textile industrial area of Bhaluka upazila, Mymensingh, from January to March, 2015. Total 15 soil samples were collected at 0m, 50m, 100m, 200m and 300m distances from the effluent discharging point. Soil texture, pH, electrical conductivity (EC), organic matter (OM), nitrogen (N), phosphorus (P), potassium (K), sulphur (S), sodium (Na) and heavy metal (lead, Pb and cadmium, Cd) content were investigated in this study. Soil pH, EC, OM and nutrient content of soil were higher at discharge point (at 0m) and lowest at 300m distance. The Pb content was maximum (36.9 ppm) at 0m and minimum (24.27 ppm) at 300m distance. The highest value (3.0 ppm) of Cd was observed at 0m and lowest value (2.8 ppm) was at 300m distance. All of the studied values were higher at the adjacent of industrial area and gradually decreased with distance.

Key words: Industrial effluent, Soil's physical and chemical properties, Spatial effect

Introduction

Bhaluka is a newly industrial growing site of Bangladesh with unregulated growth of commercial industrial installations. The untreated effluents from these industries are discharged randomly to the nearby fields and the local streams and rivers. Industrial effluents consist of many trace and heavy metals like N, P, K, S, Na, Zn, Cu, Ni, Cd, Cr, Pb, As, Fe etc. which may beneficial at minute amount and harmful at large amount. Metals such as As, Pb, Cd, Ni, Hg, Cr, Co, Zn and Se are highly toxic even in minor quantity (Bharti *et al*., 2013). In most cases, metal levels were found to exceed the common regulation guideline levels enforced by many countries (Kabir *et al.*, 2012). The waste material discharges from industrial activities may cause adverse effects on soil. Metal concentrations in contaminated soils may decrease soil microbial activity, soil fertility, crop yield and affect food quality and safety. Textile industries consume a large quantity of water and generate a huge amount of wastewater, which are generally discharged into the vicinity of industrial area. Dyeing process usually contributes Cr, Pb, Zn and Cu to wastewater (Benavides, 1992). Bhaluka upazilla also suffers from flooding during rainy season and thereby the industrial effluents spread over a large area. It is therefore essential to assess the soil quality over a large area. The objective of this study was to investigate the spatial variation of physicochemical properties of soil around the textile industrial area of Bhaluka Upazila.

Materials and Method

The study area is located in Habirbari union of Bhaluka upazila, Mymensingh within the latitude of 24° 22′ 30″ N and longitude of 90° 22′ 40.08″ E. It has an area of 444.05 sq. km. There are several types of industrial units in this area including textile, dyeing, pharmaceuticals, cosmetics, aluminum, ceramics, leather, glass, garments, packaging industry and brick fields.

Collection, preparation and analysis of soil sample

Fifteen soil samples were collected from 0-30 cm soil depth at 0m, 50m, 100m, 200m and 300m distances around industrial area. After collection, the samples were carried to the laboratory of Department of Environmental Science, Bangladesh Agricultural University, Mymensingh, dried at room temperature, ground and sieved with a 2 mm sieve. The prepared samples were kept in polythene bags and labeling for laboratory studies. The samples were analyzed for physicochemical parameters viz. soil texture, soil pH, electrical conductivity (EC), organic matter (OM), nitrogen (N), phosphorus (P), potassium (K), sulphur (S), sodium (Na), lead (Pb) and cadmium (Cd). Soil texture was determined by hydrometer method; soil pH was determined by glass electrode pH meter (WTW pH 522; Germany); EC was determined electrometrically (soil water ratio was 1:5) by a conductivity meter (WTW LF 521; Germany); OM was calculated by multiplying the content of organic carbon by van Bemmelen factor, 1.724; N was determined by Kjeldahl method; available P was determined by Olsen's method colorimetrically; available S was determined by extracting the soil samples by calcium chloride solution (0.15%); available Na and K was determined by flame photometer; total concentrations of Pb and Cd were determined using atomic absorption spectrophotometer (AAS), equipped with single elements hollow-cathode lamps at the wavelengths of 283.3 and 228.8 nm, respectively.

Results and Discussion

Effect of industrial effluent on soil texture, soil pH and electrical conductivity (EC)

The textural classes of the study area ranged from silty clay loam to clay. The silt content was higher at discharge point; clay content was higher at 300 m distance and no significant variation was found in sand content among different location. The average pH value of soil sample was 7.3, 7.2, 7.1, 6.8 and 6.4 at 0m, 50m, 100m, 200m and 300m distance, respectively (Fig. 1a). Vertical bar indicates the standard error. The highest pH value (7.3) was found at 0m distance which was slightly alkaline and the lowest value (6.4) was observed at 300m which was slightly acidic. Various materials (wastes, effluents, chemicals and salt etc.) discharged from the industry might be responsible for higher pH at 0m location. Kumar and Chopra (2010) investigated the influence of sugar mill effluent on physico-chemical characteristics of soil at Haridwar (Uttarakhand), India where pH was 9.56. The average EC value of soil sample was 446.7 (μscm^{-1}), 424.33 (μscm^{-1}), 393.23 (μscm^{-1}), 363.5 (μscm^{-1}) and 96.03 (μscm^{-1}) at 0m, 50m, 100m, 200m and 300m distance, respectively (Fig. 1b). The maximum value (446.7 μscm^{-1}) was found at 0m and minimum value (96.03 μscm^{-1}) was at 300 m distance. According to Costa *et al*. (2001), high EC value in soil, might be due to the huge quantities of salt and solid wastes in textile and other industrial effluents.

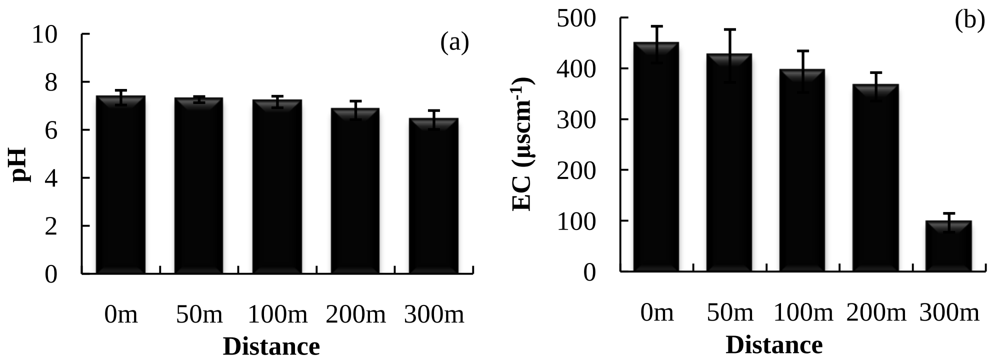

Fig. 1. (a) Soil pH and (b) electrical conductivity (EC) at different distances of the study area

Effect of industrial effluent on nutrient status of soil

The average OM content was 2.78%, 2.34%, 2.09%, 2.09% and 2.0% at 0m, 50m, 100m, 200m and 300m distance, respectively (Fig. 2a). OM was higher at 0m distance and it decreased gradually up to 100m and after that the value was constant. The higher value at 0m might be due to the deposition of large quantities of industrial wastes having higher OM (Sultana, 2012).

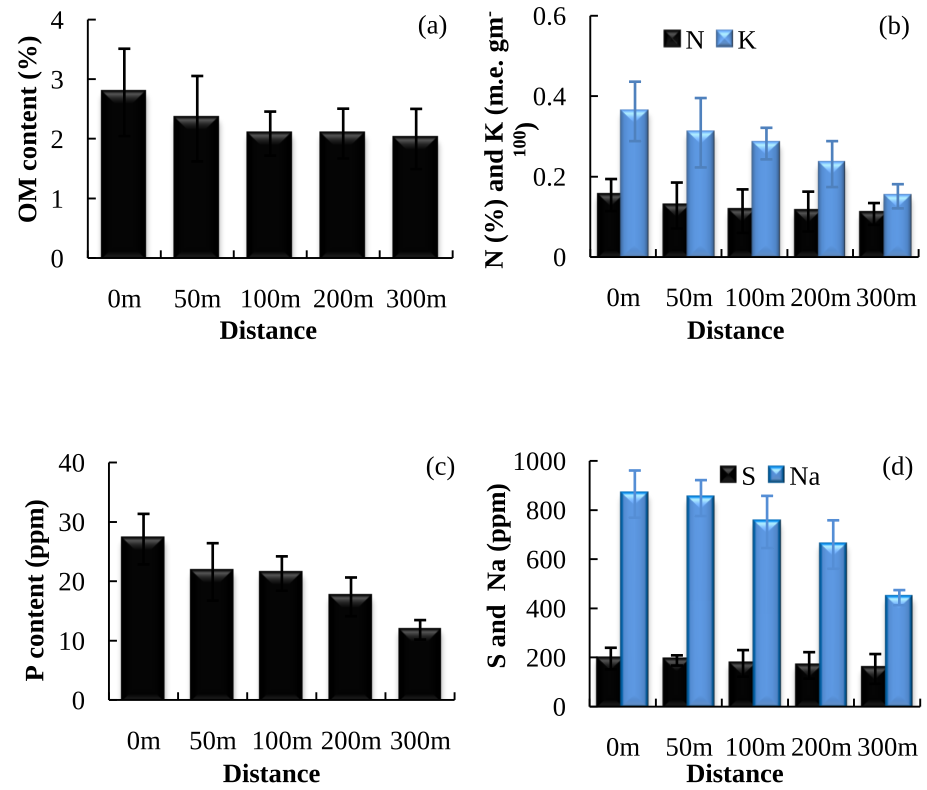

Fig. 2. (a) Organic matter (OM); (b) nitrogen (N) and potassium (K); (c) phosphorous (P); (d) sulphur (S) and sodium (Na) content at different distances of the study area

The average N content was 0.154%, 0.128%, 0.114%, 0.113% and 0.107 at 0m, 50m, 100m, 200m and 300m distance, respectively (Fig. 2b). N content decreased from canal edge to distant places and the variation in N content with distance followed the variation in OM content. Rahman *et al.* (2012) found that nitrogen content varied from 0.024% to 0.88% in the close vicinity of Dhaka Export Processing Zone (DEPZ). The average P content was 27.10 ppm, 21.59 ppm, 21.3 ppm, 17.38 ppm and 11.82 ppm at 0m, 50m, 100m, 200m and 300 m distance, respectively (Fig. 2c). The maximum value was found at 300 m distance and minimum value was at 0m distance. A significant variation in P content was found with distance. The result indicates the industrial origin of P at 0m. Sumi (2010) investigated the metallic contamination in some industrial soils of Gazipur district and reported that the mean P value was 18.86 ppm. The average K content was 0.362 (m.e.100g^{-1}), 0.309 (m.e.100g^{-1}), 0.282 (m.e.g), 0.231 (m.e.100g^{-1}) and 0.151 (m.e.100g^{-1}) at 0m, 50m, 100m, 200m and 300m distance, respectively (Fig. 2b). The mean K content decreased gradually with the increase of distance from waste discharge canal. The industrial effluent might contain higher K which increased the K content at 0m. The average S content was 195.13 ppm, 187.5 ppm, 175.5 ppm, 167.16 ppm and 153 ppm at 0m, 50 m, 100 m, 200 m and 300 m distance, respectively (Fig. 2d). S content showed a gradual decrease with the increase of distance from waste canal indicatin^{-100}the load of S at 0m sites preferably from industrial effluent. However, the variation in S content was minimum with distance. The average Na content was 864.76 ppm, 848.53 ppm, 751.26 ppm, 659.36 ppm and 443.2 ppm at 0m, 50m, 100 m, 200 m and 300 m distance, respectively (Fig. 2d). A significant variation in Na content was found with distance. There was a decreasing trend in Na concentration with increasing distance from waste canal.

Effect of industrial effluent on heavy metal status of soil

The average Pb content was 36.9 ppm, 30.37 ppm, 29.07 ppm, 28.1 ppm and 24.27 ppm at 0m, 50 m, 100 m, 200 m and 300 m distance, respectively (Fig. 3a). Higher Pb content at 0m might be due to industrial effluents. Permissible limit of Pb content for agricultural soil is 100ppm and all the studied values were below the permissible limit. Mondol *et al.* (2011) examined the dry and wet season's average Pb content of industrially polluted soils of Tejgaon area and found that Pb content was 130.29 ppm and 95.08 ppm, respectively.

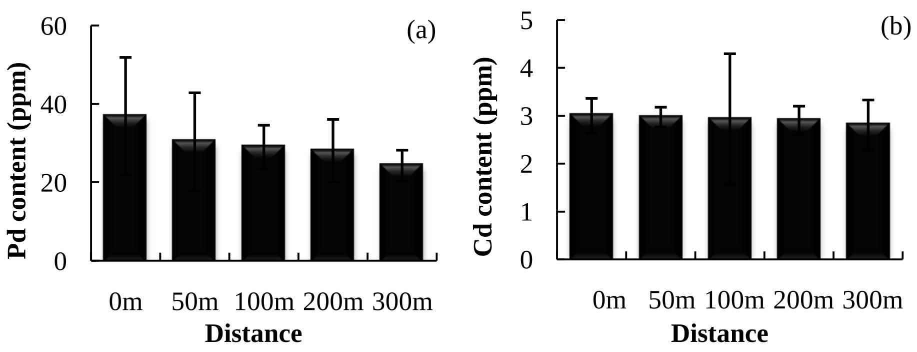

Fig. 3. (a) Lead (Pb) and (b) cadmium (Cd) content at different distances of the study area

The average Cd content was 3.0 ppm, 2.97 ppm, 2.93 ppm, 2.90 ppm and 2.8 ppm at 0m, 50m, 100m, 200m and 300m distance, respectively (Fig. 3b). The standard limit of cadmium content for soil is 0.5 ppm. The Cd content in all studied samples was higher than the standard limit. Pb and Cd content exceeded the standard limits in textile and tannery industries effluents and associated soil located near Haridwar (Deepali and Gangwar, 2010).The Cd content was 404.35 ppm around the sugar mill industries, India (Kumar and Chopra, 2010).

Conclusions

All of the components were higher at 0m distance and lower at 300m distance. The huge quantities of wastes and sludge discharged from industries might be responsible for the enrichment of all studied physico-chemical parameters at discharging point (0m location).

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