African Journal of Agronomy ISSN: 2375-1185 Vol. 2 (10), pp. 219-223, November, 2014. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Textile effluents changes physiochemical parameters of water and soil: Threat for agriculture

Akbar Hossain Kanan[1*], Sabiha Sultana Marine[2], Farzana Raihan[3], Mohammad Redowan[4] and Md. Danesh Miah[5]

[1, 3, 4]Department of Forestry and Environmental Science, Shahjalal University of Science and Technology, Sylhet-3114, Bangladesh

[2]Department of Fisheries Technology and Quality Control, Sylhet Agricultural University, Sylhet 3100, Bangladesh

[5]Institute of Forestry and Environmental Sciences, University of Chittagong, Chittagong 4331, Bangladesh

Accepted 21, March 2014

Textile is the foremost part of industrial sectors in Bangladesh and is the major source of water and soil pollution. More than 80% people are depending on agricultural sectors for their livelihood in Bangladesh. This study investigates the impacts of textile pollution on agricultural land and water in NarsingdiSadar. A total of 50 water and soil samples were collected from the study area and analyzed to determine concentration of physiochemical parameters of water and soil. Analysis revealed the values of the parameters are as pH (7.56-9.68), EC (17040-38040 µs/cm), Temperature (30.24-51.22°C), DO (1.16-4.65 mg/L), COD (810.60-1430.43 mg/L), BOD (305.58-608.16 mg/L) and TDS (3456.75-38450.26 mg/L). These values are negatively deviated from the standard values set by the Department of Environment (DOE)for textile effluents. The amount of N (0.217-0.787 µg/g), P (27.50-30.70 µg/g) and K (0.165-2 µg/g) were also found deviated from the standard values prescribed by Bangladesh Agricultural Research Council (BARC) for agricultural soil. Major rivers flowing over these industrial regions, like Burigonga, Sitalokka and Turag, have been severely polluted by textile and other pollutants as well as causing serious impact on environment. Government should strictly implement the existing environmental and industrial laws in textile effluent management.

Key words: Physiochemical parameters, Textile effluents, Soil, Water, Agriculture.

INTRODUCTION

Industries are essential for economic development of any country. Textile industries have significant contribution in uplifting Bangladesh's economic status. But these industries have negative implications for environment. Normally in production process, textile industry uses huge amount of water and after the production finishes, contaminated waters are releasedto the sewers or drains without pretreatment (Kant, 2012;Chindahet al., 2004).Discharging the contaminated water without pretreatment may directlycause environmental degradation. Direct discharge of contaminated water indisputably declines the soil productivity and negatively affectsthe level of crop production in the surrounding agricultural lands (Islam et al., 2006). The risky factors are mainlyrelated with the wet processes scouring, mercerizing, bleaching, dyeing and finishing.The dye baths take account of high level of BOD, COD, color, toxicity, surfactants, turbidity, and at the same time may enclose heavy metals (Wynne et al., 2001). Microbial activity slows down and biological treatment system also fails due to the existence of heavy metals and other dye compounds (Wynne et al., 2001). Textile effluents contain high BOD due to fiber residues and suspended solids (Yusuf et al., 2004; AEPA, 1998). These can contaminate water with oils, grease, and waxes while some may contain heavy metals such as chromium, copper, zinc and mercury (EPA, 1974). Copper is toxic to aquatic plants at concentrations below 1.0 mg/l where concentrations near this level can be toxic to some fish (Sawyer et al., 1978).

In modern economies, various types of activities including agriculture, industry and transportation, produce a large amount of wastes and new types of pollutants. Soil, air and water have traditionally been used as sites for the disposal of all these wastes. Moreover, in Bangladesh, technologies of waste water treatment plants are absent or abysmally poor (DOE, 2008). For this reason, great changes take place in soil macro and micro nutrients status which neg-

*Corresponding author. E-mail:kanan.sust@gmail.com

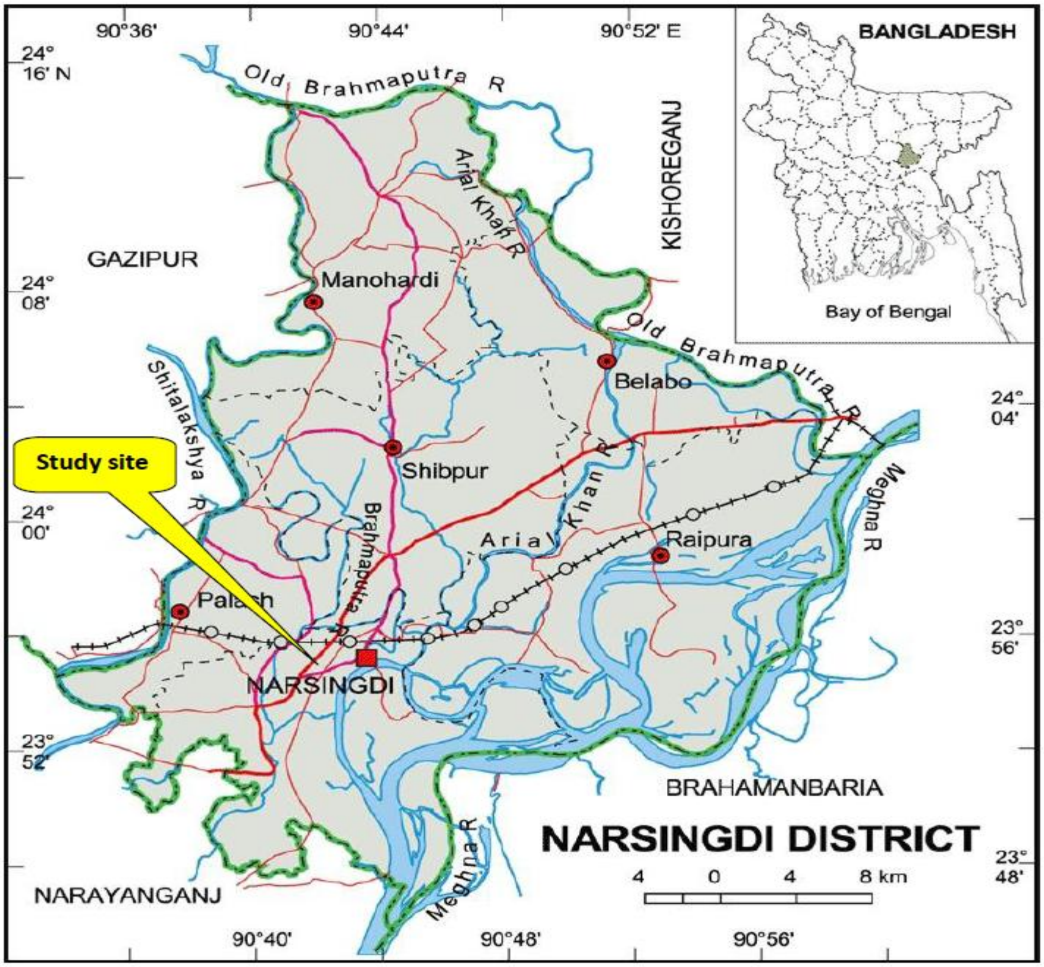

Figure 1: Study area (Source: Maps of Bangladesh)

atively impact agricultural production. Textile industries generate a large amount of effluents, sewage sludge and solid waste materials everyday those are being directly discharged into the surrounding channels, agricultural fields, irrigation channels and surface water which finally enter into the river systems. This study aimed to determine the physiochemical parameters of water such as pH, EC(Electrical Conductivity), Temperature, DO(Dissolved Oxygen), COD(Chemical Oxygen Demand), BOD (Biological Oxygen Demand) and TDS(Total Dissolved Solids) and of soil such as N, P, and Kclose to textile industries at NarsingdiSadar to compare the results with the standard level (DOE standard for water parameters and BARC standard for soil nutrients) from agricultural perspectives.

MATERIALS AND METHODS

NarsingdiSadar, a textile industrial hub, issituated 50 km north-east of Dhaka, the capital city of Bangladeshand geographically lies at 23°55′00″N and 90°43′30″E(Figure1). For transportation facilities most of the textile industries at Norsingdi were established by the Dhaka-Sylhet highway passing throughNarsingdiSadaradjacent to agricultural lands.

A total of 50 samples were collected (5 samples for each parameter) from the study areafollowingstandard procedures. Analysis was done in the laboratory of the department of Civil and Environmental Engineering at Shahjalal University of Science and Technology. For testing of water parameters, 5 samples for each parameter were collected from the discharge point (0 m) of these industries to about 1000 m after the discharge point at 200 m interval. Samples were collected with two-liters white plastic kegs, which have been thoroughly washed with nitric acid and then rinsed several times with distilled water. Analysis was carried out as per the standard methods (APHA, 1989). To analyze soil parameters, 5 samples (Soil sample collected from agricultural land of the study area and depth

Table 1. Analytical results of selected water samples (W_1, W_2…W_5) of textile effluents with DoE standard for industrial effluents.

Parameters	W_1	W_2	W_3	W_4	W_5	Mean	DOE standards
pH	8.73	9.68	8.06	7.88	7.56	8.18	6.5 - 8
EC µs/cm	26070	38040	28055	19710	17040	25781	250 µs/ cm
Temp °C	51.22	42.53	44.22	38.05	30.24	41.25	40°C
DO mg/L	1.16	2.63	2.38	4.06	4.65	2.98	4.5 - 8mg/L
COD mg/L	1430.43	1145.87	960.55	810.6	890.33	1047.56	200mg/L
BOD mg/L	608.16	504.12	433.83	418.43	305.58	454.02	150 mg/L
TDS mg/L	38450.26	21095.52	16088.38	10246.14	3456.75	17867.41	2100mg/L

0-8cm or which depth plough is done) for each parameter were collected from the discharge point (0 m) of those industries to about 1000 m after the discharge point at 200 m interval towards agricultural land. Soil samples were dried at 70°C for 24 hours in the oven. Notably, for 1 gm sample, 8 ml conc. HCl and 2 ml conc.HNO3 were added and kept for overnight 3 at 35°C. Digestion was done according to the standard method (McGrath and Eddie, 2003). After dilution and filtration, the digested solution was analyzed for determination of N, P and K of the soil.

RESULTS AND DICUSSION

The analytical results of textile effluents are given in the Table1. Obtained values of the parameters deviated from the permissible limits recommended by DOE for pH, EC, Temperature, DO, COD, BOD and TDS.

The concentration of hydrogen-ion is a major sign for measurement of quality of natural and wastewater (Bharati and Shinkar, 2013).The higher value of pH of the textile effluent indicates the alkalinity conditions which have an adverse effect on the soil permeability and soil micro flora (Robinson et al., 2002). High bicarbonate (HCO_3) and carbonate (CO_3) concentrations mean higher values of pH and highly alkaline water can strengthen sodality soil conditions, which will have implications for crop growing (Bauder et al., 2004). The pH values varied from 7.56 to 9.68 in the study area which was higher from the recommended standard value of DOE (6.5 - 8.0) for Bangladesh Industrial Effluent Standard (DOE, 2008)(Table1). Maximum value was found in sample no: W_2 which was collected from the 200m distance from the textile discharge point and minimum value was found in sample no: W_5 which was 1000m away from the respective discharge point. Electrical conductivity (EC) is important for irrigation because it is a measure of the salinity of the water and acts as a surrogate for total dissolved solids (TDS) (Metcalf and Eddy, 2003). EC values were observed 38040 to 17040µs/ cm at different sampling points which were generally higher than DOE standard given as 250 µs/ cm(Table1).Temperature plays a vital role in chemical reactions and increases evaporation rate of wastewater, thereby suitability of water hampered for beneficial uses such as irrigation (Metcalf and Eddy, 2003). Temperature varied from 51.22 °C to 30.24°C of the samples which were collected from 0m (point of source) to 1000m distance from the source respectively, which were above the standard level (40°C) for surface water (DOE, 2008). Near the discharge point (W_1) the maximum temperature was recorded as 51.22°C. Other studies reported that values of temperature as 48°C to 59°C and EC as 2250 to 19000 µs /cmin the textile effluent in DEPZ (Dhaka Export Processing Zone) area (Ahmed, 2007). This might be connected with the release of chemical salts from the textile industry as well as influx of lagoon water. One of the effects of EC in water is the impact on the taste of water and also impacts soil macro and microorganism. Short term temperature fluctuations in streams near the textile and dying industries might lead fish to die, fish eggs that won't hatch or a total change in the fish population. For aquatic life, the temperature should not exceed 25°C (77°C) during the latter half of October and the average temperature during that time period should not be higher than 22.2°C (7°C)(USEPA, 1986).

DO is essential to all forms of aquatic life including microorganisms responsible for the self-purification system in natural waters (Kant, 2012). The values of DO ranged from 1.16 to 4.65 mg/L(Table1) in the study area. There is an inverse linear correlation between TDS value and DO level, therefore, high TDS values always corresponds to low DO level (Akan et al.,2007).Lower level of DO (W_1: 0.16) was observed near the discharged points and higher amount was found comparatively at the longer distance from the textile discharge points in the study area. The mean value

Table 2. Analytical results of N (Nitrogen), P (Phosphorus), K (Potassium) in soil samples (S_1, S_2…S_5) of textile effluents with the standard value of BARC for agricultural crop production.

Parameters	S_1	S_2	S_3	S_4	S_5	Mean	BARC standard
Total N µg/g	0.217	0.434	0.328	0.543	0.787	0.461	0.271-0.36 µg/g
Available P µg/g	30	30.50	30.70	30.50	27.50	29.84	22-30 µg/g
Available K µg/g	2.0	1.87	1.65	1.76	1.65	1.786	0.271-0.36 µg/g

was 2.98 which are very poor for agricultural production compared to standard level (4.5- 8 mg/L) of DOE (DOE, 2008). Ahmed (2007) reported that, DO values of 2.15 to 5.90 mg/L in textile effluent near the DEPZ area. COD values varied between1430.43 to 810.60 mg/L(Table1) which were very high compared to DOE standard (200mg/L) for disperse in inland surface water. In the sample no: $W_1$the value of COD was 1430.43mg/L which indicates a heavy load of organic and inorganic pollution that require more oxygen to oxidize under increased thermal conditions (Koushik and Saksena, 1999).Few other studies reported that, COD values were 652.8 to 2304 mg/l in the textile effluent near Savarupozila (Roy et al., 2010) and 170.88 to 854.4 mg/L in the DEPZ area (Ahmed, 2007) in Bangladesh. The high levels of COD indicate the toxicity of the effluents and the existence of huge quantity of biologically resistant organic substances that is risk for environment (McMullan et al., 1995; Yusuff et al., 2004; Geetha et al., 2008).BOD is the measure of quantity of oxygen required by bacteria and other microorganisms under aerobic condition in order to biochemically degrade and transform organic matter present in the water bodies (Bhadja and Vaghela, 2013). The high levels of BOD are the indicators of the pollution strength of the waters (McMullan et al., 1995; Yusuff et al., 2004; Geetha et al., 2008).They also indicate that less oxygen is available for the living organisms in the wastewaters. The BOD values were varied between 608.16 to 305.58mg/L (Table 1). However, the values were high according to the DOE standard (150 mg/L). In this area BOD values were higher near to the discharge points compare to distant points. Notably, BOD values of textile effluent were found from 151.24 to 299.1 mg/L in Savar, Dhaka which is 3 to 6 times higher than the acceptable value of DOE for wastewater to release on the inland surface water (Roy et al., 2010). BOD values were found 94.33 to 141.66 mg/L in the textile effluent in DEPZ area (Ahmed, 2007). It is clear from the several studies that, the composite textile mill release a lot of biochemical oxygen demanding waste. The amount of TDS was high in sampling site W_1 (38450.26 mg/L) after the discharge, 0 to 200m distance from the point source and the lowest value was found in W_5 (3456.75) at highest distance from the source respectively. In this study, the mean value of TDS was found 17867.41mg/L which was higher than the standard level of DOE (2100mg/L)(Table1). It might be due to store of different ions in the effluents from the discharge point. High level of TDS in water is not suitable for using as industrial purposes as well as agricultural perspectives (ADB, 1994). It is important to note that, presence of excess TDS in water would have adverse impact on aquatic life, render the receiving water unfit for drinking, and reduce crop yields if used for irrigation (Roy et al., 1969; Behra et al., 1969; Verma et al., 2000).

The amounts of nutrients and their distribution in different soil horizons are associated to the growth and progress of plantation (Singh and Ramam, 1982). The total amounts of nutrients were high in this study area due to large amount of effluents discharge from the textile industry. N is a necessary primary macronutrient for plants that stimulates plant growth and is usually added as a fertilizer but can also be found in wastewater as nitrate, ammonia, organic nitrogen or nitrite (Ayres and Westcot, 1994). The sensitivity varies by means of the growth stage of crops, in early growth stage high N (Nitrogen)levels may be beneficial but may cause yield losses during the later flowering and fruiting stages, so textile wastewater can be used as a fertilizer early in near the beginning growth stage of crop production (Ayres and Westcot, 2004). In this study, the low concentrations of total Nwas 0.217 µg/g(sample no: S_1) and maximum concentrations was 0.787µg/g (sample no: S_5) in the soil, both are higher than the standard value of BARC (0.271-0.36 µg/g) (Table2)for agricultural crop production. P (Phosphorus)is also a major macronutrient that is fundamental to the growth of plants and other biological organisms but quantities is not excessive and if the concentrations in water and soil are too high poisonous algal blooms can arise (Ayres and Westcot, 2004). The concentrations of P in this study area were more or less same as regard to the BARC standard (22-30 µg/g)(Table2).K (Potassium) is not an integral part of any major plant component but it does play a key role in a vast array of physiological processes vital to plant growth, from protein synthesis to maintenance of plant water balance. This macronutrient was found with higher concentration (1.65-2.00 µg/g) compared to the BARC standard (0.271-0.36 µg/g)(Table2)for agricultural crops. These excess N, P, K result in over-stimulation and extreme growth which attracts pests, delays ripeness or decrease the excellence of the crop (Ayres and Westcot, 2004). Strongly acidic or highly alkaline soils results in poor growing conditions for micro-organisms, ultimately resulting in low levels of biological oxidation of organic matter (Biswas and Mukherjee, 1997). This study estimated approximately 40%area as highly polluted, 35% as moderately polluted, 20% as less polluted and 5% as non-polluted near the textile discharge site which is serious threat for this agricultural land.

CONCLUSION AND RECOMMENDATIONS

Majority of the textile industries in Bangladesh is devoid of pretreatment plant for detoxifying waste effluents. These effluents spread on agricultural land through the drainage system and negatively impact soil physiochemical parameters. The crop cultivated near to the dyeing industry and textile waste water locations in NarsingdiSadar were very much affected due to the slow change in soil salinity and sodality. Establishment and yield productivity was greatly interfered while none of the food crops grew in these affected locations. Besides the crop yield, the hygienic condition was also impacted negatively. The quality of groundwater was hampered by way of increased sodium, TDS, EC etc. Toxicity of physiochemical parameters of the water effluent and soil are significantly 2 to 100 times higher than the standard value of DOE and BARC. Thus, the study concludes that, the level of pollution due to effluent from textile dyeing industries of NarsingdiSadar is alarming. However, if Environment Impact Assessment (EIA) prior to the establishment of textile industries is properly done, effluent treatment plant (ETP) for detoxification of textile pollutants is established in each industry and site selection is done carefully for industry establishment, impact on public health and environment would surely be minimized.

REFERENCES

ADB (Asian Development Bank) (1994). Training manual for Environmental Monitoring Engineering Science, INC, USA, pp. 2-16.AEPA (Australian Environmental Protection Authority) (1998).Environmental Guidelines for the Textile dyeing and Finishing Industry, State Government of Victoria, Melbourne, Victoria, Australia.

Ahmed T (2007). Characterization of textile effluent from selected industries in DEPZ and their treatment by adsorption- filtration process. M. Sc. Thesis, pp. 1-132, Department of Environmental Sciences, Jahangirnagar University, Saver, Dhaka.

Akan JC, Moses EA, Ogufbuaja VO (2007). Determination of pollution levels in Mario Jose Tannery Effluents from Kano Metropolice, Nigeria. J. Appl. Sci. 7(4): 527-530.

APHA (American Public Health Association) (1989).Standard Methods for the Examination of Water and Wastewater, 17th ed. Washington, DC.

Ayres RM, Mara DD (1996). Analysis of Wastewater for use in Agriculture; A Laboratory Manual of Parasitological and Bacteriological Techniques. Switzerland, Geneva: World Health Organization.

Ayres RS, Westcot DW (1994). Water Quality for Agriculture.FAO Irrigation and Drainage Paper 29 Rev 1. Rome, Italy: Food and Agriculture Organization.

BARC (Bangladesh Agricultural Research Council) (2005). Fertilizer Recommendation Guide for different crops in soil.

Bauder TA, Cardon GE, Waskom RM, Davis JG (2004).Irrigation Water Quality Criteria.http://www.ext.colostate.edu/pubs/crops/00506.html.

Behra BK, Mishra BN (1969). The effect of a sugar mill effluent on enzyme activities of rice seedlings, Industrial Research. 37: 390-8.

Bhadja P, Vaghela A (2013). Hydrobiological studies on freshwater reservoir of Saurashtra, Gujarat, India. J. Biol. Earth Sci. (2):12-17.

Bharati S, Shinkar NP (2013). Dairy Industry Wastewater Sources, Characteristics & its Effects on Environment. Int. J. of Current Eng. Technol. 3(5): 1611-1615.

Biswas TD, Mukherjee SK (1997).Textbook of Soil Science, Tata McGraw-Hill Publishing Limited.

Chindah AC, Braide AS, Sibeudu OC (2004).Distribution of hydrocarbons and heavy metals in sediment and a crustacean (shrimps-Penaeusnotialis) from the bonny/new Calabar river estuary, Niger Delta. Ajeam-Ragee, 9: 1-14.

DOE(2008). The environment conservation rules. Department of Environment, Ministry of Environment and Forest, Government of the People's Republic of Bangladesh.

EPA(1974). Wastewater-Treatment Systems: Upgrading Textile Operations to Reduce Pollution, United States Environmental Protection Agency, Washington DC, USA, In: EPA Technology.

FEPA (Federal Environmental Protection Agency) (1991). Water Quality, Federal Water Standards, Guidelines and Standard for Environmental Pollution Control in Nigeria, National Environmental Standards – Part 2 and 3, Government Press, Lagos pp 238.

Geetha A, Palanisamy PN, Sivakumar P, Ganesh PK, Sujatha M (2008).Assessment of underground water contamination and effect of textile effluents on Noyyal (9 river basin in and around Tiruppur town, Tamil Nadu). 5(4): 696-705.

Haque ME (2002). A Compilation of Environmental Laws of Bangladesh, Administrated by the Department of Environment (DOE).

Islam F, Rumi S, Juhaina J (1994). Industrial pollution in Bangladesh.www.worldbankgroup.org.

Knat R (2012). Textile dyeing industry an environmental

hazard Natural Science. 4 (1): 22-26.
Koushik S, Saksena DN (1999). Physico-chemical limnology of certain freshwater bodies of central India.
Maps of Bangladesh. Available at: http://mapofbangladesh.blogspot.com/2011/09/narsingdi-district.html.
McMullan G, Poonam NS,Franklin S, Oxspring D (1995). Bioremediation and chemical analysis of textile industry waste water. 17: 760-764.
Metcalf, Eddie (2003). Wastewater Engineering Treatment and Reuse, Forth Edition. New York, USA: McGraw Hill.
Robinson T, Chandranand B, Nigam P (2002). Textile effluent decolorization and dye-adsorbed agricultural residue biodegradation: Biores. Tech. 84, 299 – 301.
Roy R, Fakhruddin ANM, Khatun R, Islam MS, Ahsan MA, NegerA JMT (2010).Characterization of Textile Industrial Effluents and its Effects on Aquatic Macrophytes and Algae.BangladeshJ. Sci. Ind. Res. 45(1): 79-84.
Roy RP, Prasad J, Joshi AP (2007). Effect of sugar factory effluent on some physic-chemical properties of soils – a case study. J. Environ. Sci. 49(4): 277-282.
Sawyer CC, McCarty PL (1978). Chemistry for Environmental Engineers, McGraw Hill, New York. pp. 331–514.
Secondary Drinking Water Regulations; Synthetic Organic Chemicals and Inorganic Chemicals. Federal Register.55 (143): 370.
USEPA (United States Environmental Protection Agency) (1986). Quality criteria for water. Office of water Regulation and standards, Washington dc, usepa-40015-86-256 pp.
Verma SR, Shukla GR (1969). Pollution in a perennial stream, ‘Khala’ the sugar factory effluent near lakes. Env. Health. 11: 145-162.
WHO (World Health Organization) (2006). WHO Guidelines for the Safe Use of Wastewater, Excreta and Grey water: Volume II Wastewater use in Agriculture. Geneva, Switzerland: WHO.
World Bank (2010).A detailed analysis on industrial pollution in Bangladesh. Workshop Discussion Paper,World Bank Dhaka Office, Bangladesh. Transfer, EPA-625/3-74-004, pp. 1-12.
Wynne GD, Maharaj, Buckley C (2001). Cleaner Production in the Textile Industry – Lessons from the Danish Experience, School of Chemical Engineering, University of Natal, Durban, South Africa, p. 33.
Yusuff RO, Sonibare JA (2004). Characterization of textile industries. Effluents in Kaduna,Nigeria and Pollution implications. Global Nest: the Int. J 6(3): 212-221.