Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 5 [7] June 2016: 01-04

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.533
Universal Impact Factor 0.9804

ORIGINAL ARTICLE **OPEN ACCESS**

Influence of Industrial Effluent on Physico-Chemical Properties of Soil at Sanganer Industrial Area, Jaipur, Rajasthan

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ABSTRACT
Soil degradation by various organic and inorganic contaminants is an ecological risk with socio-economic issues. Degraded soil becomes poor in physicochemical properties, at risk to erosion, loss of productivity, sustainability and diminished food chain quality. The industrial effluents are directly used for irrigation in the areas near Sanganer adjoining to AmanishahNallah. Soil samples were collected from five different sites within the Sanganer. Soil samples were analyzed for pH, EC, water holding capacity, exchangeable ions (Ca^{++} and Mg^{++}) and presence of heavy metals. Results of soil samples indicate its slight alkaline nature.Water holding capacity was decreased, exchangeable cations also showed wide variation in contaminated soil as compared to the values of standard soil of the area under consideration. Heavy metals such as Zn, Mn, Fe and Cu were also analyzed. This soil contains higher amount of heavy metals and exceed permissible limits. The effluent from the textile industry was the major source of pollution which will affect the flora and fauna existing in such environment. The research concluded that the soil quality deteriorates after continuous discharge of industrial effluent. Thus, there is need for treatment of textile effluent before they are discharged into the environment.
Keyword: *Sanganer, industrial effluent*

Received 22.01.2016 Revised 26.03.2016 Accepted 11.05.2016

INTRODUCTION

Soil is one of the essential resources on living planet Earth. It is diverse in nature. Many researchers have reported adverse effects of industrial effluents on the growth of plants and dye waste water has also been found toxic to several crop plants [1]. It is in special reference to the developing countries that the water treatment cost cannot be afforded. Although waste water is a valuable source of plant nutrients for maintaining fertility and productivity levels of the soil [2]. The textile processing waste water is reported to be the most polluted source of irrigation as compared among all other industrial sectors in reference to quantity and composition [3]. The colored effluent of the textile mill has got much attention to their dual toxicity [4]. A number of azo dyes (direct, reactive, rapid, mordant and premetalized etc) are used in textile printing industries at Sanganer. The quantities and distinctiveness of effluent vary from industry to industry depending on the water utilization and average daily product. Central Pollution Control Board has listed the textile industry as one of the heavily polluting industries [5]. Metals occur naturally in our environment, especially in the Earth's crust where they contribute to the balance of the planet. However, as a result of human activities they are distributed, concentrated and chemically modified, which may increase their toxicity [6]. So the effluents with heavy metals and organic compounds affect quality of soil and ground water of the area [7]. Heavy metals come into the human body by different pathways and become hazards [8]. Ecological pollution and exposure of human beings to toxic heavy metals such as Hg, Cd, and Pb is serious growing problem throughout the world. The growing awareness about sustainable agriculture and health risks coupled with agrochemicalshas brought a major swing in people's preference towards safe and quality food. Prevention of heavy metal accumulation in soil has become one of the pre-requisites for sustainable agriculture . The aim of sustainable heavy metal management in agro-systems, in fact, is to ensure long-term protection of soil fertility along with the quality of agricultural produce [9]. The contamination of soil by atmospheric deposition of toxic metals affects soil properties and further increase plant metal levels through root uptake. Soil is a dynamic natural body developed as a result of pedogenic processes through weathering of rocks, consisting of mineral and organic constituents, possessing definite chemical, physical, mineralogical and biological properties, having a variable depth over the surface of the earth, and providing a medium for plant growth [10]. The objective of the present study is to analyze the influence of industrial effluent on physical and chemical properties of the soil of Sanganer and Sitapura industrial area.

MATERIAL AND METHODS

The study area selected was Sanganer and Sitapura industrial area, about 20 kms far from Jaipur city. This area is famous for textile industries i.e. Sanganer prints are famous not only in Rajasthan but also in the India. Dye industries required lot of water during dye processing. The untreated waste water is being discharged directly into drains that connect the industry to the main drainage network (The Dravyavati river) in the city. Since the waste water is being used for crops cultivation which affects the quality of nearby land. Sanganer town lies between 26°41’-26°57’ latitude 75°45’-75°51’longitude. It has about 635.5 km^2 area in which urban area is 12.9 km^2 and rural area is 622.6 km^2. The population of Sanganer town is 36458.

The soil (adjoining the textile effluent) samples were collected from five different sites of Sanganer region during the year 2014. The collected samples have been analyzed to determine their physico-chemical characteristics. Temperature and *p*H was recorded on the field. Samples were collected in cleaned and sterilized plastic bags and stored at 4°C. The soil samples have been analyzed for various parameters as *p*H, electrical conductivity (EC), water holding capacity, Ca^{++} and Mg^{++} concentration and concentration of heavy metal per gram of soil as per the methods mentioned in APHA. The homogenized soil samples were air dried for seven days, gentlycrushed with a wooden roller and passed through 2 mm sieve. All samples were analyzed by carried outas per the standard methods. All the above mentioned parameters in the polluted soil were higher thanthe recommended standard.

RESULTS AND DISCUSSION

All soil samples belong to fine to very fine sandy soil, with different temperatures (30˚C to 40˚C) with varying water holding capacities. All soil samples were having a distinctive smell with unnatural colors. Difference in soil samples revealed that soil samples from five sites from industrial area are affected by textile effluents. Analysis of soil samples in the present investigation depicts that color of soil samples was unnatural because of the dyes used in textile industries. Chemical characterization of soil samples was typical of arid area type that is slightly of alkaline nature which varied from 7.9 to 9.1. In 1993, Daiz and Honrubia studied the effects of mining in south east Spain, they stated that mine spoil changes the soil chemistry. They found the pH in a range of 7.28 – 7.86, showed decrease in organic matter (0.53 – 1.31%), along with variation in Na (6.9 – 448.5 mg/Kg), Cl and $SO4^{2-}$ were very high. Electrical conductivity ranged between 375μS/cm to 421375μS/cm. In Oved *et. al*., [11] does similar work on study of lysimeter soil for effect of effluent on irrigation and found low values of organic contents (0.3%). Higher the EC, higher will be the concentration of salts, esp. Na^+ and Cl^- , which increases the salinity as compared to the uncontaminated soil. Water holding capacity of all the five samples was not too different. They were reported in the range of 59 to 67%, which was very high in comparison to the study carried out by Khan *et.al.,* in 1998, they states that in clay loam, water holding capacity was 44.82%, however in the loam soil it ranged between 10.34- 18.27%, and this finding was in line with the result obtained by a similar work in Pakistan on KTM mills. (Table 1).

Calcium and magnesium are very important elements for plantlife. Table 2 shows the state of exchangeable Ca^{++} and Mg^{++} cations in the soil samples. Ca^{++} was between 194mg/Kg to 271mg/Kg while Mg^{++} lies between 9.20mg/Kg to 45.4mg/Kg. Earlier researches had reported that the lowest soil organic calcium and soil organic magnesium are recorded in the untreated/uncontaminated soil as compared to contaminatedsamples. Irrigation with waste water increases organic magnesium content of soil. Most of the difference in magnesium content and electrical conductivity may be dueto long term application of waste water in soil.

For exact determination of the impact of excess metal ions present in the effluent on surrounding area’s soil where effluent is disposed off, metal ions in both forms, total and the form of metal that can be taken up by plants (bioavailable) should be analyzed but here only the concentration which is present in the soil i.e. not bioavailable was estimated. Zinc concentration was between 1.21ppm to 1.77 ppm which was higher than the standards. Highest value of iron in all the sampled sites was 4.65 ppm while the lowest value was 3.21 ppm. Concentration of copper for all the sites was more than the recommended levels. Its value was between 0.26 ppm and 0.53 ppm. Concentration of Mn was also found to be quite high i.e. from 2.86 ppm to 4.23ppm (Table 3).

The application of runoff water markedly enhanced the available Sodium in contaminated soil as compared to the uncontaminated soil. The minimum available sodium was recorded in the uncontaminated soil ranged between 36.9 to 46.3 ppm and maximum in contaminated soil ranged between 69.3 – 76.7 ppm. Increase in the sodium ion concentration of soil irrigated with wastewater can be credited to the presence of minerals in the waste water. High concentrations of sodium ions can result in precipitation of calcium and magnesium ions from the soil thus disturbing their efficiency in enhancing physical internal drainage.

Table 1: Physicochemical analysis of soil sample from Sanganer industrial area

Parameter	S1	S2	S3	S4	S5
pH	8.9	8.6	7.9	8.4	9.1
Electrical conductivity (μS/cm)	375	421	382	402	407
Water holding capacity (%)	62	61	59	65	67

Table 2: Exchangeable cations in the soil samples

Parameter	S1	S2	S3	S4	S5
Ca^{++} (mg/kg)	219	271	194	198	216
Mg^{++} (mg/kg)	45.4	13.62	9.20	12.30	31.02

Table3- Analysis of soil sample from Sanganer industrial area for heavy metals/ micronutrient (ppm)

Sampling sites	Zn	Fe	Cu	Mn
S1	1.21	3.21	0.41	3.76
S2	1.56	4.52	0.35	3.89
S3	1.29	3.89	0.26	2.86
S4	1.77	4.65	0.53	4.23
S5	1.72	4.37	0.46	4.15
Permissible limits	0.6	4.5	0.2	2.0

CONCLUSION

The results indicated that the application of industrial effluent/polluted water affect physicochemical properties of soil. There is an urgent need for proper- management practices of polluted water for irrigation purpose. The study suggests that the continuous application of effluent appears to deteriorate soil value as well as productiveness. It is concluded that controlled irrigation with waste water can become an environmentally sound approach for use of waste water and economically best possible and improved grain yield of suitable seasonal crops, selection of tolerant crops; treatment of wastewater prior to its re-use for irrigation; crop rotation practices**.**

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CITATION OF THIS ARTICLE

M Bansal, N Datt Jasuja, R Kr. Yadav. Influence of Industrial Effluent on Physico-Chemical Properties of Soil at Sanganer Industrial Area, Jaipur, Rajasthan. Bull. Env. Pharmacol. Life Sci., Vol 5 [7] June 2016: 01-04

