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RESEARCH ARTICLE

PHYSIOCHEMICAL COMPARISON OF TEXTILE EFFLUENT IMPACTED AND UN-IMPACTED AGRICULTURAL SOIL OF JAIPUR CITY, INDIA

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ABSTRACT

The industrial and technological progress for economic benefits has been imposing negative impact on the environment, in terms of its degradation and pollution. To find the effect of the industrial effluent on agricultural soil this study was conducted on impacted and non-impacted soil of two areas i.e. Sanganer and Durgapura respectively of Jaipur district. The soil quality was analyzed by estimation of physicochemical parameters such as pH, electrical conductivity(EC), water holding capacity, texture analysis, organic carbon, organic matter, total hardness, sodium, potassium concentration, sodium adsorption ratio(SAR), cation exchange capacity(CEC) using standard protocols. The results showed a significant difference between pH, EC, Water holding capacity, total hardness, SAR, CEC of both the soil, inferring the impact of industrial effluent on the quality of soil. Thus, to protect the deterioration soil quality, control on such industrial pollution assumes greater significance which can be assured by planned industrialization.

INTRODUCTION

Soil the "Skin of earth" is a vital resource for plant growth and means of storage of water and nutrients. Soil ecosystem is getting impacted by industrial effluents worldwide especially in developing countries as cost input is required for treatment of industrial waste before discharge in natural ecosystems (Ahmad *et al*., 2012). Pollution of Soil and water by the development of industrialization has become an emerging problem in urbo-industrialized countries as well (Hu *et al*., 2013). The untreated or improperly treated waste and discharges from these industries are becoming major reason for environmental damage. This risk is often irreversible and causing high impact on human health and premature mortality posing serious problems to human race. The industrial effluents contain organic, inorganic compounds with other biodegradable substances which accumulate at dump sites in soil and water systems (Karthikeyan *et al*., 2010).Heavy metals present in these discharges easily enter food chain from contaminated soil used for production of crops which has direct consequence on man and ecosystem(Principi *et al*., 2006).

Sanganer is situated in south of Jaipur at 26°49′-26°51′ N latitude and 75°46′-75°50′ E longitude (joshie *et al*., 2011), it is famous for textile industries. These small and large scale industries are very famous for its block printing, which is done with vibrant colors. Sanganeri prints are popular throughout the world and the products from these industries are exported in large amount. These textile printing industries uses various types of Azo dyes like direct, reactive, rapid, mordant and premetalised etc. (Goyal *et al*., 2014). As a result, the effluent from these industries contains dyes, various heavy metals in more than the permissible limit, influencing plantation and environment. These industries dispose their untreated effluent in the open land, river and agriculture fields nearby (Pande *et al*., 2009) which affect the water and soil by leaching or due to percolation of pollutants. Second sampling site is Durgapura which lie 26°85′ N latitude and 75°78′E longitude (Google maps), this area has agricultural farms with no impact of any industrial effluent.

The present study was planned to analyze the physicochemical parameters of impacted and un-impacted soil to find the deleterious effect of the industrial discharges on the soil quality which can be concluded by this study.

MATERIAL AND METHOD

Soil Sample Collection

Soil samples were collected from nearby agricultural field receiving textile effluent in Sanganer area and an un-impacted agricultural soil of Durgapura area, Jaipur, Rajasthan. These samples were collected in the month of January 2013 in sterile

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polypropylene zip lock bags from a depth of 10-15cm. Samples were passed through 2 mm sieve to remove sand gravel, plant debris and stored at 4°C. These samples were analyzed for their physicochemical parameters. The soils samples were designated with Lab name i.e. impacted soil of Sanganer as “S1” while un-impacted Durgapura soil as “S2”.

Physicochemical Analysis

Physiochemical analyses of both the soil sample were done using standard methods. Physical parameters like pH was measured by digital pH meter (Electronic India, digital pH meter model-III) calibrated with pH- 4 and 7 buffer (Maiti., 2003) to estimate the acidity or alkalinity of the soil as it indicates the suitability for crop plantation and availability of nutrients. EC is a measure of soluble salts in the soil which was determined by digital conductivity meter (Century CC-601).Water holding Capacity of soil depicts the physical and chemical health of soil which was performed using gravimetric method (Maiti, 2003). Texture of soil was determined by sieving method (Gee and Bauder., 1986) to find whether the soil is sandy, clay or silt in nature, as it depicts nutrient retention and water storage condition. It was interpreted using soil texture triangle according to USDA (United States Department of Agriculture) guidelines.

Chemical Analysis included the estimation of organic carbon and organic matter (Rapid titration method,Walkley and Black, 1934),Total hardness by determining Calcium and magnesium content(EDTA titration method Tucker and Kurtz., 1961), whereas sodium and potassium ions were also determined (Ammonium acetate method by flame photometer , Lal Singh 2012). All the above determined positive charged elements helped establishing the cation exchange capacity (CEC) as it is the capacity of soil to exchange cations. Sodium adsorption ratio (SAR) is the only factor which determines the suitability of water used for irrigation (Moasheri *et al.*, 2012) of agricultural soil was estimated using sodium, calcium and magnesium values. Following formula is used where all the ions in milliequivalents/liter.

$$\text{S.A.R.} = \frac{Na^+}{\sqrt{\frac{1}{2}(Ca^{2+} + Mg^{2+})}}$$

Statistical Analysis

Each parameter was performed in triplicates and results were represented as mean± standard error. The results of impacted and un-impacted agricultural soil were compared using unpaired student’s t-test at the significance levels of p<0.05, p<0.001, p<0.01. The Statistical analysis was performed using Microsoft Excel (Version 2007).

RESULT

In this study adverse impact of textile effluent on agricultural soil was deduced by comparing Impacted and un-impacted agricultural soil results are supported by Statistical interpretation (Table 1). On analysis of soil pH, both the soils were estimated to be neutral to alkaline, although the pH levels differed significantly (p<0.001).Electrical conductivity and Water holding capacity of sample S1 was also found to be significantly higher (p<0.001) than the sample S2. Texture of S1 soil was very fine sandy soil which contains 92.1% sand, 6.8 % silt and 1.1 % clay, whereas soil S2 was found to be Sandy loam containing 62% sand, 28.4 silt and 9.6% clay particles.

Carbon content was nearly same for both the soils showing similarity in their agricultural use. Organic Carbon (%) of S1 and S2 was 1.116 ±0.100, 0.851±0.006, while organic matter (%) was 1.923±0.175 and 1.46±0.010 respectively. Total hardness (%) of both the soils varied drastically i.e. 439.6±0.33 (S1) and 55.01±0.033 (S2) .Calcium Magnesium ratios also varied from 3.0 to 4.2 in un-impacted and impacted soil respectively. Sodium content of the two soil samples were significantly (p<0.05) different from each other. But this was not the case with potassium content which showed similarity in the amount of K in both the soils with S1 having 0.02±0.001meq/100g of soil while S2 nearly with same value of 0.019±0.001meq/100g of soil. Cation exchange capacity and Sodium adsorption Ratio was deduced from the above cations value which also showed difference (p<0.001) in both the soils.

Table 1 Results of Physico-chemical Parameters of agricultural Soil S1 (Impacted Sanganer soil), S2(Un-impacted Durgapura soil).

	Physical Parameters	Unit	Sanganer impacted Soil (S1) (mean±S.E)	Durgapura un-impacted soil (S2) (mean±S.E)
1.	pH		8.143±0.003*	6.913±0.008
2.	Electrical Conductivity	(mS/cm)	0.606±0.018*	0.246±0.006
3.	Water Holding Capacity	(%)	60.376±0.923*	20.19±0.33
4.	Texture Analysis		Very Fine Sandy Soil	Sandy Loam
	Chemical Parameter			
5.	Organic Carbon [NS]	(%)	1.116±0.100	0.851±0.006
6.	Organic Matter [NS]	(%)	1.923±0.175	1.46±0.010
7.	Calcium	(ppm)	355±0.33*	41.43±0.28
8.	Magnesium	(ppm)	84.30±0.66*	13.8±0.03
9.	Total hardness	(ppm)	439.6±0.33*	55.01±0.033
10.	Ca^{2+}/Mg^{2+}		4.2	3.0
11.	Sodium	(meq/100g soil)	0.056±0.003**	0.03±0.003
12.	Potassium	(meq/100g soil)	0.02±0.001*	0.019±0.001
13.	Sodium Adsorption ratio(meq/l)	(meq/l)	0.161±0.009	0.316±0.012
14.	Cation exchange Capacity	(meq/100g soil)	2.54±0.003*	0.371±0.002

* = p<0.001 (Highly Significant), ** = p<0.05 (Statistically Significant),NS=non significant

DISCUSSION

Soil characteristic feature depicts the health of soil for agriculture which is of great importance for our agricultural economy. The adverse effects of pollutants from untreated textile effluents on the agricultural soil has been studied and discussed in this paper. The agriculture soils were collected from impacted area, receiving industrial discharge drain nearby the field (S1) and the other from un-impacted area with no textile mills nearby (S2) were taken for the study.

The optimum pH range required for crops in the soil is from 6.5-8.5, which is considered as neutral range for crops (Ramachandra *et al*., 2012).S1 impacted soil showed higher pH (alkaline) than S2 showing the accumulation of salts due to the exposure to the effluents which is also reported by Patil *et al*., 2014.Reddy in 1991 stated the effect of higher pH in contaminated soil greatly effecting the seed germination.

The amount of soluble salts in the soil has direct relationship with the conductivity as it is the current carrying capacity of soil (Ramachandra *et al*.,2012).Electrical conductivity of soil determines the salinity of agricultural soil, making it very important aspect. The EC of impacted soil was significantly higher ($p<0.001$) than un-impacted soil which can be due to ions in the effluent. Similarly, high level of EC has also been reported by Goyal *et al*., 2014 at the same site.

Water holding capacity shows physical condition of soil, it is the point at which soil gets completely saturated with water. This capacity was found to be significantly higher in S1 than S2 which supports the fact that pollutants and industrial discharges increases the soil water holding capacity (Sheikh and irshaad 1980, Rai *et al*., 2011).

Increase in soil water retention in sandy soil texture, according to Tisdall and oddes 1982 is due to increase in organic matter in effluents. While sandy loam soil of site S2 depicts good conditions for the availability of highest culturable bacteria which can be due to high pH, high cation exchange capacities of soil sample which are main factors which elevates the number of cultureable bacteria (Faryal *et al*., 2007).

Soil organic carbon (OC) and organic matter (OM) have long been identified as factors that are important for soil fertility in natural ecosystems (Kucharik *et al*., 2001).Organic carbon and Organic matter was slightly higher in contaminated soil which indicates the prolonged accumulation of carbon in soil. The higher OM results in the increase water content at field capacity, available water content in sandy soil and increases both air and water flow rates through fine textured soil (Ramulu. 2001). As both the soil samples belong to the agricultural field where carbon is fixed by plants and is transferred to the soil via dead plant matter including dead roots, leaves and fruiting bodies(Lal.,2008) this supports the non significant variation in carbon content of both soil samples which contain nearly equal organic content.

The amount of Ca^{2+}, Mg^{2+},Na^{+}, ions in impacted soil were much higher as the soil was contaminated from industrial effluents which have also been reported earlier by Devrajan *et al*., 1996, Baskar *et al*., Kayalvizhi *et al*., 2001 in spentwash discharged by distillery industry. This increase in concentration also supports the higher pH of the soil due to effluent exposure (Sweeney and Grartz., 1991).The increase amount of sodium ions in the industrial discharge results in precipitation of calcium and magnesium ions. Potassium is an essential nutrient for plants to carry out various metabolic activities; It has to be supplied as component in fertilizers in the agricultural fields to fulfill the adequate need of potassium in the crop (Johnston, 2003). Although it is also reported by Ahmed *et al*., 2012 that the industrial waste enhances the potassium in the soil which is the reason for the impacted soil also have good amount of potassium just like un -impacted soil containing fertilizer in this study.

Sodium Adsorption ratio (SAR) is the measure of sodicity in the soil, which is the ratio of the amount of cationic charge contributed by sodium, to that contributed by calcium and magnesium. Soil with high levels of sodium but with low levels of total salt are called sodic which pose harmful effect on plants. The limit of SAR according to Indian standard is 10 while generally; SAR above 13 is classified as sodic. (Davis *et al*., 2012) It is calculated by calcium, magnesium and Sodium value in milliequivalent/liter, in our study SAR value of both the soils fall in the permissible range concluding soils to be non sodic.

The CEC is calculated from the levels of potassium, magnesium, calcium, sodium and hydrogen which were estimated in the soil analysis and were found higher in S1 due to presence of increased amount of cations in the soil. These cations have also been reported in sewage, which result an increase in CEC as reported by Aboulroos *et al*., (1989). These ions act as pollutants when their amount increases more than desired value. They are supposed to come in contact with the soil due to unplanned release of untreated textile discharge in the open field, which also increases pH and EC of the soil as compare with the un-impacted soil.

CONCLUSION

The present study aims to bring in notice the harmful effect of unplanned, non systematic industrialization. It can be concluded by the above experimentation that dyes and other pollutants in the textile discharges resulted in higher pH, electrical conductivity, water holding capacity, total hardness and sodium values than the un-impacted agricultural soil. The highly significant differences in soil parameters focuses on immediate measures to be taken to treat the effluents to avoid their hazardous effect on nature, also quick measures should be employed to remediate contaminated soil nearby the Sanganer industrial area, Jaipur. Thus, Soil conservation is an essential step as it will not only minimize hazards to natural resources but will also improve the socio- economic condition of people.

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