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EFFECT OF TEXTILE WASTEWATER IRRIGATION ON SOIL PROPERTIES IN WESTERN RAJASTHAN

Shellina Khan, Navneet Joshi*

Department of Biosciences, Mody University of Science and Technology, Lakshmangarh, 332311, Sikar, Rajasthan, India

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ABSTRACT

The current research is focused on the evaluation of physico-chemical properties of soil. Textile industries of Jodhpur and Balotra cities of Western Rajasthan discharge plenty of pollutants that get mixed up with water bodies. These water bodies are basically the parts of Jojari and Luni Rivers. The soil sites near to the end points or nearby points of these rivers became polluted due to mixing of industrial effluents coming from textile industries located nearby these rivers. When same wastewater is used for irrigation it adversely affects the soil properties. Thus the analysis of soil became an apparent need for best agriculture practices. Results of current study analysis revealed significant variance in the values of the parameters like pH, EC, CEC and OC from the range of standard values set by IS: 2490-1982 for industries. The N (275.8-387 mg/100g), P (51.2-115.4 kg/ha) and K (378-756 kg/ha) amount was also found very high in soil samples compared with IS values. Hence, it can be conclude that the concentration of effluents affects the soil quality. Therefore, monitoring of physico-chemical properties of soil are required for better crop production.

* Corresponding author

E-mail: navybiotech@gmail.com (Navneet Joshi)

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1 Introduction

Soil plays a significant role in growth of plants sustaining the biome with its natural flora, fauna and indirectly endures the environs. In the present providence, several kinds of operations involving transportation, agriculture and industry create the large volume of trashes and novel soil pollutants (Hossain et al., 2014). In terms of the amount and structure, the textile handling effluent is noted as ultimate pollutant out of total industrial regions (Anjaneyulu et al., 2005). At many places of world including India this textile effluents disposed in nallah or rivers are directly utilized for agriculture practices (Hossain et al., 2014). When such water used for irrigation, increases the level of soil contamination.

The United States Environmental Protection Agency stated that the effluent released from different textile industries may vary in composition according to their source of production. This textile effluent not only contains the toxic substances but it also has some essential nutrients (Chhonkar et al., 2000). Micronutrients are essential nutrients which required in very small quantities for normal plant growth but in textile effluents concentration of these micronutrients became higher due to continuous accumulation of dyes and other reagent (Meena & Mathur, 2017). The lesser availability of agricultural water in Rajasthan forced farmer to use wastewater for irrigation. Essential macro and micronutrient present in effluent may increases the soil fertility but due to the presence of higher concentration of toxic substances it may reduces the soil fertility and adversely affects the nearby agricultural lands (Chhonkar et al., 2000). Further presence of higher concentration of pollutants also changed quality of water which does not support the best agricultural yield (Hossain et al., 2014). Effluents from the textile industries not only manipulate the surface water quality but also affect the underground water and soil productivity. Further, continuous uses of this type of water for irrigation changes the physico-chemical properties of soil which affects the agricultural productivity (Hossain et al., 2014). Also improper nutrient management has led to emergence of multinutrient deficiencies in the soils (Meena & Mathur, 2017). Hence, concern over the sustainability of environment, the present study was aimed to determine the physico-chemical parameters of industrial wastewater contaminated soil.

2 Materials and Methods

2.1 Study area

The study areas selected for the present research are located in the Western part of Rajasthan, India. The Salawas and Sangariya village of Jodhpur district situated near the Jojari

River are highly polluted area as of established textile industries. Jojari River is lying between 26°07'39.7" north latitude to 72°59'05.9" east longitude in Jodhpur district while the site of Luni River is located from 25°50'07.4" north latitude to 72°12'30.7"E longitude in Barmer district of Rajasthan India. Similarly, RIICO at Balotra, Barmer, Rajasthan, India has become the industrial state (Meena & Nama, 2016). Textile industries located in the above said areas discharge pollutants in Jojari and Luni Rivers and other water bodies. This wastewater when used for irrigation affects the quality of the soil of the surrounding area. Study sites are abbreviated as **S1** (Dangiyawas Bypass, Sangariya Village, Jodhpur), **S2** (Jojari River, Boranada-Salawas Road, Jodhpur), **S3** (Dumping Area, RIICO Complex, Balotra) and **S4** (Waste treatment Plant, E-240, 3rd Phase Industrial Area, Balotra).

2.2 Sample Collection

The soil samples were collected from the above mentioned selected sites (S1-S4) with the help of hand trowel in plastic bags. These samples were dried in oven for 4-5 hours at temperature 50° C. The samples were analyzed for Physico-chemical properties using standard procedures.

2.3 Chemical Analysis

Collected soil samples were analyzed by studying various parameters like total Phosphorus (P_2O_5), Nitrogen (N), Organic Carbon, Potassium (K_2O), Magnesium (Mg^{2+}) (Versenate EDTA method), Calcium (Ca^{2+}), Carbonate (HCO_3^-), Phosphate (PO_4^-), Nitrate (NO_3). The pH and electrical conductivity were determined by the standard method given by Edori & Iyama (2017). Further, Okoye & Agbo (2011) method was used to estimate nitrates and chlorides concentration. The P_2O_5 was determined by the Olsen's method (Libutti et al., 2018) and Walkley-Black Method was used to estimate TOC % in soil samples (Libutti et al., 2018). Nitrogen was determined by Kjeldahl method (Reeuwijk, 2002). Similarly, CEC was estimated by ammonium acetate method (Reeuwijk, 2002).

3 Results and Discussion

Available literature from national and international repositories suggested that textile industry of study areas discharged unprocessed wastewater directly into the main drainage network which further released into the sample collection areas. Results presented in table 1 revealed various physico-chemical properties of contaminated soils at different sampling sites. These results were further compared with standard values. The overall nutrient availability in study area soil were found very high as compared to the standard soil nutrient value, this might be because of large amount of effluents discharged from the textile industries.

Table 1: Physico-chemical properties of contaminated soil samples from different sites

S.No.	Sites Properties	S1	S2	S3	S4	IS:2490-1982Values
1.	pH	8.91	8.65	8.00	8.80	8.5-9.5
2.	EC (dSm ⁻¹)	0.828	1.30	0.776	12.0	1.5-3.0
3.	CEC (meq/100g)	3.87	3.79	3.70	3.58	3.5-4.0
4.	Organic C (%)	0.180	0.195	0.300	0.195	0.5-0.75
5.	Nitrogen (N) (mg/100g)	289.5	275.8	296.7	387.0	180-207
6.	Phosphorus (P ₂ O ₅) (kg/ha)	51.29	57.50	53.86	115.41	23.0-56.0
7.	Potassium (K ₂ O) (kg/ha)	378.0	580.5	243.0	756.0	144-336
8.	Calcium (meq/100g)	0.168	0.161	0.160	0.152	>0.10
9.	Manganese (meq/100g)	0.110	0.095	0.091	0.087	>0.1

Here S1-(Dangiyawas Bypass, Sangariya Village, Jodhpur), S2 (Jojari River, Boranada-Salawas Road, Jodhpur), S3 (Dumping Area, RIICO Complex, Balotra) and S4 (Waste treatment Plant, E-240, 3rd Phase Industrial Area, Balotra); The resultant values were out sourced and analyzed by RSPCB Laboratory, Jodhpur with standard protocols and readings are average values.

3.1 Electrical Conductivity and pH

The soil pH was recorded alkaline in all the samples collected from study areas. The pH of effluent contaminated soil was ranging between 8.0-8.9. Although this range is in limitation of better crop growth but slightly higher than standard value. There are many views associated with effects of long-term wastewater application on soil pH. Previous studies also confirmed the higher soil pH values in soil irrigated with wastewater (Kaur & Sharma, 2014). Further, electrical conductivity (EC) of contaminated soil has higher variation than standard one. EC values of the affected soil increased by the increasing concentration of chemical salts released from the textile industries. Further, in contaminated soil, higher concentration of cations led to increase in EC. Sample collected from 3rd Phase of Industrial Area in Balotra (S4) have higher EC value as compared to IS: 2490-1982 recommendation while the rest of the sample collected from the other three sites were found to have very lower EC value.

3.2 Cation Exchange Capacity (CEC) and Organic carbon (OC)

CEC was found in the range of Indian Standard value of all samples (Table 1) while reading of OC were recorded very less than IS: 2490-1982 (Table 1). The variation in OC content is due to long term irrigation of wastewater in soil (Kaur & Sharma, 2014). Generally, the CEC value increase with increase in organic contents and pH. Jolly et al. (2012) reported a reduction in CEC value due to presence of humus and clay in the effluent.

3.3 Nitrogen, Phosphorus and Potassium

Nitrogen is an essential macronutrient required for stimulating plant growth. It is an important constituent of all fertilizer

formulations. The textile wastewater also contains variable amount of nitrogen as nitrate, ammonia, organic nitrogen or nitrite. Samples investigated in present study contained higher values of total N (275.8-387 mg/100g) than IS values (Table 1). The similar results for the total nitrogen were reported by Hossain et al. (2014). Thus its mixing in the soil increases the plant productivity directly but raises the level of toxicity too (Hossain et al., 2014).

Phosphorus is also a major macronutrient for the growth of the plant but excess amounts of phosphorus enhances the formation of algal blooms in water and depresses the soil quality (Hossain et al., 2014). The total phosphorus found in soils collected from study areas was estimated between 51.2-115.4 kg/ha (Table 1).

Potassium plays an important role in protein synthesis and maintaining water balance in plant (Hossain et al., 2014). In this study, potassium was reported in range of 378-756 kg/ha and it was found higher than the Indian Standard as shown in Table.1. HaqMidrar (2004) reported NPK values as 21.58, 8.39 and 95.22 mg kg⁻¹ respectively upto 20 cm soil depth (contaminated) while 19.54, 6.39 and 73.72 mg kg⁻¹ respectively at 20-40 cm soil depth (standard soil from sub-surface).

3.4 Calcium and Manganese

Calcium was estimated up-to 0.05 meq/100g higher in all the samples while Manganese in Site S1 showed higher concentration as compared with standard values. Similar results were reported by Libutti et al. (2018).

Results of current study are in agreement with the findings of Trivedi & Verma (2016) who have reported higher concentration

of sodium and potassium with moderate accumulation of available potassium in soil near textile effluent outlets along Jojari River. According to Maheswari (2013), around 120 km surrounding of the Bandi River became barren due to textile effluent discharge. Similarly, Shrivastava & Koka (2014) assessed the effect of textile effluent discharge in the area near to Bandi River and found similar results. Dutta & Singh (2014, 2015) reported that soil of Pali region became hard and barren due to excess use of textile effluent in irrigation. The condition of soil in Jodhpur and Balotra region is badly affected by the discharge of industrial effluents which gets mixed up in the Jojari and Luni Rivers at initial stages. Therefore, the wastewater used for irrigation decreases the soil properties. Agriculture soils of the above regions were found to become barren and not suitable for vegetation. Similarly, Jhamaria & Bhatnagar (2015) found higher pH, EC and organic carbon percentage at wastewater irrigated sites as compared to that irrigated with bore well water. Krishna & Govil (2004) also studied soil samples collected from a depth of 5-15 cm around industrial area of Pali district, Rajasthan and found higher concentration of heavy metals like lead, chromium, copper. They also reported cadmium accumulation in study area soil and it was above safe limits.

Conclusion

The higher concentration of industrial effluents that mixed up in the soil disturbs negatively the overall physico-chemical properties. The textile wastewater should not directly used for irrigation purpose. Therefore some suitable approach to detoxify wastewater must be applied for cost effective and economically healthier crop yield. The present study highlights that textile discharges mixed up with water and turn it into misfit for irrigation. Moreover, organic pollutants and industrial effluents adversely affects the soil quality. The inherent soil parameters such as nitrogen, potassium, calcium, manganese, phosphorous, organic carbon are found to be in higher magnitudes that make them toxic. Therefore the overall soil fertility decreases. Findings of this research study reveal an intimating scenario for the farmers who are mostly dependent on the agriculture for their livelihoods, and frequently use contaminated industrial wastewater for irrigation.

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Conflict of interest

Author hereby declares that they have no conflict of interest.

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