



### Short Communication

## Influence of dye industrial effluent on physico chemical characteristics properties of soil at Bhairavgarh, Ujjain, MP, India

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### Abstract

Soil degradation from various inorganic and organic contaminants, is not only an ecological risk, but simultaneously it is also a Socio-economic issue, such soils become poor in physicochemical properties, susceptible to erosion, loss of productivity, sustainability and diminished food chain quality. The dye industrial effluent directly used for irrigation at Bhairavgarh area Ujjain city. Soil samples were collected from both areas i.e. contaminated (irrigated with effluent water) and uncontaminated areas (not irrigated with effluent water) at 0-25cm depth for analysis. Three sites were selected in each area for collection of soil samples from ten different locations. Before irrigation waste water analysed for selected parameters i.e. pH, electric conductance, bicarbonate, chloride, Ca, Mg, Na and K ions while in soil samples various parameters analysed were pH, electric conductance, water holding capacity, bicarbonates, Ca, Mg, Na, K ions, total organic carbon and organic matter. Results indicate that water was alkaline in nature. Chloride was highest (700mg/l) in W1 samples and lowest (500mg/l) at W2 samples while other parameters also have great variability. Results of soil samples indicate its neutral to slight alkaline nature. Cation and anion concentration, organic carbon and organic matter were also shows a wide variation in contaminated soil samples as compared to uncontaminated samples. The study concluded that the continuous application of effluent appears to deteriorate soil quality in the area.

**Keywords:** Physicochemical analysis, industrial effluent, bhairavagarh, contaminated, uncontaminated, dye industry.

### Introduction

Soil is one of the vital resources on living planet Earth. It is heterogeneous in nature. The use of effluents for irrigating agricultural land is worldwide practice. It is especially common in developing countries, where water treatment cost cannot yet be afforded. Irrigation with sewage effluents provides with water, nitrogen (N) and phosphorus (P) as well as organic matter to the soil. All these have beneficial effects on soil biota, at the same time it provides a convenient mean of sewage disposal through land treatment, preventing potential health and environmental hazards, caused by the uncontrolled flow of waste water. Wastewater is a valuable source of plant nutrients and organic matter needed for maintaining fertility and productivity levels of the soil<sup>1</sup>.

With respect to both the quantity and composition, the textile processing wastewater is recorded as the most polluted sources among all industrial sectors<sup>2</sup>. Many scientists have documented adverse effects of different industrial effluents on the growth of plants dye waste water has also been found toxic to several crop plants. The present investigation was aimed to know the effect of dye industrial effluent on soil quality.

### Materials and Methods

The study area selected was Bhairavgarh, about 10kms. far from the Ujjain city. Bhairavgarh is a place of textile industry of Dye i.e. Bhairav garh Prints famous not only in Madhya Pradesh but also in the India. Dye industries required lot of water during dye processing. This untreated waste water is being discharged directly into drains that connect the industry to the main drainage network (The River Kshipra) in the city. Since the waste water is being used for crops cultivation which affects the nearby agricultural land. Ujjain is located at 23°10'58"N and 75°46'38"E. It has an average elevation of 491 meters (1610 ft), average rainfall of the city is 36inch and mean temperature 35°C.

The objectives of the present study is to analyze the physicochemical properties of soil and water (adjoining the textile effluent) of agricultural region and the water used for irrigation which can help in identification of environmental impacts. Soil samples were collected from the nearby agricultural land where untreated industrial effluent is used for irrigation purpose. Three replicates of each sample from ten different locations were collected from 0-25cm depth. Composite sample for each replicate were prepared, air-dried, gently crushed with a wooden roller and passed through 2mm

sieve. Sieved soil samples (<2 mm) were stored in plastic bags for further analysis. The collected effluent samples have been analysed to determine its physicochemical parameters. The water and soil samples were collected during the month of March-April 2012. Temperature and pH were recorded on the field. The soil samples have been analyzed for pH, electrical conductivity (EC); water holding capacity (WHC); percent organic carbon (OC); and organic matter (OM); available phosphate (P) and potash (K); available sodium (Na); bicarbonates (HCO<sub>3</sub>); calcium (Ca) and magnesium (Mg). The effluent samples were analyzed for pH; electrical conductivity (EC); cation and anions concentration. Physicochemical parameters of waste water and soil samples were analysed by standard protocol<sup>3-4</sup>.

## Results and Discussion

A huge volume of untreated textile dye waste water is discharged into various drains adjoining textile printing units. A number of azo dyes were used in textile printing industries<sup>5</sup>. Untreated waste water was being discharged directly into drains that connect the industry to the main drainage network (The River Kshipra) in the city.

The collected sample have been analysed to determine their physicochemical characteristics of the effluent water showed that pH ranged between 8.2 to 9.0 means alkaline in nature also reported<sup>6</sup>. The electrical conductivity which represents total ions concentration ranged from 410.38 to 500.46  $\mu\text{S cm}^{-1}$ . This indicates that salts used in the dyeing process are leached out in outlet. Chloride concentration was maximum (669mg/lit) as compared to other parameters like Na, Mg and K shows wide variation i.e. 70mg/lit, 121mg/lit and 39.7mg/lit respectively in W1 sample.

The data revealed that the soil pH is affected due to application of different industrial waste/ polluted water. The pH of effluent irrigated soil was ranged from 7.76 to 8.7 while pH of uncontaminated soil was ranged from 6.90 to 7.31. In sample Site 1 and 2, the contaminated soil pH increased with the application of effluent as compared to uncontaminated soil. The increase of soil pH is due to addition of various soluble salts in industrial effluent also reported<sup>7</sup>, while working on soil characteristics affected by long term application of sewage waste water. Accordingly<sup>8</sup> crop growth neither need a high pH (above 8.4) nor low pH (below 5.0) is favorable for maximum yield of crops. Electrical conductivity is commonly used as a measure of salinity of soil. Electrical conductivity was ranged between 220 to 418  $\mu\text{Scm}^{-1}$  in uncontaminated and contaminated soil samples respectively. The maximum electrical conductivity of soil recorded in contaminated soil is 418 $\mu\text{Scm}^{-1}$  at site-2 while minimum 373 $\mu\text{Scm}^{-1}$  at site-1. In the contaminated soil, EC increased with the application of effluent as irrigation water having high concentration of salts, particularly Na<sup>+</sup> and Cl<sup>-</sup> has significantly increased the salinity as compared to the uncontaminated soil<sup>9</sup>. The higher concentration of cations such

as Na and K in waste water led to an increase in EC and exchangeable Na and K in soil irrigated with waste water<sup>10</sup>. Water holding capacity is an index for a number of physical properties. More water holding capacity shows the good physical condition of soil. Use of waste water in agriculture increases the water holding capacity WHC ranged between 53% to 65% in the uncontaminated and contaminated soil i.e contaminated soil have more water holding capacity than uncontaminated soil<sup>11</sup>.

Bicarbonates are directly related to total alkalinity i.e increase in carbonates and bicarbonates increases the total alkalinity. Bicarbonates of contaminated soil ranged between 440 to 540 mg/kg. and in uncontaminated soil ranged between 280 to 380 mg/kg. Maximum was recorded in contaminated soil (540 mg/kg) at site-1, and minimum in uncontaminated soil (280 mg/kg) at site-1 respectively. High pH values indicate alkalinity (bicarbonates) problem with sodium ion likely to be the dominant cation in the soil colloid<sup>9</sup>.

Calcium and magnesium are very important elements for plant life. The calcium in contaminated soil was ranged between 189 to 273 mg/kg and magnesium 8.50 to 45.9 mg/kg. In uncontaminated soil, calcium was ranged from 63 to 94.5 mg/kg and magnesium 3.08 to 6.99mg/kg. The lowest SOC and SOM (0.18 and 0.31 %) respectively was recorded in the non-treated/uncontaminated soil as compared to contaminated samples. Irrigation with waste water increases OM content of soil<sup>12</sup>. Most of the difference in OM content and EC may be due to long term application of waste water in soil<sup>13</sup>.

The application of effluent water markedly improved the available Sodium in contaminated soil as compared to the uncontaminated soil. The minimum available sodium was recorded in the uncontaminated soil ranged between 37.8 to 46.6 ppm and maximum in contaminated soil ranged between 70.3 – 79.7 ppm. Increase in the sodium ion concentration of soil irrigated with waste water can be attributed to minerals in the waste water<sup>12</sup>. High amounts of sodium ions can result in precipitation of calcium and magnesium ions from the soil thus affecting their effectiveness in enhancing physical internal drainage<sup>9</sup>.

The data revealed that application of industrial waste/effluent markedly improved the soil available potassium in contaminated soil as compared to uncontaminated soils. The minimum available potassium was recorded in the uncontaminated soil ranged between 30.7 to 33.8 ppm. The potassium content was maximum in the contaminated soil as compared to uncontaminated soil and was ranged between 50.7 to 58.7ppm. Available potassium content of soil increased significantly by the waste water application<sup>14</sup>.

The minimum available phosphate was recorded in the uncontaminated soil ranged between 0.67 – 0.78 mg/kg. Waste water produced continuously could cater for the needs of irrigated crops<sup>15</sup>. Soil irrigated with waste water contains high amount of available phosphorus which play significant role in plant growth<sup>16-18</sup>. Since the waste water is being used for crops

cultivation which affects the nearby agricultural lands, there may built up toxic substances in the soils of the area.

### Conclusion

This study has shown that Bhairvagarh textile industry discharges effluent with high degree of alkalinity, chlorides, cations and anions values which are not in compliance with standard. 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 waste water/ polluted water for irrigation purpose. The study suggests that the continuous application of effluent appears to deteriorate soil quality as well as fertility. It is concluded that controlled irrigation with waste water can become an ecologically sound strategy for use of waste water and economically optimum and healthier grain yield of suitable seasonal crops, selection of tolerant crops; treatment of waste water prior to its re-use for irrigation; crop rotation practices.

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**Table-1**  
**Physicochemical properties of waste water samples**

S.No.	Name of Parameter	Name of Water Samples		
		W1	W2	W3
1	pH	9.0	8.2	8.3
2	EC $\mu\text{S cm}^{-1}$	500.46	410.38	450.28
3	Bicarbonates mg/l	430	390	398
4	Cl mg/l	669.99	500.99	558.99
5	Ca mg/l	382	328.5	340.5
6	Mg mg/l	121	27.16	30.17
7	K mg/l	39.7	36.3	38.5
8	Na mg/l	70.2	68.4	63.5

**Table-2**  
**Analysis of physico-chemical parameters of contaminated and uncontaminated soil**

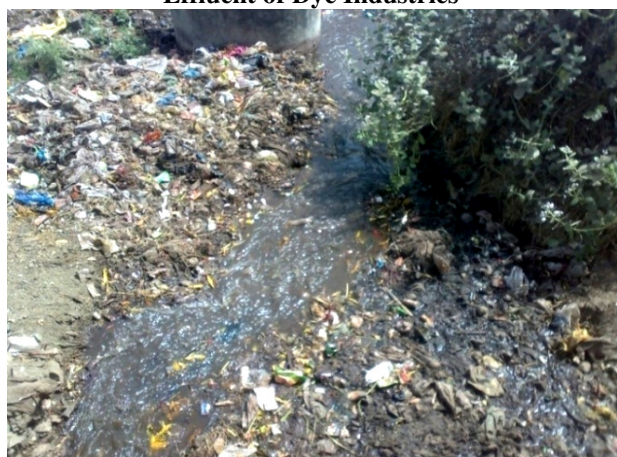
S. No.	Parameters	Contaminated soil			Uncontaminated soil		
		S1	S2	S3	S1	S2	S3
1	pH	8.7	8.63	7.76	6.90	7.20	7.31
2	Conductivity ( $\mu\text{S}/\text{cm}$ )	373	418	384	220	260	230
3	Water Holding Capacity (%)	63	60	65	60	53	58
4	Bicarbonates (mg/kg)	540	440	460	280	340	380
5	$\text{Ca}^{++}$ (mg/kg)	231	273	189	63	84	94.5
6	$\text{Mg}^{++}$ (mg/kg)	45.9	11.42	8.50	6.99	3.08	3.76
7	Total Organic Carbon (%)	0.32	0.42	0.34	0.18	0.20	0.24
8	Organic Matter (%)	0.55	0.72	0.59	0.31	0.34	0.41
9	Phosphate (mg/kg)	0.98	0.93	0.83	0.78	0.74	0.67
10	Potassium (ppm)	55.6	50.7	58.7	32.6	30.7	33.8
11	Sodium (ppm)	70.3	75.5	75.7	37.8	46.6	43.1



**Figure-1**  
**Effluent of Dye Industries**



**Figure-3**  
**Wastewater used for Irrigation**



**Figure-2**  
**Discharge of Dye Effluent**



**Figure-4**  
**Washing of Dye Clothes**