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A Comparative Assessment of the Effects of Industrial Wastewater and Rainwater Irrigation on Soil Characteristics in the Vidarbha Region of Maharashtra

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Abstract: ***The safe disposal of industrial wastewater has become a major challenge for industrial managers and scientists. Rapid industrialization and urbanization have resulted in the generation of enormous quantities of wastewater. The use of untreated industrial wastewater for crop irrigation is a common practice among farmers. One potential solution to the growing problem of water scarcity is the reuse of industrial and domestic wastewater for agricultural and related activities after appropriate treatment. The present research work investigates the effects of industrial wastewater irrigation on the soil characteristics of nearby areas in Buldhana District, Vidarbha region, Maharashtra, India. The data obtained in the present study indicate that electrical conductivity (EC), phosphate, total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), calcium (Ca), and magnesium (Mg) exhibit higher values in fertilizer industry wastewater, whereas pH, total alkalinity (TA), total hardness (TH), and chlorine (Cl_2) exhibit maximum values in sewage water from the Khamgaon MIDC area. At sugar industry sites, the values of EC, temperature, phosphate, TDS, Ca, Mg, and Cl_2 are comparatively higher in wastewater. The concentrations of organic carbon, available nitrogen (N), potassium (K), phosphorus (P), sodium (Na), sulphate (SO_4), chloride (Cl), magnesium (Mg), iron (Fe), copper (Cu), zinc (Zn), and manganese (Mn) are comparatively higher in wastewater-irrigated soils than in tube-well-irrigated soils.***

The findings of this study highlight the influence of industrial wastewater irrigation on the physicochemical properties of soil and emphasize the importance of appropriate wastewater treatment before its use for agricultural purposes.

Keywords: Industrial Wastewater, Soil Characteristics, Physicochemical Study, Wastewater Irrigation, Buldhana District.

I. INTRODUCTION

The requirement of water is increasing day by day due to tremendous increase in our demands on account of increasing domestic and industrial activities. Rapidly increasing industrialization and urbanization have resulted into the generation of higher quantities of wastewater. Use of untreated industrial wastewater for crop irrigation is a common practice by the farmers.

Irrigation with sewage and pulp paper mill effluent had enriched the soil mainly with respect to N, P, K and enhances the crop yields considerably[1]. Wastewater application for crop irrigation increases the zinc concentration in soil and sugarcane[2]. Increase in the organic carbon is beneficial for crops as it increases the update of potassium. Tannery and textile industrial wastewater contain appreciable amounts of plant nutrients such as N,P,K,Ca,Mg and S. These nutrients can be used for plant growth after proper treatment. Enrichment of soil organic carbon in soil due to addition of industrial wastewater is reported is reported by Chhonkar et.al[3]. The use of paper mill wastewater has favourably influenced the crop production, its continuous application for a number of years may results in enrichment of heavy metals in the top layers of soil[4]. Untreated industrial effluents contains higher amounts of Cd,Pb,Zn,Cu,Mn and Fe enhances the concentration of heavy metals in surface at irrigated soil[5]. Higher amounts of heavy metals like Cu,Zn,Fe and Mn is recorded in irrigated soil near in industrial complex[6]. Long term and indiscriminate application of raw sewage effluent result in the accumulation of heavy metals in surface and sub-surface soils[7]. Excessive accumulation of heavy metals such as Cd,Pb,Cr and Ni in the soil and the resultant phytotoxicity reported by Tsakou and Peralta[8].

II. MATERIALS AND METHODS

Wastewater and soil samples were collected from Khamgaon Industrial area of Buldana District,Maharashtra. At Khamgaon industrial site, soap unit is discharging wastewater into common drainage, which is being used for crop irrigation by local farmers.Wastewater samples were collected from the identified sites during the different seasons,i.e.,premonsoon,monsoon and

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postmonsoon. Tube well water samples (control)were also collected for comparative studies. Samples were processed for the analysis of various physico-chemical parameters viz., pH, EC, DO, BOD,COD,TS, TSS, TDS, TH, Ca cations, Mg anions, Cl_2 as per the standard methods of APHA-AWWA-WPCF (1985) . The heavy metal analysis samples were processed by acid digestion with 1:4 mixtures of $HCLO_4$ and HNO_3 and measured by atomic absorption Spectrophotometer.

Composite soil samples, irrigated with industrial wastewater were collected in three different seasons at depth of 0-15 and 15-30 cm. Samples were air dried and processed for the measurement of physico-chemical parameters viz., pH, EC by pH meter and conductivitymeter[9], organic carbon[10], available Phosphorus[11], available K and Na[12].

III. RESULTS AND DISCUSSION

A. *Wastewater Characteristics*

Wastewater and control samples analysis was characterised for pH, EC, organic carbon, total solid, hardness, alkalinity and heavy metals. Result of analysis of waste water and soil presented in table 1 and 2.of both sides and heavy metals of wastewater and soil presented in fig.2 and 3.pH value of khamgaon industry site was slightly alkaline in nature (7.1-8.2). EC values (1.3-4.0) were high in wastewater at Khamgaon site than control(1.0-2.0). EC values low in monsoon season in all sites than premonsoon and postmonsoon season due to dilution by rainwater.

Dissolved oxygen(DO) values were low in industrial and sewage water than control,it could be due to high organic load in wastewater.BOD values were high in industrial and sewage wastewater (42-89) in comparison to control(0.98-1.8).COD values similarly high in wastewater at Khamgaon and Sugar mill sites than control.Average values of BOD and COD of wastewater were high in comparison to control the permissible limit (30 and 250 mg/l resp.) prescribed for the discharge of the effluent into inland surface water(EPR,1993)[13].Temperature values marginally vary from site to site.Average values (176-374) of total alkalinity (TA) were high in wastewater in premonsoon and postmonsoon season than control(183-348).Phosphate values were comparatively high in industrial wastewater(1.8-5.6) than control.Total solid (TS) values including total dissolve and total suspended solid average values were high in waste water (1432-1903) than control (643-1730). In comparison to prescribed values of total suspended solid (TSS) for discharging waste water was (100mg /l). High concentration of suspended solid were found in monsoon season, it could be due to addition of loose soil particles from the adjacent land along with run off water. Total hardness values were high in waste water. Ca and Mg cation values were high in wastewater than control. Chloride values (251-596) low in control than wastewater (348-889). Average values of chloride were below maximum tolerance limit (600mg /l) for irrigation quality standard except Khamgaon industries and common drainage wastewater at sugar industries site. Heavy metals such as Cu, Zn,Fe

And Mn concentration were high in wastewater than control,whereas Fe values were high in control at Khamgaon Industries. Concentration of heavy metals were below the maximum recommended limit (100µg/l) prescribed for irrigation water[14].

B. *Soil Characteristics*

Results of the different parameters of soil analysis at both the sites are presented in Table No.3 and 4. Data indicates that pH values were high (7.4-9.0) in wastewater irrigated soil than control (7.1-8.5). The negative impact on soil pH can be attributed to wastewater irrigation, higher Na concentration increases pH of the soil. EC values were high in wastewater irrigated soil(0.4-3.0) than control values(0.25-0.6).High values of EC indicate that it could be due to availability of salt components K,Na,Mg,Cl and SO_4 in higher concentration in wastewater. EC values increases during the period of wastewater irrigation[15].Values of EC were comparatively low in monsoon season than premonsoon and postmonsoon seasons due to dilution by rainwater.Moisture content values (0.32-6.3) were high in control soil in monsoon season than wastewater irrigated soil(0.37-6.0).Porosity values were low in wastewater irrigated soil (43.4-58.4) than control (49.8-59.3) it could be due to accumulation of salts in surface layer soil.Higher concentrations of Na,Ca,Mg salts and heavy metals affect the soil properties due to decrease in porosity after irrigation with wastewater.Organic Carbon values (0.37-0.94)were comparatively high in wastewater irrigated soil than control(0.11-0.79),due to high organic load in wastewater.Nutrient content N,P,K values high in wastewater irrigated soil in premonsson and postmonsson season than control.Increase in N,P,K concentration after wastewater irrigation without any significant negative impact has been reported by Vindhya et.al.2001[16].Na and Mg values were high in wastewater irrigated soil in monsoon season at Sugar Industry site.Observations indicates that the soil infested with moderate sodicity problem because of long term application of wastewater.Wastewater contains Na,Ca and Mg salts in higher concentration affects soil by direct accumulation of large quantities , as well as the interaction Na with exchange complex,which causes the deflocculation of soil particles[17].Cl_2 and SO_4 values were low in control than wastewater irrigated soil.Carbonate content in soil layer was not detectable because of its possible conversion in $CaCO_3$.However HCO_3 values(0.23-0.57) were high in wastewater irrigated soil in comparison to control(0.24-0.50).

Analyzed values were high in premonsoon and postmonsoon than monsoon season.Concentrationa of Cu,Fe,Zn and Mn were comparatively high in wastewater irrigated soil than control.Heavy metal concentration increases in soil after wastewater irrigation[18].Long term application sewage sludge containing higher Zn and Cr content exerts adverse effect on plant growth [19].Analysis of heavy metal indicates that the long term and indiscriminate application of wastewater may causes accumulation of heavy metals in surface soil and it will be harmful for plants and animals. Therefore ,extensive research is required for the long term assessment of heavy metals accumulation in soil, crops and consumers due to wastewater irrigation.

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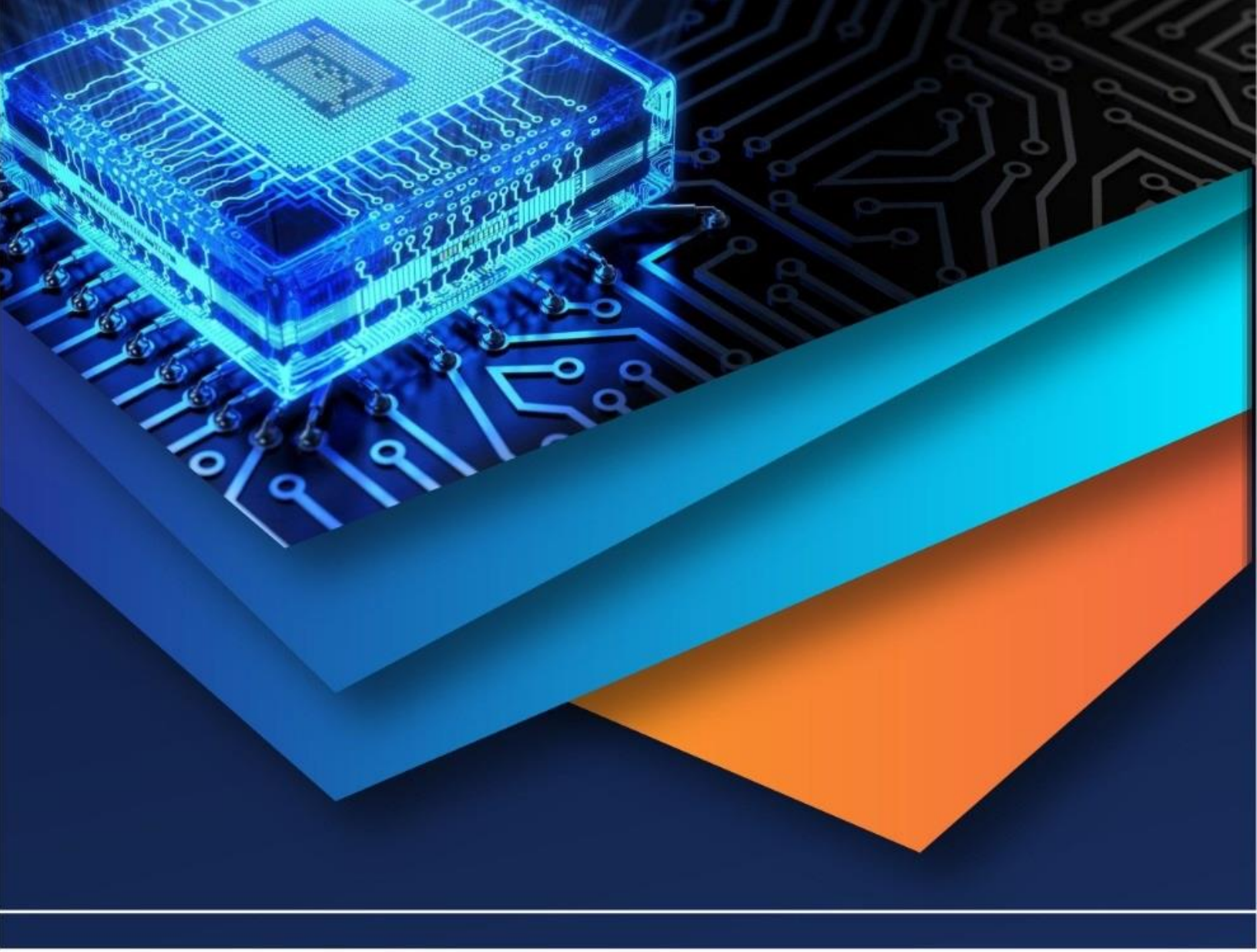

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