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ORIGINAL ARTICLE

Analysis of Industrially Polluted Water Used for Irrigation in Grassland in Agra District

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ABSTRACT

The present research aims with effect of industrial effluents on productivity of grassland in Agra District of Uttar Pradesh, India. For this purpose first, status of pollution is measured in water used for irrigation which is mainly effected by industrial effluents. Grasslands are very important from ecological point of view. The poor and polluted water supply affects these important ecosystems. Keeping these points in view present article emphasized the status of industrial pollution in water used for irrigation in grasslands in Agra district.
Key words: *Polluted Water, Irrigation, Grassland*

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INTRODUCTION

Water is a universal solvent and medium of solutes and raw materials in various forms and functions. It is an important ecological factor in the life of living organisms. Water relations of plants bring about in them many physiological changes by affecting transpiration, respiration translocation, photosynthesis, seed germination, uptake of nutrients, growth and some biochemical processes. The concentration and composition of dissolved and suspended constituents in water determine its quality for use of plants. The dissolved salts in water can change the physico-chemical properties of soil by affecting the chemical composition and concentration of the soil solution and subsequently that may affect the cations present in the soil water exchange complex. The changes in soil properties may be beneficial or harmful depending upon concentration and nature of dissolved constituents of water and the original character of the soil. However, the concentration of various ions in water and soil of a particular habitat varies with respect to rainfall, temperature and plants inhabiting it. Therefore, the relationship between certain ions and the amount of water they are dissolved in must be considered. Effluent from industries are normally considered as the main pollutants as they contain various colours, tastes, odour, organic and inorganic compounds, acids, alkalies and other materials in dissolved and suspended forms. When these effluents are discharged into the environment, they disrupt the ecological niches of living organism. Knowledge of physico-chemical properties of the effluent is very essential for understanding their effects on the biota and soil of the ecosystem receiving such discharges from the industries.

MATERIALS AND METHODS

Five replicates each of one litre of the effluents (Polluted) and tap water (Control) were collected periodically in three seasons, i.e., rainy, winter and summer in new plastic sampling bottles. During the collection of effluents and water, samples were analysed for the physical properties - temperature, colour, odour and pH value at the time of sampling. The collected samples were stored in a cool, dark and dry place till analysis. Care was taken to see that no contamination of the collection sample took place during transportation and storage. Necessary sampling precautions and specialized sampling equipments were used whenever needed (Michael, 1984). The study would be under taken to examine the physico-chemical and biological characterization of the industrial effluents discharged into the nearby grassland soils affected.

Since water pollution is essentially a biological phenomenon, the degree of pollution can be estimated either from physical and chemical properties or from biological characteristics of water. The present study includes physico-chemical and biological analysis of industrial effluents discharged into grassland at selected site. Physico-Chemical and Biological Analysis of the Industrial Effluents from Selected Area will be carried out following NEERI (1979), Grob (1983), APHA (1992, 1995), APHA-AWWA-WPCF (1995).

PHYSICO-CHEMICAL CHARACTERIZATION OF EFFLUENTS

Temperature, Transparency, Colour, Odour, pH, Turbidity, Conductivity, Free CO_2, DO (Dissolved Oxygen), BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand), TSS (Total Suspended Solids), TDS (Total Dissolved Solids), Chlorides, Ca2+, Na+, K+, Mg+, SO4-.

RESULTS AND DISCUSSION

Samples of liquid discharge from industrial areas were collected from time to time. Five replicates of each sample were analysed by the methods described above. The results obtained are discussed below as given in Table-1; Graphs 1a, 1b:

Colour: The colour of the effluent and water was recorded at control and polluted sites. The colour of effluent was recorded brown during rainy, blackish during winter and dark brown summer seasons respectively. The control site had a supply of clear and colourless water throughout the study period.

Odour: The odour of the effluent had stinking smell at polluted site during rainy season, foul pungent in winter season while pungent stinking smell during summer season whereas the control water was always odourless.

Transparency: The transparency showed a blackish tinge both during the rainy and winter seasons in the effluent while it was yellowish during summer season. The control water was found to be clear.

Turbidity: The turbidity of the effluent showed values of 8.2 in the rainy season, 9.806 in the winter season and 10.917 during summer season in the polluted effluent whereas the control water was turbidity in the range of 1.317 (rainy season), 1.647 (winter season) and 1.717 (summer season) in the three seasons.

Free CO_2: The free carbon dioxide showed values of 202.333 in the rainy season, 183.00 in the winter season and 223.33 during summer season in the polluted effluent whereas the control water free CO_2 was in the range of 225.21 (rainy season), 224.33 (winter season) and 186.61 (summer season) in the three seasons.

Dissolved Oxygen: The dissolved oxygen showed values of 17.607 in the rainy season, 24.00 in the winter season and 26.077 during summer season in the polluted effluent whereas the control water DO was in the range of 5.31 (rainy season), 5.757 (winter season) and 5.497 (summer season) in the three seasons.

Biological Oxygen Demand: The biological oxygen demand showed values of 43.3 in the rainy season, 65.00 in the winter season and 70.58 during summer season in the polluted effluent whereas the control water BOD was in the range of 10.713 (rainy season), 9.387 (winter season) and 10.94 (summer season) in the three seasons.

Chemical Oxygen Demand: The chemical oxygen demand showed values of 322.33 in the rainy season, 545.96 in the winter season and 640.667 during summer season in the polluted effluent whereas the control water COD was in the range of 8.1 (rainy season), 9.053 (winter season) and 10.1 (summer season) in the three seasons.

Temperature: The average temperature (^{0}C) of the effluent and water was recorded at the control .and polluted sites. The average temperature of effluent at polluted site was recorded 32.5^{0}C, 26.32^{0}C and 38.16^{0}C in rainy, winter and summer seasons respectively. The temperature of control water was always lower i.e., 27.9^{0}C (rainy), 23.94^{0}C (winter) and 32.22^{0}C (summer) in comparison to polluted site.

pH: The average pH value of effluent was higher than that of control water in different seasons (rainy, winter and summer) as shown in Table 1. The average pH of the effluent and water was recorded at the control and polluted sites. The average pH of effluent at polluted site was recorded 8.433, 9.106 and 9.323 in rainy, winter and summer seasons respectively. The temperature of control water was always lower i.e., 7.167 (rainy), 7.593 (winter) and 7.61 (summer) in comparison to polluted site.

Electrical conductivity: It indicate that the electrical conductivity of effluent was much higher than the water. The electrical conductivity was recorded maximum at polluted site i.e., 11.683, 14.860 and 16.637 mmhos/cm during rainy, winter and summer seasons, respectively. Minimum values were recorded at control site i.e., 0.617, 1.753 and 1.823 mmhos/cm during rainy, winter and summer seasons, respectively.

Chloride content: The chloride content of effluent at polluted site was higher i.e., 413.123, 621.97 and 675.73 mg/l during rainy, winter and summer seasons, respectively in comparison to control site. The chloride content of control was comparatively much lower than polluted site viz., 12.727 (rainy season), 3.51 (winter season) and 16.113 (summer season).

Sulphate: The sulphate content noted at polluted site was 271.073, 257.45 and 260.432 mg/l during rainy, winter and summer seasons, respectively. Minimum sulphate content was found at control site i.e., 23.707, 27.976 and 28.76 mg/l in rainy, winter and summer seasons, respectively.

Sodium: The sodium content was maximum during winter season. The sodium recorded 124.773, 199.27 and 215.32 mg/l during rainy, winter and summer seasons, respectively at polluted site. The sodium was recorded 17.193, 23.243 and 22.646 mg/l during rainy, winter and summer seasons at control site which was significantly less as compared to polluted site.

Potassium: The values of potassium content recorded at polluted site were 57.933, 62.803 and 63.506 mg/l during rainy, winter and summer seasons, respectively. The value of potassium at control site was very low as compared to polluted site 10.57 (rainy season), 17.626 (winter season) and 18.78 (summer season).

Calcium: The values of calcium content at polluted site were 83.887, 85.373 and 85.203 mg/l during rainy, winter and summer seasons, respectively. The calcium content at control site was always lower i.e., 10.047, 12.643 and 16.653 mg/l in rainy, winter and summer seasons.

Magnesium: It was maximum at polluted site i.e. 13.77, 18.326 and 18.756 mg/l during rainy, winter and summer seasons, respectively. Minimum magnesium was recorded at control site i.e., 8.616, 14.826 and 15.343 mg/l, respectively in the three seasons.

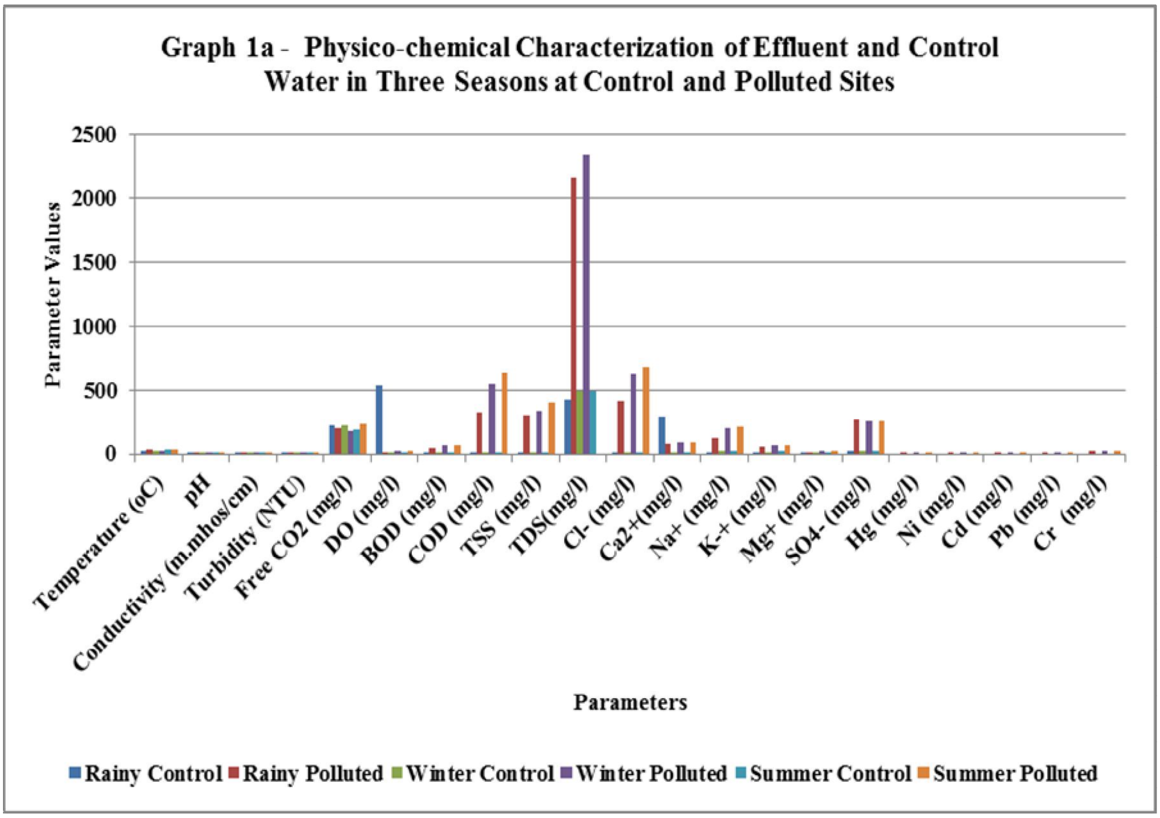
Total Suspended solids TSS: The values of suspended solids recorded at polluted site were 297.23, 331.6 and 397.687 mg/l during rainy, winter and summer seasons, respectively. The control site had a lower level of suspended solids 13.733 (rainy), 13.8 (winter) and 14.263 (summer).

Total Dissolved solids TDS: The total dissolved solids were recorded maximum at polluted site i.e., 2158.33, 2337.00 and 2446.7 mg/l during rainy, winter and summer seasons, respectively. Total solids were recorded in very small amount at control site i.e., 421.243, 492.34 and 494.333 mg/l during rainy, winter and summer seasons, respectively.

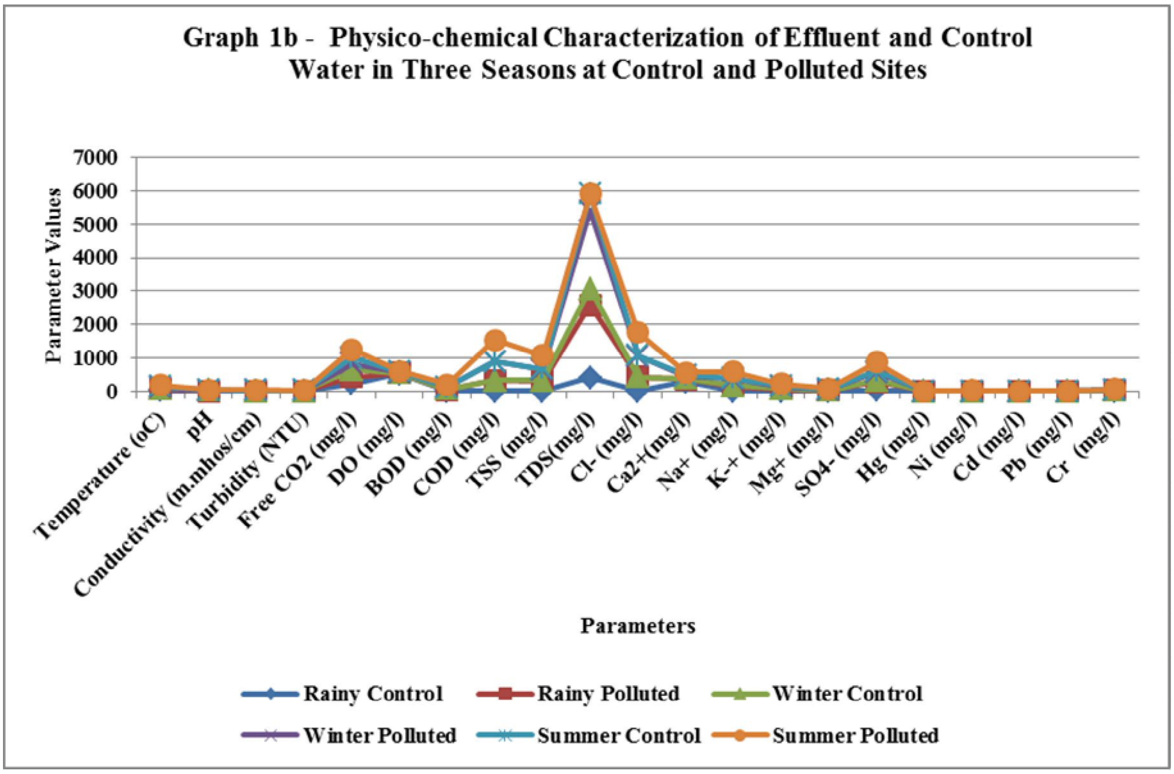
Chromium: The amount of chromium at polluted site was recorded 20.61, 22.863 and 27.123 mg/l during rainy, winter and summer seasons, respectively. The control site was always free from chromium content.

Table 1: Physico-chemical Characterization of Effluent and Control Water in Three Seasons at Control and Polluted Sites

Parameters	Season					
	Rainy		Winter		Summer	
	Site					
	Control	Polluted	Control	Polluted	Control	Polluted
1. Colour	Colourless	Brown	Colourless	Blackish	Colourless	Dark brown
2. Odour	Odourless	Stincking	Odourless	Foul pungent	Odourless	Pungent sticking
3. Transparency	Clear	Blackish	Clear	Blackishr	Clear	Yellowish
4. Temp. (^{0}C)	27.9 ± 0.153	32.5 ± 0.288	23.943 ± 0.241	26.32 ± 0.160	32.22 ± 0.147	38.166 ± 0.120
5. pH	7.167 ± 0.145	8.433 ± 0.117	7.593 ± 0.283	9.106 ± 0.066	7.61 ± 0.058	9.323 ± 0.102
6.Conductivity (m.mhos/cm)	0.617 ± 0.044	11.683 ± 0.246	1.753 ± 0.037	14.860 ± 0.156	1.823 ± 0.014	16.637 ± 0.091
7.Turbidity (NTU)	1.317 ± 0.044	8.2 ± 0.208	1.647 ± 0.047	9.806 ± 0.178	1.717 ± 0.044	10.917 ± 0.060
8. Free CO_2 (mg/l)	225.21 ± 0.484	202.333 ± 0.520	224.33 ± 0.882	183 ± 1.527	186.61 ± 0.978	233.35 ± 1.965
9. DO (mg/l)	5.31 ± 0.058	17.607 ± 0.225	5.757 ± 0.136	24 ± 1.154	5.497 ± 0.033	26.077 ± 0.153
10. BOD (mg/l)	10.713 ± 0.173	43.3 ± 0.404	9.387 ± 0.162	65 ± 0.578	10.94 ± 0.031	70.58 ± 0.876
11. COD (mg/l)	8.1 ± 0.173	322.33 ± 1.138	9.053 ± 0.029	545.96 ± 1.490	10.1 ± 0.072	640.667±1.763
12. TSS (mg/l)	13.733 ± 0.203	297.23 ± 1.127	13.8 ± 0.115	331.6 ± 0.839	14.263 ± 0.131	397.687±1.705
13. TDS(mg/l)	421.243 ± 0.601	2158.33±31.667	492.34 ± 1.51	2337 ± 1.527	494.333 ± 0.882	2446.7 ± 2.905
14. Cl^- (mg/l)	12.727 ± 0.203	413.123 ± 0.505	13.51 ± 0.072	621.97 ± 0.999	16.113 ± 0.073	675.73 ± 1.852
15. Ca^{2+}(mg/l)	10.047 ± 0..477	83.887 ± 0.926	12.643 ± 0.179	85.373 ± 1.085	16.653 ± 0.179	85.203 ± 1.628
16. Na^+ (mg/l)	17.193 ± 0.188	124.773 ± 0.839	23.243 ± 0.944	199.27 ± 0.526	22.646 ± 0.254	215.32 ± 1.710
17. K^+ (mg/l)	10.57 ± 0.218	57.933 ± 0.415	17.626 ± 0.270	62.803 ± 0.735	18.78 ± 0.147	63.506 ± 0.158
18. Mg^+ (mg/l)	8.616 ± 0.268	13.77 ± 0.291	14.826 ± 0.217	18.326 ± 0.379	15.343 ± 0.188	18.756 ± 0.182
19. SO_4^- (mg/l)	23.707 ± 0.225	271.073±33.463	27.976 ± 0.234	257.45 ± 1.410	28.76 ± 0.056	260.423±0.347
Hg (mg/l)	0 ± 0	1.28 ± 0.083	0 ± 0	1.456 ± 0.029	0 ± 0	1.71 ± 0.037
Ni (mg/l)	0 ± 0	8.376 ± 0.192	0 ± 0	9.76 ± 0.118	0 ± 0	10.93 ± 0.051
Cd (mg/l)	0 ± 0	4.216 ± 0.089	0 ± 0	5.06 ± 0.023	0 ± 0	5.07 ± 0.036
Pb (mg/l)	0 ± 0	0.04 ± 0.005	0 ± 0	0.07 ± 0.005	0 ± 0	0.06 ± 0.005
Cr (mg/l)	0 ± 0	20.61 ± 0.282	0 ± 0	22.863 ± 0.265	0 ± 0	27.123 ± 0.072



Graph 1a: Physico-chemical Characterization of Effluent and Control Water in Three Seasons at Control and Polluted Sites



Graph 1b: Physico-chemical Characterization of Effluent and Control Water in Three Seasons at Control and Polluted Sites

Mercury: The amount of Hg at polluted site was recorded 1.28, 1.456 and 1.71 mg/l during rainy, winter and summer seasons, respectively. The control site was always free from Hg content.

Nickel: The amount of Ni at polluted site was recorded 8.376, 9.76 and 10.93 mg/l during rainy, winter and summer seasons, respectively. The control site was always free from Ni content.

Cadmium: The amount of Cd at polluted site was recorded 4.216, 5.06 and 5.06 mg/l during rainy, winter and summer seasons, respectively. The control site was always free from Cd content.

Lead: The amount of Pb at polluted site was recorded 0.04, 0.07 and 0.06 mg/l during rainy, winter and summer seasons, respectively. The control site was always free from Pb content.

The pH of the effluent at polluted site was high (pH 8.433, 9.106 and 9.323) due to the presence of excess of caustic soda, bleaching powder, washing soda (Na_2S0_3) and other above mentioned chemicals. The pH of control site was moderately neutral. The conductivity of effluent at polluted site was high (11.683, 14.860 and 16.637 mmhos/cm) because of the high concentration of salts and chemicals. But these values are very high as compared to water (control) and much above the toxic range. Due to very little amount of salts dissolved in water, its conductivity was very low ranging from 0.617, 1.753 and 1.823 mmhos/cm, which is in normal range. The higher concentration of ammonium, sodium, potassium, chromium and sulphate may mainly be due to their higher concentration in residual dye present in the dyeing effluent. Elgabaly (1955), Heimann (1958), Agrawal *et.al* (1964) and Tripathi (1975) have discussed the adverse effects of excessive sodium of the irrigation water, on soil and plant growth. Thus the high concentration of sodium, calcium, chloride, potassium, ammonium, sulphate, chromium, carbonate and soapanified water at alkaline pH, may cause detrimental effect on the physico-chemical properties of the soil and growth of the plants growing there.

High alkalinity, salinity and sodicity of the effluents may also adversely affect the soil. Paliwal, *et at*. (1976) have emphasized that the alkalinity and salinity of irrigation water is the cause of alkaline and saline soils in Rajasthan. In addition to dissolved chemicals, suspended chemical substances, dye, dust and dirt particles are responsible for very high content of total solids in the effluents. It was maximum (297.23, 331.6 and 397.687 mg/l) in polluted site and relatively very less (13.733 (rainy), 13.8 (winter) and 14.263 (summer)mg/l) at control site during rainy, winter and summer seasons, respectively. The increase in dissolved, suspended and total solids of water deteriorates the suitability of its quality for plant growth. The solid content is directly proportional to the chemicals present in the water, which may prove toxic to the plants. These solids require huge amounts of biochemical oxygen for their decomposition. Thus the effluent receiving soils show oxygen deficiency. It may adversely affect the growth activity of the plants. The suitability of water for irrigation is determined by the amount and kind of salts present therein. A continuous supply of such effluents may also lead to increased level of heavy metal chromium, which can prove toxic for growth of plants in due course of time.

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