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ESTIMATION OF PHYSICO-CHEMICAL PROPERTIES OF SEWAGE WATER AND THEIR IMPACT ON SELECTED CROP PLANTS

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ABSTRACT:

Water is the basis of life. It is a priceless national asset must therefore be harnessed property to meet the basic need of the people. As a result of civilization, industrialization, urbanization, population explosion and other developmental activities, most of our water resources have become polluted. Temperature of sewage water was highest during summer. pH increases with increasing the pollution level. The highest concentration of sulphate, chloride, iron, copper, chromium, nickel, manganese, zinc and lead was reported in sewage water. The total hardness, BOD and COD was also highest in sewage water than control. The growth and development of selected crop plants *viz. Citrullus lanatus, Lycopersicon esculentum* and *Tagetes erecta* in sewage water was better at 50% and 25% concentration than the control while 75% and 100% concentration gave poor results than control. So, it was concluded that the low concentration of sewage water is better for the growth and development of the plants.

KEY WORD: *Pollution, water, Citrullus lanatus, Lycopersicon esculentum, Tagetes erecta.*

INTRODUCTION:

Water is the basis of life. It is one of the most important natural resource. Water is crucial for sustainable development, including the preservation of our natural environment and the alleviation of poverty and hunger. Disposal of sewage waste water is a problem of increasing importance throughout the world. Faster industrialization and urbanization in India has resulted introduction of large volumes of industrial and municipal wastes. At present 17.4 million cubic liters of raw sewage is generated per day in urban areas of the country (Kansal, 1992).

Waste water is used as a source of irrigation waste as well as a source of plant nutrient and trace element allowing farmers to reduce o even eliminated the use of chemical fertilizer and of organic matter that serves as a soil conditioner and humus replenisher. The fertilizer value of sewage supplying large amount of nitrogen and phosphorus and their beneficial effect on improving and maintaining good soil structure is well established. Such as use of this organic water not only recycles nutrients but also reduced the use of more expensive and energy consuming inorganic fertilizer. This option is becoming even more important as other options for the disposal of sludges are diminishing (Taylor *et al.* 1982).

Continuous irrigation with sewage may also cause various changes in biological and microbiological characters, including microbial populations (fungi, bacteria and Nematodes etc.) which are causing diseases to plants (Szontagh, 1981) or are harmful to useful microbes, like *Rhizobium*, suppressing its population (Juwarkar, 1988) or by antagonizing pathogenic microbes. Further, the changed composition of plants growing under sewage irrigated conditions will also affect the incidence of diseases and rests. The quality and population of weeds is also affected by these practices.

Irrigation is the means of biggest water use in all the countries. It is one of the basic needs of the crop production. Owing to tightening supply and rapid expansion in demand, fresh water is expected to emerge as a key constraint for future agricultural growth as globally, the demand for water has grown by 2.4% per year (Selvarajan and Joshi, 2000). To compensate the profoundly increasing demand, the domestic waste water currently produced, is being used for production of agricultural crops, forage grasses and trees (Raja Rajan and Ramalu, 1988; Dhankhar & Dahiya, 2000; Pradhan *et al*. 2001). The objective of the present study is to analyze the physico-chemical properties of sewage water and their impact of different polluted water on water melon, tomato and marigold.

MATERIALS AND METHODS:

Physico-chemical properties

Pure water is colorless. Highly colored water generally has an oxygen demand after a long storage. Colour was observed simply by necked eyes. Temperature was determine by means of Celsius thermometer at the time of and expressed in degree Celsius (°C). The effect of pH on the chemical and biological properties of liquids determined by an electronic pH meter to the accuracy of 0.05 and for electrical conductance (EC) conductivity meter was used to measure the electrical conductance of the sample and expressed in µmhos/cm at 25^0C.

Dissolved Oxygen (DO)

All living organism are dependent up on oxygen in one form or the other to maintain the metabolic process the produce energy for growth of phytoplankton and related zooplankton leading to higher biological activities which was observed in the biodegradation of organic matter and decay of vegetation. An automatic oxygen analyzer was used to analyze the DO content. The result was expressed in mg/l.

Biochemical Oxygen Demand (BOD)

BOD is related to the concentration of the bacterial facilitated decomposable organic material in the water. More BOD means more micro organism which turn means he presence of more organic wastes or sewage pollution. An automatic oxygen analyzer was used to analyze the initial DO and DO after 5 days of incubation of their samples at 20^0C in BOD incubator. The BOD value was calculated by the following formula.

BOD (mg/l) = [Initial DO- final DO (after 5 day)]

$$\text{BOD (mg/l)} = \left[\frac{\textit{Initial DO} - \textit{Final DO}(\textit{after 5 days})}{\textit{Decimal fraction of samples used}}\right]$$

Chemical Oxygen Demand (COD)

Chemical oxygen demand is the measure of oxygen consumed during the oxidation of oxidizable organic matter by strong oxidizing agent. A dichromate reflux method was $K_2Cr_2O_7$ and Fl_2SO_4 in presence of mercuric sulphate to neutralize the effect of chloride and silver sulphate. The access of potassium dichromate was titrated against ferrous ammonium sulphate using Ferro in indicator. The COD was calculate using following formula:

$$\text{COD mg/l} = \frac{\text{(a-b) Nx 1000 x 8}}{\text{ml samples}}$$

Where, a = volume of $FeSO_4$ in sample, b = volume of $FeSO_4$ in blank, N = Normality of $FeSO_4$

Alkalinity

The 100 ml of water sample was takes 2 drops of 0.1% phenolphthalein (p) solution, as indicator was added and disappeared. Thereafter, another 2 drops of 0.1% methyl orange solution as indicator was added to the sample of water. Titration against N/50 H_2SO_4 was contributed until the yellow colour changed to pink. The tit rent consumed in ml gave the value for total alkalinity.

Chloride

Practically all natural water contains chloride in varying concentration. A considerable amount of chloride in stream receiving trade wastes from urine in estimated to contain chloride in the form of NaCl to the extent of 1%, the addition of sewage effluent to water source is bound to increase their chloride concentration so that any sudden increase in chloride concentration would point towards the possibility of organic pollution of the water source.

Estimation of chloride in water sample was done by titrimetic methods procedures adopted was a follows 50 ml sample was taken and 2-3 drops of $K_2Cr_2O_7$ indicator was added to the sample. The solution was titrated against standard $AgNo_3$.

$$Cl = \frac{B.R. \times 1000 \times Factor}{Sample\ volume}$$

Nitrate

Nitrate is the most highly oxidation from of the nitrogen compounds commonly present in natural waters, because it is the product of the aerobic decomposition of organic nitrogen matter. Nitrate in water source originates and agriculture nitrate was analyzed by phenol disulphonoc acid methods. The results were expressed in mg/l.

Total Dissolved Solid

TDS are mainly the inorganic minerals and sometimes some organic matter. In solution from it may not produce any colour and escape visual detection but they may causes some disagreeable taste. Extensive saline, saline, sodic and alkaline waste lands have formed due to high content of dissolved solids in water. Determination of total solids was mode by evaporation methods and of suspended solid by using gooch crucible. The dissolved solids were computed by subtracting the suspended solid from the total solids. The methods were those described by the APHA (1989) and the result was expressed in mg/l.

Total Hardness (TH)

Hardness of water is not a specific constituent but is variable due to complex mixture of actions and onions; it is caused by dissolved polyvalent metabolic ions. Total hardness is defined as the sum of calcium and magnesium concentration both expressed as $Caco_3$ in mg/l. 50 ml of water + 5 of Buffer 'B' +2-3 drop of Eriochrome Black – T indicator were mixed and titrated against 0.2 NEDTA. Total hardness was determined by determined by using following formula.

$$TH = \left[\frac{B.R. \times N \times F \times 1000 \times 50}{Sample\ volume} \right]$$

B. R. = Burette reading

N = Normality of EDTA used

Sulphate

Sulphate is a naturally occurring onion (So_4) found in all kinds of natural water. Discharge of industrial wastes and domestic sewage in water ends to increase its concentration. Sulphates were estimated by spectrophotometrically. 2 ml of sample + 1 gram of $BaCl_2$ solid +5 ml conditioning solution stirred well till $BaCl_2$ was dissolved, the solution was made 100 ml and the mg in standard graph of turbidity mater were seen. Same procedure was adopted separately for blank.

$$SO_4^{--} = \left[\frac{mg \times 1000}{Sample\,Volume} \right]$$

Heavy Metals

Have metals ware determined by Anomic Absorption Spectrophotometer. Atomic Absorption spectroscopy is an absorption methods where radiation absorbed by none, excited atoms in the vapors state. In atomic absorption spectroscopy, the sample is first converted at a selected wavelength, which is characteristic of each individual element. The measured absorbance with that given upper the same experimental condition by reference samples of known composition.

The sampling of water for determination of heavy metal in water samples was done in glass or plastic containers were thoroughly washed and rinsed with 8N HNO_3 following by dematerialized water (DMW). Then 5 ml conc. HNO_3 was evaporation of metals on analysis of heavy metals, our liter sample along with 4ml conc. HNO_3 Was evaporated in a beaker on water bath to approximately 50 ml and then cooled. The concentrate was transferred to 100 ml measuring cylinder and added 2 ml 1% conc. The solution was made to 100 ml with dematerialized water. The acidified samples were then analyzed for heavy metal content with half of Atomic Absorption spectrophotometer (AAS).

Iron (Fe), Lead (Pb), Copper (Cu), Zinc (Zn) Nickel (Ni) and Chromium (Cr) were determined by directly aspirated into air- C_2H_2 flame of an atomic adsorption spectrophotometer and the absorbance was measured at 248.3,358, 325, 279.5, 232 and 283.3 nm, respectively.

Collection of Plants Samples

Diseased specimens and infected plant samples of water melon, tomato and marigold were collected from cultivated fields which were irrigated by different polluted water in and around Allahabad districts. Samples were collected in polythene bags and incubated at room temperature for taxonomical, identification, physiological and control studies and they were critically examined. Fungi were isolated and purified by sub-culturing and maintained on Potato Dextrose Agar (PDA) medium. Careful examinations were done by testing the diseased material on the slides, adding one drop of cotton blue stain. The better diseased specimens were selected and preserved for further studies.

Test materials were incubated at 17± 1^{o}C in B.O.D. incubator or at room temperature. Waring blender was used for churning of the fungal mats into suspensions. For making spore suspensions, camel hair brush was used to dislodge the spore from culture growth on Potato Dextrose agar (PDA) medium. Perforated aluminum trays were used for raising the seedlings in soils or for setting the vials.

RESULTS AND DISCUSSION:

Table-1 reveals the physic-chemical properties of sewage water. The color of the sewage water was greenish yellow in monsoon season, greenish brown in winter season and black during summer season in both the year i.e. 2009-2010 and 2010-2011. The odour of water was soapy during monsoon season, soapy and rotten egg smell was observed during winter season and soapy smell was during summer season of both the years. The temperature of year 2009-2010 was maximum (33.6^{O}C) during summer season followed by monsoon season (32^{O}C) and winter season (16.1^{O}C). The temperature of the year 2010-2011 was maximum (33.8^{O}C) during summer season followed by monsoon season (32.2^{O}C) and winter season (17.3^{O}C). The maximum *p*H (8.8) in year 2009-2010 was recorded during summer season followed by winter season (8.2) and monsoon season (7.8). The maximum pH (8.6) in the year in the year 2010-2011 was recorded during summer season followed by winter season (8.3) and monsoon season (7.7).

The maximum electrical conductance in year 2009-2010 was reported during summer season (1548 µmhos/cm) followed by winter season (1480 µmhos/cm) and monsoon season (1298 µmhos/cm). The maximum electrical conductance in year 2010-2011 was reported during summer season (1568 µmhos/cm) followed by winter season (1445 µmhos/cm) and monsoon season (1330 µmhos/cm). The maximum value of total dissolved solid in years 2009-2010 and 2010-2011 was 682 mg/l and 692 mg/l respectively during summer season followed by winter season (588 mg/l and 619 mg/l) and monsoon season (524 mg/l and 543 mg/l). The maximum value of alkalinity in years 2009-2010 and 2010-2011 was 294 mg/l and 295 mg/l respectively during summer season followed by winter season (204 mg/l and 206 mg/l) and monsoon season (196 mg/l and 198 mg/l).

The maximum value of total hardness in year 2009-2010 and 2010-2011 was 318 mg/l and 321 mg/l respectively during summer season followed by winter season (279 mg/l and 298 mg/l) and monsoon season (259 mg/l and 270 mg/l). The maximum value of sulphate in years 2009-2010 and 2010-2011 was 148 mg/l and 150mg/l respectively during summer season followed by monsoon season (126 mg/l and 144 mg/l) and winter season (124 mg/l and 136 mg/l). The maximum value of chloride in year 2009-10 and 2010-11 was 136 mg/l and 140 mg/l respectively during summer season followed by winter season (134 mg/l and 138 mg/l) and monsoon season (12 4 mg/l and 132 mg/l). The maximum value of nitrate in year 2009-10 and 2010-11 was 44.2 mg/l and 45.7 mg/l respectively during monsoon season follow by summer season (37.7 mg/l and 38.8 mg/l) and winter season (22.1 mg/l and 23.6 mg/l). The maximum value of dissolve oxygen in years 2009-10 and 2010-11 was 1.6 mg/l and 1.4 mg/l respectively during winter season followed by monsoons season (1.4 mg/l and 1.2 mg/l) and summer season (0.0 mg/l and 0.0 mg/l).

The maximum value of biochemical oxygen demand in year 2009-10 and 2010-11 (60.8 mg/l and 64.0 mg/l) respectively during summer season followed by monsoon season (57.7 mg/l and 59.8 mg/l) and winter season (41.8 mg/l and 42.8 mg/l).The maximum value of chemical oxygen demand in 2009-10 and

2010-11 was analyzer 382 mg/l and 418 mg/l respectively during summer season and was followed in winter season (366 mg/l and 394 mg/l). It was analyzer in monsoon season (356 mg/l 364 mg/l).

The maximum concentrations of iron in year 2009-10 and 2010-11 was (11.1 mg/l and 10.4 mg/l) respectively during summer season followed by winter season (9.6 mg/l 10.4 mg/l) and monsoon season (8.6 mg/l and 9.8 mg/l). The maximum concentration of copper in year 2009-10 and 2010-11 was (0.88 mg/l and 0.88 mg/l) respectively during summer season followed by winter season (0.59 mg/l and 0.76 mg/l) and monsoon season (0.44 mg/l and 0.55 mg/l). The maximum concentration of chromium in year 2009-10 and 2010-11 was (0.474 mg/l and 0.466 mg/l) respectively during summer season followed by winter season (0.394 mg/l and 0.349 mg/l) and monsoon season (0.223 mg/l and 0.218 mg/l). The maximum concentration of nickel in year 2009-10 and 2010-11 was (0.154 mg/l and 0.188 mg/l) respectively during summer season followed by winter season (0.150 mg/l and 0.166 mg/l) and monsoon season (0.126 mg/l and 0.134 mg/l). The maximum concentration of manganese in year 2009-10 and 2010-11 was (0.108 mg/l and 0.124 mg/l) respectively during summer season followed by winter season (0.084 mg/l and 0.110 mg/l) and monsoon season (0.046 mg/l and 0.082 mg/l). The maximum concentration of zinc in year 2009-10 and 2010-11 was (1.84 mg/l and 1.85 mg/l) respectively during summer season followed by winter season (1.48 mg/l and 1.68 mg/l) and monsoon season (1.64 mg/l and 1.54 mg/l). The maximum concentration of lead in year 2009-10 and 2010-11 was (0.166 mg/l and 0.194 mg/l) respectively during summer season followed by winter season (0.158 mg/l and 0.123 mg/l) and monsoon season (0.106 mg/l and 0.109 mg/l).

Growth and developmental of selected crops irrigated with sewage water

Table-1a, 1b and 1c presented that the growth and development of *Citrullus lanatus* in sewage water was better at 50% and 25% concentration than the control while 75% and 100% concentration gave poor results than control. In such way same result was obtained in *Lycopersicon esculentum* and *Tagetes ercta.*

Sewage is over 99.9 percent water, has slightly soapy and oily odour, is cloudy and contains solid substances including heavy metals like iron, copper, zinc, lead, cadmium, cobalt, nickel (Adhikari, 1993) and nutrients like nitrogen (27-70 mg/l), phosphorus (9-30 mg/l) and potassium (12-4 mg/l) along with the micronutrients. Domestic waste water is being used for agriculture at several places in the world. A review by Haruvy (1977) indicated that Israel is at the forefront of planned waste water use with fully 70% of the total agricultural demand for water in 2040 to be met by treated effluent.

For developing countries, like India, Pakistan, China and Mexico to quote a few examples, waste water for irrigation originated as an unplanned, often spontaneous, activity and have been practiced for decades and even centuries by poor formers in urban areas. Studies by Mara and Cairncross (1989) have concluded that an estimated 80% of waste water may be used for irrigation with China and South Asia making significant use of untreated waste for irrigation. In America alone at least 5000,000 ha of land is being irrigated with untreated waste water, over half of which is in Mexico (Rodriguez *et al.* 1998).

Soil is affected greatly by the application of waste water and in many cases, the affects are beneficial. Raw or treated sewage can supply major part of nitrogen and phosphorus and also the organic matter for conditioning of soil. Nelson *et al.* (1991) reported higher extractable N, P, K and B levels and lower Ca and Mg levels in soil irrigated with waste water. Irrigation with waste water increases soil fertility and soil tilts. Payne *et al*. (1989) reported that soil receiving waste water had high soil pH, organic matter, cation exchange capacity and available phosphorous in the upper soils horizon which increases crop productivity. A number of scientists have worked on the changes in physico chemical properties of the soil due to the sewage irrigation. The work on changes in physical properties of the soil, (Purves, 1983) and changes in chemical properties subsequent to sewage irrigation (Genevini *et al.* 1986; Andrade *et al.*, 1987) are sufficiently documented. The change in soil quality not only depends on the longevity of sewage treatment but also quality of sewage being applied on the land. The presence of large amounts of carbonate and bicarbonate or total solids in sewage waste may also make these unsuitable for long term application to agricultural lands (Arora, 1985)

The raw sewer contains toxic metal. A long term use of raw sewer waste for irrigating crops may cause metal accumulation in soils to such an extent that they may become toxic to plants. Unplanned and untreated disposal of waste water cannot only render soil unproductive, but also make it a sink for survival of pathogens. Dogan *et al*. (1997) observed the contamination of soil with fecal coliforms when irrigated with domestic waste water and industrial effluents. Singh *et al.*, (1999) establish that the quality of sewage used for irrigation directly affects the soil. For example high salinity of sewage results in high salinity of soil and medium pH of sewage leads to normal alkalinity of soil. The high salinity of soil can have adverse effects on plants.

Increase in crop yield can be achieved by use of sewage as a good source of nutrients for plants (Sharma and Kale, 1968). However, it has been observed that for better crop yield application of sewage should be discontinued after the flowering stage of the plant (Vimal and Talashikar, 1983). The soluble salts of calcium, sodium and potassium present in the sewage may affect the ion exchange status of the soil (Vimal and Talashikar, 1983). Hence effective and profitable utilization of sewage for plant growth assumes greater importance and the present work is an attempt in that direction.

So, from the above findings it was concluded that the low concentration of sewage water is better for the growth and development of the plants.

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Table1: Phyisco-Chemical properties of sewage water collected from near Rasoolabad Ghat, Allahabad

Parameter	**Year 2009-2010**			Year 2010-2011		
	Monsoon	**Winter**	**Summer**	**Monsoon**	**Winter**	**Summer**
Colour	Greenish yellow	Greenish brown	Black	Greenish yellow	Greenish brown	Black
Odour	Soapy	Soapy and Rotten egg	Soapy	Soapy	Soapy and Rotten egg	Soapy
Temp (C^0)	32.0	16.1	33.6	32.2	17.3	33.8
pH	7.8	8.2	8.8	7.7	8.3	8.6
EC(µmhos/cm)	1298	1480	1548	1330	1445	1568
TDS (mg/l)	524	588	686	543	619	692
Alk (mg/l)	198	204	294	198	206	295
T.H (mg/l)	259	279	318	270	298	321
SO_4 (mg/l)	126	124	148	144	136	150
Cl (mg/l)	124	134	136	132	138	140
Nitrate (mg/l)	44.2	22.1	37.7	45.7	23.6	38.8
Do (mg/l)	1.4	1.6	Nil	1.2	1.4	Nil
BOD (mg/l)	57.7	41.8	60.8	59.8	42.8	64.0
COD/(mg/l)	356	366	382	364	394	418
Fe (mg/l)	8.6	9.6	11.1	9.8	10.4	10.4
Cu (mg/l)	0.44	0.59	0.88	0.55	0.76	0.88
Cr (mg/l)	0.223	0.394	0.474	0.218	0.349	0.466
Ni (Mg/l)	0.126	0.150	0.154	0.134	0.166	0.188
Mn (mg/l)	0.046	0.084	0.108	0.082	0.110	0.124
Zn (mg/l)	1.64	1.48	1.84	1.54	1.68	1.85
Pb (mg/l)	0.106	0.158	0.166	0.109	0.123	0.194

Table2: Effect of sewage water on growth and development of *Citrullus lanatus.*

S. No.	Concentration (%)	DAS											
		10				**20**				30			
		RL (cm)	**SL (cm)**	**FW (gm)**	**DW (gm)**	**RL (cm)**	**SL (cm)**	**FW (gm)**	**DW (gm)**	**RL (cm)**	**SL (cm)**	**FW (gm)**	DW (gm)
1	25%	4.08	6.25	2.74	0.406	9.25	40.44	80.81	14.21	13.36	64.24	150.56	**25.12**
2	50%	4.12	6.56	2.87	0.418	9.85	42.14	81.12	14.50	13.79	65.32	151.57	**25.42**
3	75%	3.22	4.75	1.75	0.274	7.12	30.34	70.12	12.14	11.34	54.81	140.39	**23.34**
4	100%	2.15	3.62	1.08	0.170	5.08	18.89	60.13	10.15	7.10	39.10	120.12	**20.11**
5	Control	3.95	5.85	2.50	0.385	8.75	39.34	78.34	13.36	12.12	60.41	141.81	**24.32**

Where: RL (root length), SL (Shoot length), FW (fresh weight), DW (dry weight)

Table3: Effect of sewage water on growth and development of *Lycopersicon esculentum*

S. No.	**Concentration (%)**	**DAS**											
		10				**20**				**30**			
		RL (cm)	**SL (cm)**	**FW (gm)**	**DW (gm)**	**RL (cm)**	**SL (cm)**	**FW (gm)**	**DW (gm)**	**RL (cm)**	**SL (cm)**	**FW (gm)**	**DW (gm)**
1	25%	1.97	3.95	3.06	0.50	3.75	10.43	5.19	0.85	6.17	17.26	105.15	17.17
2	50%	2.19	4.98	3.14	0.52	4.38	11.39	6.29	1.50	7.26	18.98	110.10	18.10
3	75%	1.15	2.75	1.57	0.34	2.87	6.12	3.13	0.57	4.08	14.14	80.17	15.12
4	100%	0.85	1.85	0.95	0.16	1.87	4.81	1.57	0.18	3.06	12.12	65.12	12.11
5	Control	1.45	3.05	2.87	0.41	3.07	8.43	4.16	0.70	5.06	16.26	92.16	15.15

Where: RL (root length), SL (Shoot length), FW (fresh weight), DW (dry weight)

Table4: Effect of sewage water on growth & development of *Tagetes erecta.*

S. No.	**Concentration (%)**	**DAS**											
		10				**20**				**30**			
		RL (cm)	**SL (cm)**	**FW (gm)**	**DW (gm)**	**RL (cm)**	**SL (cm)**	**FW (gm)**	**DW (gm)**	**RL (cm)**	**SL (cm)**	**FW (gm)**	**DW (gm)**
1	25%	2.98	4.14	3.16	0.52	4.78	19.12	56.34	10.34	8.85	31.25	90.25	16.19
2	50%	3.12	4.21	3.22	0.54	5.08	20.43	58.12	10.45	9.25	32.36	91.78	16.78
3	75%	2.64	3.76	2.84	0.44	4.12	15.25	50.36	8.15	6.75	25.43	80.19	13.14
4	100%	2.04	2.64	1.34	0.25	3.06	8.25	32.74	5.26	4.38	18.43	60.12	10.10
5	Control	2.78	4.02	3.04	0.51	4.48	17.25	54.12	9.43	7.75	29.19	87.15	15.18

Where: RL (root length), SL (Shoot length), FW (fresh weight), DW (dry weight)