Effect Of Treated Wastewater On Growth Of Vegetable Crops

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Abstract- Present study deals with agricultural practices using treated wastewater of ONGC, Hazira to examine the effectiveness of treated wastewater. In this study, vegetable crop plants like smooth guard (*Luffa aegyptica*), spinach (*Spinacia oleracea*) and radish (*Raphanus sativus*) were grown and irrigated using tap water (control) from VNSGU site and treated wastewater (experimental) from ONGC site. Physico-chemical properties of soil and water used for irrigation of both the sites were analyzed. The soil and treated wastewater of ONGC site were contained more nutrient compared to soil and tap water of VNSGU site. Growth studies on anatomical and histo-chemical observations of ONGC plants were compared with plants grown at VNSGU campus. Higher growth was noticed from the plants grown at ONGC site. However, the development of xylem and phloem tissues was higher in plants at ONGC site. Similarly, histochemical observations revealed that the production of various cellular substances were normal under the effect of treated effluents. But there was higher deposition of cellulose and pectin on the walls of collenchyma in smooth gourds grown at ONGC site. Findings of the study concluded that treated wastewater of ONGC, Hazira was most suitable for growth of vegetable plants and add step towards conservation of water resource.

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Key words- Effluent, Smooth guard, Spinach, radish, growth, anatomical and histochemical study

I. Introduction

Water is considered as main factor for sustainable development and the most important component for all of the living organisms in the biosphere, Singh and Mishra (1997). The reuse of wastewater is one of the main options being considered as a new source of water in region where water is scarce (Ursula et al., 2000; Vojdani, 2006). Reuse of wastewater for irrigation is not new concept and it has been practiced in agricultural and landscape irrigation in many countries like USA, Germany, India, Kuwait, Tunisia, Oman, Jordan and Saudi Arabia (Rowe and Abdel-Magid 1995; Alderfasi 2009). These investigations indicated the beneficial role in reuse of wastewater in increasing crop yield without or with minimal risks to the plant, soil, groundwater and health (Shatanawi and Fayyad 1996; Selim 2008). The area of land to be irrigated with wastewater increased the concerns over the environmental implications (WRc, 2001).

Oil and Natural Gas Corporation (ONGC) is leading national oil company, refines crude oil and natural gas etc. and huge quantity of water is used in refining process. Water used in the process is non-consumptive and come out as wastewater with major pollutants like high COD, hydrocarbons, suspended solids, oil and grease etc. ONGC has setup the wastewater treatment system which includes physical, chemical and biological methods. Present work was undertaken to analyze water quality of treated wastewater of ONGC, its use in raising the vegetable crops and check its effects.

II. Materials and Methods

Experimental plots were prepared at Veer Narmad South Gujarat University (VNSGU) as well as Oil and Natural Gas Corporation (ONGC), Hazira. Equal quantity of healthy seeds of Smooth gourd (*Luffa aegyptica*), spinach (*Spinacia oleracea*) and radish (*Raphanus sativus*) were sown. Same amount of normal tap water and treated wastewater were used for the irrigation of crops at VNSGU (control) and ONGC (experimental) site respectively.

Tap water of VNSGU, Treated wastewater of ONGC, and soil samples were collected, brought to laboratory of Department of Aquatic Biology, VNSGU Surat and analyzed for important physico-chemical parameters (for water viz., color, temperature, total solids, total dissolved solids, total suspended solids pH, COD, total hardness, total alkalinity, nitrate, chloride, oil and grease, phosphate and for soil pH, conductivity, organic matter, total alkalinity, calcium, magnesium, sodium, potassium, sulphate and nitrate) following the standard methods of (APHA 1995); (Trivedy and Goel 1986).

Seed germination was counted at both sites. For the growth study, at different stages plants with their intact roots were carefully removed and fresh weight and dried weight was determined for biomass estimation.

Anatomical study was carried out to follow the standard method of (Berlyn and Miksche, 1976).

Histochemical studies of lignin, starch and cellulose and pectin sections were carried out by the method of (Johansen, 1940).

III. Results and Discussion

Water quality assessment showed that results of temperature, total solids, total dissolved solids, total hardness, total alkalinity, nitrate and phosphate were higher in treated waste water of ONGC compared to tap water of VNSGU. Table 1 shows that total dissolved solids (402.3 ± 61.0 mg/L), total suspended solids (61.0 ± 11.5 mg/L), pH (7.09 ± 0.5), nitrate (0.539 ± 0.26 mg/L) and phosphate (45 ± 14.69 µg/L) were observed in treated wastewater of ONGC which was found suitable for irrigation and growth of vegetable crops.

TABLE1. PHYSICO-CHEMICAL PROPERTIES OF WATER

S.N.	Parameter	VNSGU	ONGC
1	Color	Colorless	Yellowish
2	Temperature (^{0}C)	29±1.0 (28-30)	29± 1.15 (27-31)
3	Total Solids (mg/L)	209±169 (40-378)	463.3± 72.64 (330-580)
4	TDS (mg/L)	160±140 (20-300)	402.3±61.06 (290-500)
5	TSS (mg/L)	49±29 (20-78)	61± 11.59 (40-80)
6	pH	6.56± 0.13 (6.69-6.43)	7.09± 0.50 (6.09-7.58)
7	C O D (mg/L)	---	69.73± 11.18 (48-85.2)
8	Total hardness (mg/L)	151± 19 (132-170)	150.33±34.15 (83-194)
9	Total alkalinity (mg/L)	181.5± 13.5 (168-195)	152.0± 17.43 (120-180)
10	Chloride (mg/L)	107.21± 27.69 (79.5-134.9)	193.12±28.19 (139.1-234.3)
11	Oil and grease (mg/L)	Nil	0.53± 0.26 (0.7-0.85)
12	Nitrate (mg/L)	0.09±0.02 (0.02-0.07)	0.539.0±0.26 (0.02-0.88)
13	Phosphate (µg/L)	10±5 (5-15)	45± 14.69 (Nil-63)

Physico-chemical parameters of soil from VNSGU and ONGC are depicted in Table 2 and in ONGC all of the parameters showed higher values which were suitable for growth of plants.

TABLE 2. PHYSICO-CHEMICAL PROPERTIES OF SOIL

S.N.	Parameter	VNSGU	ONGC
1	pH	7.29 ± 0.77 (5.74-8.09)	8.06 ± 0.811 (6.60-9.40)
2	Conductivity (µs)	131 ± 19 (94-157)	196.33 ±57.64 (113-307)
3	Organic matter (%)	1.80 ± 0.029 (1.75-1.85)	2.435 ± 0.162 (2.14-2.70)
4	Phosphorous (mg/100g)	0.51 ± 0.14 (0.37-0.80)	0.573 ± 0.123 (0.44-0.82)
5	Total alkalinity(mg/100g)	34.29 ± 7.28 (25.89-48.80)	43.51 ± 8.91 (31.72-61.00)
6	Calcium (mg/100g)	24.34 ± 1.52 (21.30-26.09)	50.414 ± 16.21 (23.57-48.09)
7	Magnesium (mg/100g)	8.69 ± 0.75 (7.29-9.90)	15.77 ± 4.05 (9.61-23.43)
8	Sodium (mg/100g)	15.29 ±9.41 (4.08-7.80)	27.57 ± 15.39 (6.02-19.30)
9	Potassium (mg/100g)	17.9 ± 10.97 (2.10-12.60)	31.36 ± 19.85 (3.20-21.20)
10	Sulphate (mg/100g)	0.13 ± 0.120 (Nil-0.37)	0.265 ± 0.159 (0.03-0.57)
11	Nitrate (mg/100g)	0.15 ± 0.10 (0.12-0.35)	0.198 ± 0.032 (0.14-0.45)

Seed germination time was lesser and germination rate was higher in all the vegetable viz; smooth gourd, spinach and radish grown at ONGC than VNSGU (Table 3).

TABLE 3. GERMINATION OF PLANTS

S. N.	Parameter	Plants grown at VNSGU			Plants grown at ONGC		
		SG	Spinach	Radish	SG	Spinach	Radish
1	Seed germination (Days)	8.00	6.00	3.00	5.00	4.00	2.00
2	Germination (%)	75.0	70.0	80.0	80.0	80.0	95.0

Better morphological growth of plants was observed at ONGC site. Growth of Smooth gourd (SG) at VNSGU and ONGC is depicted in Fig. 1 and 2 respectively.

A comparative study has shown that the biomass of plants was higher with irrigation of treated wastewater than tap water (Table 4).

TABLE 4. BIOMASS OF PLANTS (GM)

S. N.	Duration (Days)	Plants grown at VNSGU			Plants grown at ONGC		
		SG	Spinach	Radish	SG	Spinach	Radish
1	10	2.44	0.25	1.2	5.26	0.68	4.88
2	30	17.99	4.88	9.46	53.34	28.14	40.89
3	50	22.56	8.19	14.10	74.29	46.17	56.28
4	Mature	130.00	12.92	25.52	1120.0	80.00	73.00

Figure 1. SG at VNSGU

Figure 2. SG at ONGC

Similarly the anatomical study revealed that the growth and size of xylem and phloem cell were relatively higher in the plants cultivated with treated wastewater of ONGC (Fig. 3 and 4).

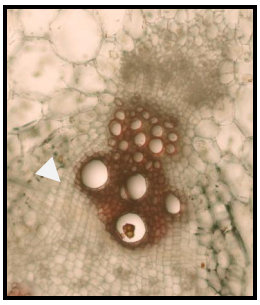

Figure 3. Growth of xylem and phloem cell at VNSGU

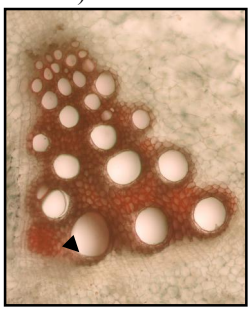

Figure 4. Growth of xylem and phloem cell at ONGC

Deposition of cellulose and pectin on the walls of collenchyma cells and lignin on the walls of vessel element, xylem fibers and phloem fibers were higher in the plant irrigated with treated wastewater of ONGC than VNSGU site.

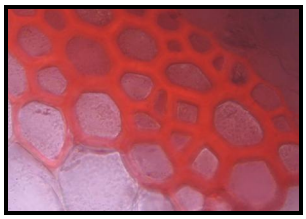

Figure 5. Growth of phloem fiber in plant at VNSGU

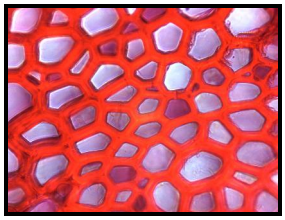

Figure 6. Growth of phloem fiber in plant at ONGC

Starch grains were found relatively more dense in the roots of plants of ONGC site than VNSGU (Fig. 7 and 8).

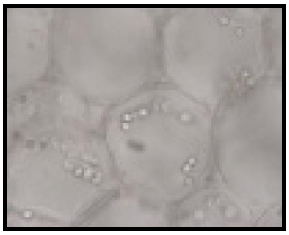

Figure 7. Starch grain density in plant tissue at VNSGU

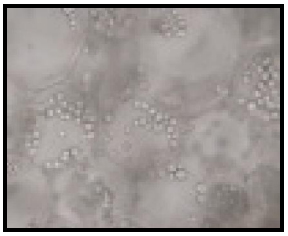

Figure 8. Starch grain density in plant tissue at ONGC

Vigneswaran (2004) reported that the water with 1000-2000 mg/L total dissolved solids, 200 mg/L total suspended solids, (5.5-8.5) pH, (150 mg/L) chemical oxygen demand, (250 mg/L) chloride and (5mg/L) oil and grease was suitable for the cultivation of vegetables crops in China. (Bansal and Kapoor 2000) pointed out that the usage of wastewater supplied nutrients to different crops and also improved soil physical properties and its fertility. Comparative account on physico-chemical parameters of water and soil from control and experimental sites in present study showed remarkable changes. They are also in favor of earlier finding to increase the nutrients and other parameters level which are responsible for better growth of plants.

(Alderfasi 2009) reported the increase in the growth of wheat plants irrigated with treated wastewater. The effect of irrigation with secondary treated wastewater was reported by (Campbel and Davidson 1983), (Shatanawi and Fayyed 1996), (Vasquez-Montiel et al. 1996), (Palacios et al. 2000), (AbdEL-Latief et al. 2007) and (Selim 2008). The current observations on morphological and anatomical growth difference are in good co-relation with their research.

IV. CONCLUSION

From the above work it is suggested and concluded that the treated wastewater of ONGC,

Hazira is most suitable for cultivation of vegetable crop, smooth gourd (*Luffa aegyptica*), spinach (*Spinacia oleracea*) and radish (*Raphanus sativus)* without using fertilizers.

The approach of utilizing treated wastewater for raising crops is towards minimizing cost of fertilizers and conservation of water resources. Comparing these parameters with treated wastewater of ONGC, it can be suggested that the treated wastewater of ONGC is most suitable for the cultivation of vegetable crops.

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REFERENCES

[1] Singh, K.K. and Mishra, L.C. Effects of fertilizer factory effluents on soil and crop productivity. Water & Soil Pollut. 1997, 33(14): 309-320.

[2] Ursula J. Blumenthal, D. Ducan Mara, Anne Peasey, Guillermo Ruiz-Palacios, and Rebecca Stott, Guidelines for the microbial quality of treated wastewater used in agriculture: recommendations for revising WHO guidelines, Bulletin of the World Health Organization, 2000, 78.

[3] Vojdani, Fowad. Potable Water supply from Ground water Resources in Drought Situation, International Workshop on Ground water for Emergency Situations, October 2006, Tehran – Iran, 29-31.

[4] Rowe, D. R. and Abdel-Magid, I. M. Handbook of Wastewater Reclamation and Reuse, 1995 Lewis Pub., US.

[5] Alderfasi, Ali Abdullah. Agronomic and Economic Impacts of Reuse Secondary Wastewater in Irrigation under Arid and Semi-Arid Regions, World Journal of Agricultural Sciences, 2009. 5 (3); 369-374.

[6] Shatanawi, M. and Fayyad, M. Effect of Khirbet As-Samra treated effluent on the quality of irrigation water in central Jordan valley. Water Research1996, 30(12):2915-2920.

[7] Selim, M.M. Evaluation of the reuse of treated wastewater for irrigation. Acta Agronomica Hungarica, 2008, 56(4):71-79.

[8] WRc, Effluent reuse demonstration trials. Alexandria Effluent and Reuse Study, WRc Report No. ESRS, 2001, 15.

[9] APHA. Standard methods for the examination of water and wastewater, 1995, 18th edition. American Public Health Association, Washington DC.

[10] Trivedy R. K. and Goel P.K. Chemical and Biological Methods for Water Pollution Studies, 1986. Published by Environmental Publications Karad.

[11] Berlyn, G. P. Miksche, J.P. Botanical micro technique and cytochemistry, 1976. IOWA state Univ. Press, Ames, IOWA.

[12] Johansen, D.A. Plant micro technique, 1940. McGraw-Hill Book Company, New York.

[13] Vigneswaran S., Sundravadivel M. Recycle and reuse of domestic wastewater, 2004. http://www.eolss.net/ebooks/Sample%20Chapters/C07/E2-14-01.pdf

[14] Bansal Sudha, K.K. and Kapoor, A. Vermicomposting of crop residues and cattle dung with Eisenia foetida. Bioresource and Technology, 2000. 73: 95-98.

[15] Campbel, C.A. and Davidson, H. R. Effect of temperature, nitrogen fertilization and moisture stress use by Manitou spring wheat. Canadian J. Plant Sci. 1983. 59:603-626.

[16] Vasquez-Montiel, O.N., J.Horan, Mara, D.D. Angelakis, A. and Asno, T. Management of domestic wastewater for reuse in irrigation. Water Science and Technology, 1996. 33(10-11): 355 362.

[17] Palacios, N.P., Pard, O.A., E. Del. Nero, F. Rodríguez and L. Sulos. Legumes for Mediterranean forage crops, pastures and alternative uses. Proceeding of the 10th meeting of the FAO CHIEAM, Interregional Cooperative research, 2000. Cahiers Options Mediters, 45:181-185.

[18] Abd El-Lateef, E.M., J.E. Hall, S.R. Smith, A.A. Farrag and M.M. Selim. Bio-Solid Recycling in Warm Climates: Cairo and Alexandria Sludge Reuse studies. International Conference on Sustainable Sanftation, Dongsheng, Ordos, China, 26-29 August 2007.

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