Un Treated Waste water used for Radish Cultivation in Nehru Memorial College Campus, Puthanampatti, Tiruchirappalli, Tamilnadu

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Abstract-*This research work was designed to study the effect of grey water on the yield of vegetable crop (radish) under field conditions. Availability of irrigation water at reasonable cost is one of the most important factors for agricultural development. Conjunctive use of fresh and grey water can successfully be adopted for cultivation. The waste water was collected from the Sir. CVR ladies hostel, Nehru Memorial College, Puthanampatti. An experiment was laid out at the research plot of Nehru Memorial College, Puthanampatti, Tiruchirappalli. The collected samples were subjected to systemic analysis of the below stated physiochemical parameters and biological testing. The tested physiochemical parameters are pH, Dissolved oxygen (DS), Total Dissolved Solids (TDS), Salinity and conductivity. Treated waste water samples were serially diluted and microbial analysis was done for identify the bacterial colonies. It was observed that the higher level of vegetative yield of radish crop and provides maximum return at 100% sewage water. Plant height, root length and girth significantly increased with the increase of sewage content in the grey water. The crop production using waste water favourably altered the physicochemical parameters of the soil and water. The present study shows the good yield and water use efficiency of radish (Raphanus Sativus) crop increase with an increase in grey water.*

KeyWords: *Bacterial colonies, Grey Water, Physiochemical parameters, Plant yield*

I. INTRODUCTION

Freshwater is already scarce in many parts of the world and population growth in water-scarce regions is expected to further increase its value. In 1995, 31 countries were classified as water-scarce or water-stressed and it is estimated that 48 and 54 countries will fall into these categories by 2025 and 2050, respectively (Hinrichsen, et al., 1998). These numbers are said not to include people living in arid regions of large countries where there is enough water but is poorly distributed e.g. China, India, and the USA (Hinrichsen, et al., 1998).

The wastewater generally refers to the water generated from household uses like bathing and washing clothes. This wastewater is distinguished from more heavily contaminated “black water” from toilets. In many utility systems around the world, greywater is combined with black water in a single domestic wastewater stream. Yet greywater can be of far higher quality than black water because of its low level of contamination and higher potential for reuse. When greywater is reused either onsite or nearby, it has the potential to reduce the demand for new water supply, reduce the energy and carbon footprint of water services, and meet a wide range of social and economic needs. In particular, the reuse of grey water can help reduce demand for more costly high-quality potable water (Lucy Allen, 2010). Wastewater is approximately 99% (Helmer and Hespanho, 1997) increasing water scarcity and stress, and degradation of freshwater resources resulting from improper disposal of wastewater, population increase and related increased demand for food and fiber. A growing recognition of the resource value of wastewater and the nutrients it contains Wastewater re-use may be 'direct' or 'indirect'.

This untreated wastewater irrigation has been going on for over 20 years. The primary crops grown are lettuce, tomatoes, onions and cabbage. Vegetables are preferred because they grow faster and are more economically profitable. Wastewater is an important source of irrigation water and nutrients for crops in arid and semi-arid climates. When wastewater use is well managed, it is known to help in the recycling of plant nutrients and water thus reducing the cost of fertilizers or simply makes them accessible to farmers. (WHO, 2006b).

The wastewater farmers applied on average only 65 kg of fertilizer per hectare per year, as compared to the 530 kg per hectare per year applied by farmers who used regular irrigation water.

This resulted in a total saving of over US$ 51,000 for the complete site. Saving in fertilizer, higher cropping intensities and the cultivation of vegetables meant that the farmers used waste water for an irrigation on average earned US$ 600 per hectare per year more than farmers who used regular irrigation water (Ensink et al., 2006). Thus, the present study was assessed a non-treatment option on the production of vegetable radish (Raphanus sativus) using the untreated grey water. The effect of irrigation with wastewater on the soils under vegetable cultivation and analyze the physico-chemical parameters and biological parameters of waste water used for vegetable crop production.

II. MATERIAL AND METHODS

Experimental design:

The present study was conducted in Green house of Nehru Memorial College, Puthanampatti was used to culture the crops through grey water irrigation.

Grey water collection:

Water samples were collected with the aid of 30 liters capacity of plastic container. Grey water samples were collected from kitchen drainage, Sir. CVR Women hostel, Nehru Memorial College (Autonomous), this hostel accommodates about 1500 women students. As grey water varies in both magnitude of flow and strength throughout the day, samples were collected in the morning and worked upon within twenty four hours of collection to ensure a balance composition. The land in the green house was separate into two plots: Plot – I:300 liters of normal tap water irrigated for 50 days to the crops. This plot is considered as control; Plot – II: 300 liters of grey water irrigated for 50 days to the crops and it is considered as treatment plot. Sewage water was supplied through the portable garden pipes from the water mixing.

III. RESULT AND DISCUSSION

Vegetative growth of radish plant:

A good quality cabbage head should be fresh, hard, fully developed with average head size since exceptionally large cabbage heads has limited appeal to consumers and therefore lowers the market response (Wagner et al., 1998). The onions irrigated with greywater showed a significantly higher yield compared to other treatments. Salukazana et al., (2006) confirmed these results when it was discovered that onions had a significantly higher yield when irrigated with greywater compared to hydroponic nutrient solution and tap water.

The variation on the plant height of radish crop for fresh water and grey water irrigation treatments were shown in table 1 and plate 1. The parameters measured to identify the variation between the fresh and grey water irrigated vegetative growth of the plant by measuring leaf length, leaf width, leaf height, shoot length, root length, circumference of radish and weight of the tuber. The results showed that there is an increased leaf length was observed in the fresh water irrigated crops. The leaf width, leaf height, shoot length, root length, circumference of radish and weight of the tuber was increased in grey water irrigated treated crops when compared to the fresh water irrigated crops. Even though there is no significant difference (‘t’ test; p<0.05) was observed in all the parameters.

Table 1: Measurements of plant growth

Parameters	Fresh water				Grey water			
	Mean ± SD	t value	Df	p	Mean ± SD	t value	Df	p
Leaf length	16.4 ± 3.52	48.41	106	0.000*	15.1 ± 4.84	29.49	88	0.000*
Leaf width	5.9 ± 1.27	48.83	106	0.000*	6.5 ± 2.84	21.76	88	0.000*
Leaf weight	12.5± 11.61	4.19	14	0.000*	17.1 ± 6.54	10.11	14	0.000*
Shoot length	12.4 ± 1.56	30.83	14	0.000*	13.7 ± 1.99	26.62	14	0.000*
Root length	8.4 ± 2.79	11.68	14	0.000*	9.7 ± 7.78	4.84	14	0.000*
Circum ference	8.4 ± 1.75	18.64	14	0.000*	7.6 ± 1.11	26.56	14	0.000*
Tuber weight	19.4± 12.33	6.09	14	0.000*	44.1± 14.57	11.73	14	0.000*

Quality of fresh and grey water irrigated soil:

Due to no significance difference in pH of the water treatments used in the study, there was no significant difference observed in pH throughout the soil profile (Qishlaqi et al., 2008). In worse scenarios, researchers find the opposite, where pH of soils irrigated with greywater become significantly lower that the freshwater irrigated soils due to probability of enhanced bacterial activities such as respiration (Weil-Shafran et al., 2006).

The soil pH of both the fresh and grey water irrigation showed more or less neutral pH and it showed no significant difference between the plants. Dissolved oxygen of the fresh and grey water irrigated soil showed a significant difference between the groups (‘t’ test; p>0.05). Salinity and total dissolved solid of the soil was slightly increased in the grey water irrigated soil when compared to the fresh water irrigated soil (‘t’ test; p>0.05). The increased conductivity was observed in the fresh water irrigated soil and it was found to be very low in grey water irrigated soil (‘t’ test; p>0.05).

Table 2: Physico-chemical parameters of soil:

Type of soil	Parameters	Mean ± SD	t value	Df	*P*
Fresh water irrigated	Soil pH	6.8 ± 0.24	48.67	2	0.000*
	Dissolved oxygen	0.4 ± 0.34	2.15	2	0.164*
	Salinity	0.2 ± 0.06	7.00	2	0.020*
	Total dissolved solid	0.5 ± 0.26	3.06	2	0.092*
	Conductivity	0.7 ± 0.35	3.27	2	0.082*
Grey water irrigated	Soil pH	6.8 ± 0.30	39.07	2	0.001*
	Dissolved oxygen	0.4 ± 0.21	3.56	2	0.071*
	Salinity	0.3 ± 0.06	8.00	2	0.015*
	Total dissolved solid	0.6 ± 0.30	3.53	2	0.072*
	Conductivity	0.3 ± 0.31	1.82	2	0.210*

Quality of fresh and grey water:

Greywater at pH 6.7 falls within an accepted range between 6.5 and 8.4 pH indicating the likelihood that this water is suitable for irrigation (Baunder et al., 2007). However, the elevated EC levels could increase the risk to human health, plants or soil as the observed in a range was between 40 to 200 mS/m (Rodda et al., 2011). An average of 50 m/m EC was observed when greywater was used and was recorded in the upper quartile of 70 mS/m at least once in the twenty four samples.

The presence of high acid food, for example, tomato and cooking oil, in greywater could be the cause of lower pH 6.7 (Al-Jayyousi, 2004). Tomatoes contain about 9% of citric acid, 4% of malic acid, and 2% of dicarboxylic acid (Petro-Turza, 1987 cited by Yilmaz, 2001) and cooking oil contains different kinds of fatty acids (Noureddini et al., 1992).

It is interesting to note that Ca in potable water (municipal water from a tap stand) was significantly higher and Mg was slightly higher than other water treatments in which, in combination with Na, were useful in calculating SAR (Sodium Absorption Ratio). Greywater had a significantly higher SAR value of 2.5, but according to Gross et al., (2005), this appears not to be destructive to the environment and soil properties in the long term. Although salinity in the diluted greywater was lower than that of greywater, Al-Jayyousi (2004) discovered that greywater salinity was lower than that of potable water since greywater was diluted with rainwater.

The water pH of both the fresh and grey water irrigation showed more or less neutral pH. Dissolved oxygen of the fresh and grey water showed a significant difference between the groups (‘t’ test; p>0.05). Salinity and total dissolved solid (p<0.05) was slightly higher in the grey water when compared to the fresh water (‘t’ test; p>0.05). The increased conductivity was observed in the grey water and it was found to be low in fresh water (‘t’ test; p>0.05).

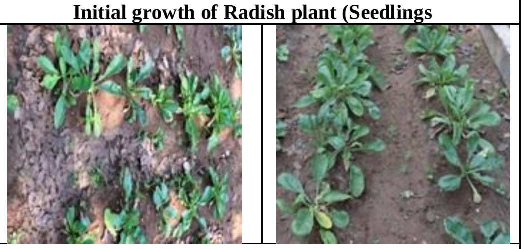
Table 3: Physico-chemical parameters of water:

Type of water	Parameters	Mean ± SD	t value	Df	*P*
Fresh water	pH	6.6 ± 0.13	85.08	2	0.000*
	Dissolved oxygen	0.4 ± 0.35	2.10	2	0.171*
	Salinity	0.3 ± 0.12	4.00	2	0.057*
	Total dissolved solid	0.4 ± 0.25	2.42	2	0.137*
	Conductivity	0.4 ± 0.38	1.94	2	0.192*
Grey water	pH	6.5 ± 0.15	75.19	2	0.000*
	Dissolved oxygen	0.5 ± 0.01	76.00	2	0.000*
	Salinity	0.3 ± 0.01	8.00	2	0.015*
	Total dissolved solid	0.6 ± 0.16	6.22	2	0.025*
	Conductivity	0.6 ± 0.46	2.12	2	0.169*

*** Significant difference at 0.05 level**

Control (Fresh water irrigated) | **Treatment (Grey waer irrigated)**

Initial growth of Radish plant (Seedlings



Final Growth of radish plant

Microbial observation:

Most water quality studies that include microbial parameters use fecal bacteria, commonly the fecal coliform group or E.Coli in particular, as indicators for the presence of pathogenic organisms in water. This is also the standard practice for surface and recreational water testing, which uses concentrations of total coliforms, fecal coliforms, and E.Coli as the basis for water quality standards. The use of indicators to measure pathogen contamination is however a source of significant debate in the field, since some scientists believe that the use of fecal coliforms or E.Coli as indicator organisms may lead to an overestimation of the pathogen count of water samples. With respect to greywater, Ottosson (2005) suggests that Coliforms and E.Coli may grow quickly in treatment and storage systems due to elevated levels of easily degraded organic compounds in greywater, thereby exaggerating the actual pathogen content. Fecal streptococci bacteria, and enterococci in particular, have been recommended as a more suitable indicator organism than coliform bacteria because they are less likely to regrow in treated water and are well correlated with rotavirus risk (Ottosson, 2005). Harwood et al. however found no significant relationship between common indicator organisms (including total and fecal coliforms, enterococci, and coliphages) and pathogenic microorganisms of concern in their 2005 study of treated and untreated wastewater samples. Similarily, Birks (2005) found no direct correlation between indicator organism (E.Coli and Enterococcus) numbers and those of true pathogens (Salmonella veltereden, Giardia, E.Coli H0157: H7 and others) in greywater samples. Ottosson and Stenström (2003) suggested that indicator organisms including fecal coliforms and enterococci could overestimate pathogen concentrations in greywater by 100-1000 fold as compared to the chemical biomarkers coprostanol and cholesterol (Sara Finley, 2008).The presence of bacterial colonies such as E.coli and coccus species were observed in the grey water and fresh water when cultured on semisolid media are also useful for identification. When inoculated to solid medium bacteria develop in to colonies of characteristic size, shape, color, elevation, and margin which aid in identification are white, creamy yellow color.

IV. CONCLUSION

The study shows that the content of sewage in irrigation water significantly increases the vegetative growth. The experimental results show that 100% grey water irrigation provides significantly higher yield of radish. It points to greywater as a potential source for food production in poor peri-urban communities with minimal resources. Furthermore reusing greywater reduces the use of potable water. Possible negative impacts include cumulative buildup of heavy metals, salinization and soil structure. These negatives factors can all be controlled through research and development of proper guidelines. Research and development of guidelines will improve and increase the use of greywater for irrigation purposes as well as public acceptance.

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REFERENCES

[1] Abdo, M.H., Sabae, S.Z., Haroon, B.M., Refaat, B.M., Mohammed,A.S., Physico-chemical characteristics, microbial assessment and antibiotic susceptibility of pathogenic bacteria of Ismailia canal water, River Nile, Egypt.Journal of American Science, 2010. 6 (5), 234–250.

[2] Al-Jayyousi, O., Greywater reuse: knowledge management for sustainability. Desalination, 2004.167:27-37.

[3] Allen, L., Juliet Christian-Smith, and Meena Palaniappan, Overview of Greywater Reuse: The Potential of Greywater Systems to Aid Sustainable Water Management. Pacific Institute, Oakland, California. 2010. p- 41.

[4] Bauder, T.A., Waskom, R.M. & Davis, J.G. Irrigation: Irrigation Water quality Criteria. Colorado State University Extension no. 2007. 0.506.

[5] Ensink, J. H. J., Simmons, R. W., and van der Hoek, W. Livelihoods from wastewater: water reuse in Faisalabad, Pakistan. In B. Jimenez, and T. Asano (Eds): International survey on water reuse, International Water Association Publishing, London, UK. 2006.

[6] Helmer, R. and Hespanho, I. Water pollution control- A Guide to the Use of Water Quality Management. Published on behalf of the United Nations Environmental Programme, the Water Supply & Sanitation Collaborative Council and the World Health Organisations

(WHO/UNEP) by E. & F. Spon © 1997 WHO/UNEP. ISBN 0 419229108.

[7] Hinrichsen, D., Robey B. and Upadhyay, U.D. Solutions for a water-short world. Baltimore, MD, Johns Hopkins University, School of Public Health, Population Information Program, September Population Reports, Series M, No. 14.1998.

[8] Howard, I., Espigares, E., Lardelli, P., Martı´n, J.L., Espigares, M., Evaluation of microbiological and physicochemical indicators for wastewater treatment. Journal of Environmental Toxicology, 2004. 19, 241–249.

[9] Noureddini, H., Teoh, B.C., & Clements, L.D.Densities of vegetable oils and fatty acids. Journal of American Oil Chemists Society, 1992.69 (12): 1184-1188.

[10] Ottosson, J.Comparative Analysis of Pathogen Occurrence in Wastewater-Management strategies for barrier function and microbial control. Royal Institute of technology (KTH)/Swedish Institute for Infectious Disease Control (SMI), Stockholm: Doctorate Thesis.2005.

[11] Ottosson, J., & Stenström, T.A. Growth and reduction of microorganisms in sediments collected from a greywater treatment system. Letters in Applied Microbiology, 2003. 36(3), 168-72.

[12] Petro-Turza, M., Flavor of tomato and tomato products. Food Reviews International Journal. 1987.2: 327-328.

[13] Qishlaqi, A., Moore, F. and Forghani, G. Impact of untreated wastewater on soils and crops in Shiraz suburban area, SW Iran.Environmental Monitoring & Assessment, 2008.141 (1-3): 257-273.

[14] Salukazana, L., Jackson, S., Rodda, N., Smith, M., Gounden, T., McLoed, N. & Buckley, C. Re-use of greywater for agricultural irrigation. Paper presented at the 3 International Conference of Ecological Sanitation, Durban, South Africa. 2005.

[15] Sara Finley, Reuse of Domestic Greywater for the Irrigation of Food Crops. Thesis submitted to McGill University. 2008. P-71.

[16] Wagner, J.J., Oliver, O.J. & Van Blommestein, J.A., The displaying of vegetables at agricultural shows. Vegetables: General 1.1., Agricultural Research Council, Roodeplaat, South Africa. 1998.

[17] WHO, Guidelines for the safe use of wastewater, exceta and grey water: Wastewater use in agriculture (Volume 2). Report of a WHO Scientific Group. WHO Technical Report Series 778. World Health Organization, Geneva, Switzerland, 2006. p 74-219.

[18] Wielshafran, A., Ronen, Z., Weisbrod, N., Adar, E., Gross, A. Potential changes in soil properties following irrigation with surfactant-rich greywater. Ecological Engineering, 2006. 26, 348-354.