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Short Communication:

IMPACT OF TREATED DOMESTIC SEWAGE IRRIGATION ON PATHOGENIC MICROBES IN SPINACH MICROBIAL COUNT IN SOIL

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The rising population has not only increased the fresh water demand but also increased the volume of wastewater generated. Increasing need for water has resulted in the emergence of domestic wastewater application for agriculture and its relative use. In the present study a field experiment was conducted during 2012-13 and 2013-14 in which spinach (*Spinacia oleracia*) were irrigated with domestic treated sewage water (DTSW) and well water (WW). The bacterial, fungal and actinomycetes population in soil after harvest of the crop were found more as compared with irrigation with well water. Post harvest pH of the soil in DTSW was in the range 7.85 whereas, it was 7.93 in WW. EC and OC were found 0.43 dS m^{-1} and 5.41 g kg^{-1} respectively in DTSW whereas, it was 0.31 dS m^{-1} and 5.27 g kg^{-1} respectively in WW. NPK were found 279.6, 17.22 and 435.70 kg ha^{-1} respectively in DTSW whereas, it was found, 266.8, 16.44 to 428.1 kg ha^{-1} respectively in WW. The findings give applicable advice to commercial farmers and agricultural researchers for proper management and use of treated domestic wastewater for agricultural purpose.

Changing scenario with the economic development of the society towards large-scale urbanization and industrialization is leading to production of huge quantities of wastewater in India. Industrial and domestic effluents are either used or disposed off on land for irrigation purposes that create both opportunities and problems. Opportunities exist as sewage effluents from municipal origin are rich in organic matter and also contain appreciable amounts of major and micronutrients (Gupta *et al.,* 1998, Brar *et al.,* 2000). Accordingly nutrient levels of soils are expected to improve considerably with continuous irrigation with sewage (Yadav *et al.,* 2002). Again sewage effluents may contain variable amounts of heavy metals, which may limit the long-term use of effluent for agricultural purposes as a likelihood of phytotoxicity and environmental effects. Water is an indispensable resource that permeates every aspect of human society affects every man, women and child. Sewage water is an untouched source of water in India and abroad and if treated through the phytorid wetland engineering technology can became a good water resource and increase water potential which can be used for agricultural irrigation and reduce the burden on the fresh water and the cost of fertilizers with sustainable protection to degradation of environmental resources.

Water is a vital resource but a severely limited in most countries. The population is growing by geometric mean and food demand is increasing with arithmetic means but water availability is constant and to feed sufficiently to people of India, increase in irrigation is the need of the day. Rapid industrial developmental activities and increasing population growth had declined the resources day to day throughout the world. Therefore, there is an urgent need to conserve and protect fresh water and to use the water of lower quality for irrigation (Al-Rashed *et al.*,2000). Rapid industrial developmental activities and increasing population growth had declined the resources day to day throughout the world. Therefore, there is an urgent need to conserve and protect fresh water and to use the water of lower quality for irrigation Al-Rashed *et al.*(2000). Treated or recycled wastewater (RWW) appears to be the only water resource that is increasing as other sources are dwindling (Anonymous, 1992).

Consequently the reuse of wastewater for agriculture is highly encouraged (Mohammad and Mazahreh, 2003). The reuse of wastewater for agricultural irrigation purposes reduces the amount of water that needs to be extracted from water resource (Gregory, 2000). It is the potential solution to reduce the freshwater demand for zero water discharge avoiding the pollution load in the receiving sources. It is the necessity of the present era to think about the existing urban wastewater disposal infrastructure, wastewater for agriculture practices, quality of water used, the health implications and the level of institutional awareness of wastewater related issued (Rutkowski *et al,*.2006).

Indiscriminate disposal of such water is a cause for pollution of air, soil and groundwater supplies (Omron *et al* ., 2011). Cost of treatment of domestic wastewater for recycling is too high to be economically unfeasible in

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developing countries like India. However, such wastewater exerting most of the nutrient load and could be used as irrigation water to certain crops, tree and plants that may lead to increase in agricultural produce and plantation. It has a potential to supply (organic) carbon nutrients nitrogen, phosphorus, potassium (NPK) and (inorganic) micro nutrients to support crop/plant growth [Weber *et al.,* 1996].

In the agriculture practices, the irrigation water quality is believed to have an effect on the soil characteristics, crops production and management of water. Application of saline /sodic water results in the reduction of crop yield and deterioration of the physico-chemical characteristics of soil (Lado and Meni Ben, 2002). Treated domestic sewage irrigation effects on soil hydraulic properties in arid and semiarid zones :A review metal contents of soils under vegetables in Harare, Zimbabwe. (Mapanda *et al.,* 2005).

. Present study deals with application of domestic treated sewage water for irrigation and its effect on soil characteristics.

Site Description

An experimental setup was made for conducting the study to investigate the effects of application of DTSW and WW on pollutant uptake of the crop and yield. Field experiments were conducted during the year 2012-13 and 2013-14 at agriculture farm, Agriculture College, Maharaj bag, Nagpur situated at 21.14^0N and 79.090^0E and an altitude of about 312 meters above mean sea level. Research work was carried out using treated sewage water generated from the Phytorid based sewage treatment plant which comprises wetland engineering technology was installed and commissioned during June-2012 on the Nag river passing through the Agriculture College Farm Maharajbag under Dr. Panjabrao Deshmukh Krishi Vidyapeeth at Nagpur (Fig.1).

The experiment was a factorial, completely randomized design with two main treatments of DTSW (T1) and WW (T2). Each treatment had ten replications. Vegetable crop spinach was grown by dibbling method and crops were irrigated with DTSW and WW @ 5 ha cm per irrigation and allowed to grow till maturity. The meteorology of the study area indicated the temperature range from 10–28.6 æ%C to 30.7–44.5 æ%C in winter and summer, respectively with annual rainfall of 1145 mm and humidity from 10 to 88%. The soil at the experimental site is having texture class of 57.43% clay, 19.25% silt, 14.90% fine sand and 8.46% coarse sand.

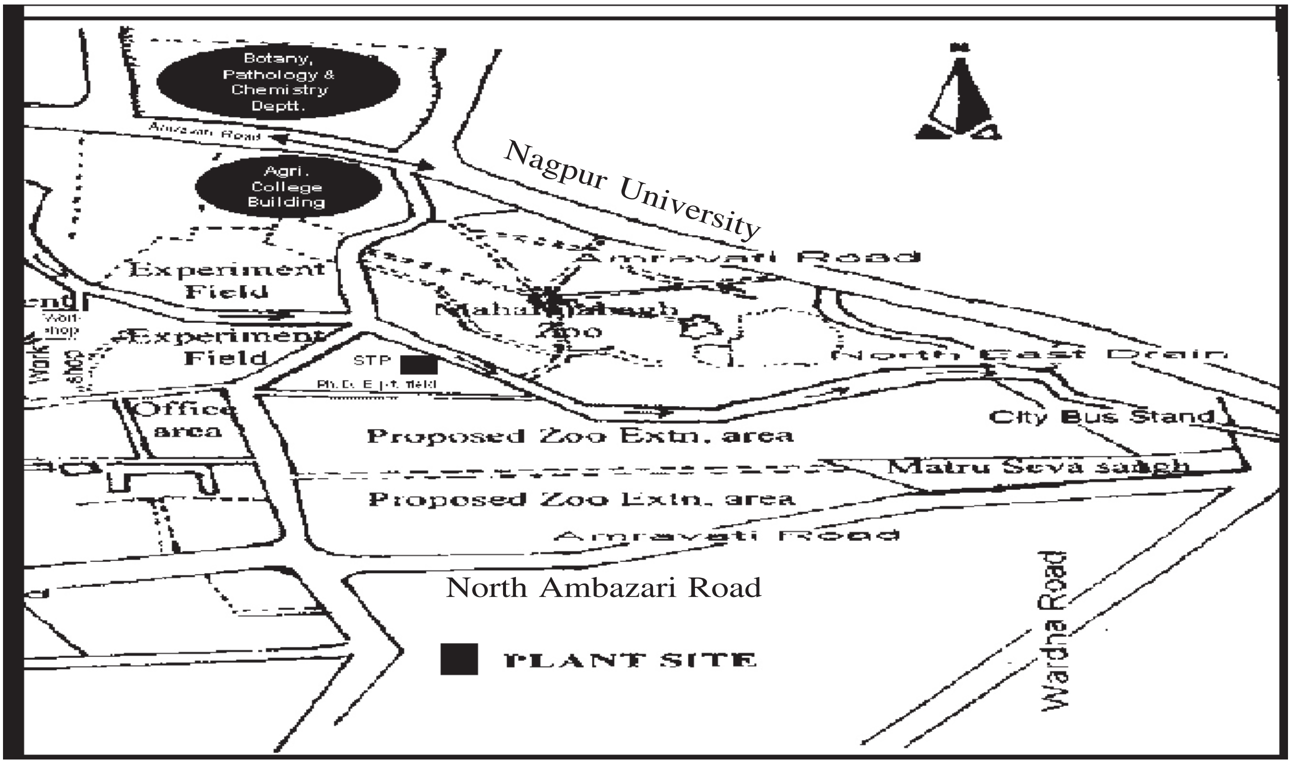

Fig.1. Location map of Nag river, phytorid sewage treatment plant and crop experimental site

Pathogenic count in DTSW

As revealed in the table 1 pathogenic counts in the two samples of the raw sewage water and two samples of DTSW are studied and as per finding the faecal colliform are more than the recommended revised microbiological guidelines for treated wastewater use in agriculture (Alikhasi *et al.*, 2012). Therefore, treated sewage water is suitable for the irrigation to the field crops except the vegetables which can be eaten raw or uncooked vegetable used in the food.

Table 1.Pathogenic count in sewage water and treated sewage water

		Parameters					
	Paramet-ers	Faecal colliform	*Salmonella* spp.	*Shigella* spp.	*Vibrio cholerae*	*Entamoeba histolytica* cyst	*Ascaris lubricoldes* egg
	Method	APHA	IS5887 (part3)	IS5887 (part 7)	IS5887 (part 5)	By Microscopy	By Microscopy
Sample No.1 (SW)	Results	$3.5x10^6$	Absent	Absent	Absent	ND	ND
	Unit	MPN100 ml^{-1}	100 ml^{-1}	100 ml^{-1}	100 ml^{-1}	lit^{-1}.	lit^{-1}
Sample No.2 (SW)	Results	$3.5x10^6$	Absent	Absent	In Absent	ND	ND
	Unit	MPN100 ml^{-1}	100 ml^{-1}	100 ml^{-1}	100 ml^{-1}	lit^{-1}	lit^{-1}
Sample No.3	Results	$5.4x10^5$	Absent	Absent	Absent	ND	ND
	Unit	MPN100 ml^{-1}	100 ml^{-1}	100 ml^{-1}	100 ml^{-1}	lit^{-1}	lit^{-1}
Sample No.4 (TSW)	Results	$5.4x10^5$	Absent	Absent	Absent	ND	ND
	Unit	MPN100 ml^{-1}	100 ml^{-1}	100 ml^{-1}	100 ml^{-1}	lit^{-1}	lit^{-1}

In raw sewage water feacal colliform was 3.5x106 MPN 100ml^{-1} while in treated sewage water 5.4x105 MPN 100ml. $^{-1}$ *Salmonella* spp., *Vibrio cholerae*, *Shigella* spp., *Entamoeba histolytica* Cyst, *Ascaris lubricoldes*

3: Microbial count in soil after harvest of spinach

The data pertaining to the microbial count viz., bacterial population, fungal population and actinomycetes population in soil after harvest of cotton are presented in table 2. The results revealed that the bacterial, fungal and actinomycetes population in soil after harvest of crop was found slightly higher in soil with irrigation of DTSW as compared to irrigation with WW (*Belligno et al*.,2001). Results of the purifying action of the constructed wetlands were not always consistent. The coli bacteria were reduced by 25 - 85%; and faecal coli bacteria by 13 - 90%.The reduction in microbial load was not sufficient to comply with the existing regulations.

Table 2.Changes in the microbial properties of the soil irrigated with DTSW and WW after harvest of the spinach

Treatments	Bacterial population (cfu x 10^6)	Fungal population (cfu x 10^4)	Actinomycetes population (cfu x 10^4)
T1-Treated water	41.00	8.89	29.67
T2-Well water	24.67	3.04	10.33
SE(m)±	0.54	0.22	1.55
CD at 5 %	1.44	0.57	4.09

4: Pathogenic Count in spinach crop irrigated with treated sewage water

As revealed in the table 3, pathogenic counts in the two samples of the spinach crop irrigated by treated sewage water are studied and as per finding the total colliform, faecal colliform and *E coli.* are in negligible quantity in spinach crop as compared with the government and industry standards for bacterial indicator organisms in selected foods and in water.

Sr. No	Name of Pathogen	Method	Unit	Result
1	Total colli forms	IS 5401Incubated at 370 C for 24 hrs	Cfu g^{-1}	Less than 10
2	Feacal Colliform	B.M.A.	MPN g^{-1}	Less than 3
3	E.Coli	IS 5887 (Part 1)	g^{-1}	Absent

(Anonymous, 2014)

If land with suitable topography, soil characteristics and drainage is available, DTSW can put good use as a source of both irrigation water and plant nutrients. The faecal colliform found more than the recommended revised microbial guideline for vegetables when irrigated with treated sewage water. Therefore, treated sewage water is suitable for the field crop except vegetables which can be eaten raw. The bacterial, fungal and actinomycetes population in soil after harvest of the crop were found more as compared with irrigation with well water. Pathogenic count in spinach was found in negligible quantity irrigated with DTSW.

REFERENCES

Alikhasi, M. M. Kouchakzadeh and E. Baniani, 2012. The effect of treated municipal wastewater Irrigation in non-agricultural soil on cotton plant. J. Agri. Sci. Tech. **14**: 1357-1364.

Al-Rashed, M.F and M.M.Sherif, 2000. "Water resources in the GCC countries: an overview", Water Res. Manag, **14** (1) : 59–73.

Al-Salem, S. S**.** 1996. "Environmental considerations for wastewater reuse in agriculture. Water Sci. Technol **33** (10–11):345–353.

Al Omron, A.M., S.E. El-Maghraby, MEA, Nadeem, A.M. El-Eter, H. Al-Mohani, 2011. Longterm effort of irrigation with the treated sewage effluent-on same soil properties of A.L. -A1-Hassa Governorate, Saudi Arbia, J. Saudi Sol. Agril, Sci., xxx, xxx-xxx.

Anonymous, 2014. Microbiological Guidelines for Food For ready-to-eat food in general and specific food items. Risk Assessment Section Centre for Food Safety, Food and Environmental Hygiene Department 43/F, Queensway Government Offices, 66 Queensway, Hong Kong.

Anonymous,1992 . U.S. Environmental Protection Agency (USEPA). U.S. EPA. Offices of water and wastewater and compliance (Ed.) Guidelines for water reuse. U.S. EPA, Washington. WA State Water Strategy.

Anonymous, 1995. APHA (American Public Health Association), Standard Methods for the examination of water and wastewater. American Public Health Association, Washington, DC.

Belligno, A., A. Hamdy and V. Sardo, 2001. Using urban wastewaters purified in constructed wetlands for irrigation and aquifer recharge (2001): ICID International Workshop on Wastewater Reuse Management19, 20 September 2001, Seoul, and Rep. Korea at http://www.nwl.ac.uk/research/ cairoworkshop /papers /WASTEWATER/ws2_6.PDF.

Brar, M. S., S.S. Mahli, A. P. Singh, C. L. Arora and K.S.Gill, 2000. Sewer water irrigation effects on some potentially toxic trace elements in soil and potato plants in north western India. Can J. Soil Sci. **80**: 465–71.

Gregory, A**.** 2000. "Strategic direction of water recycling in Sydney", Proceeding Of the First Symposium Water Recycling, Australia Adelaide, **19–20**: 35–41.

Gupta, A. P., R. P. Narwal and R. S. Antil,1998.Sewer water composition and its effect on soil properties. Bio-resource Ethnology **65**: 171-173.

Lado, M. and Meni Ben-Hur,2002. Treated domestic sewage irrigation effects on soil hydraulic properties in arid and semiarid zones: A review metal contents of soils under vegetables in Harare, Zimbabwe. Agric, Ecosy. and Environ. **107**:151–165.

Mapanda, F., E.N. Mangwayana, J. Nyamangara and K.Giller,2005. The Effects of Long-Term Irrigation Using Water on Heavy Metal Contents of Soils under Vegetables. Agric. Ecosy. and Environ. **107:**151-165.

Mohammad, M.J. and N. Mazahreh**,** 2003. "Changes in soil fertility parameters in response to irrigation of forage crops with secondary treated wastewater", Comm. Soil Sci. Plant Anal, **34** (9 &10) :1281–1294.

Rutkowski, T L., S. Raschid-Sally and Buechler, 2006. Wastewater irrigation in the developing world – Two case studies from the Kathmandu Valley in Nepal", Agric Water Manage. **88**:83–91.

Weber, B., Y. Avnimelech and M. Juanico, 1996. Salt enrichment of municipal sewage new prevention approaches in Israel. Environ. Manag. **20** **(4)** : 487–495.

Yadav, R. K., B. Goyal, R. K. Sharma, S. K. Dubey and P. S. Minhas**.,** 2002. Post-irrigation impact of domestic sewage effluent on composition of soils, crops and ground water- A case study. Environment International. **28(6):** 481-486.

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