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Impact of Domestic Treated Sewage Water on Agricultural Soil

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Abstract : *Treated Sewage effluent is rich source of nutrient for agricultural land and is a potential irrigant and therefore it is gaining importance in agriculture. Application of wastewaters to agricultural land may promote the growth of crops and conserve water and nutrients. But careless and long term use of the sewage effluents for irrigation of agricultural crops may cause soil and groundwater pollution problems. The present research study comprised the analysis of treated sewage effluent from Nag river, flowing through Nagpur city. Its impact on alteration of Physical, chemical, micronutrients and heavy metals of agricultural soil by conducting a field experiment by irrigating Spinach (*Spinacia oleracea*) and Fenugreek (*Trigonella foenum-graecum*) with freshwater and treated sewage effluent. Electrical conductivity (EC), Organic carbon Content, Nitrogen (N), Phosphorous (P), Potassium (K) of soil was slightly increased after crop harvesting as compared to fresh water irrigation whereas bulk density, hydraulic conductivity was found to be reduced. Not much difference was found in the micronutrients content of soil irrigated with treated water and fresh water. Accumulation of the heavy metals in soil irrigated with treated effluent was below the safe limits. Treated sewage effluent irrigation can be a good substitute for freshwater irrigation and potential source of plant nutrients.*

Keywords: *Treated Sewage effluent, Soil Parameters (EC,N,P,K), Micronutrients, Heavy metals*

I. INTRODUCTION

It is well known fact that large Gap exists between demand and supply of fresh water. Moreover, economic development of society increases urbanization and industrialization resulting in huge effluent production. In a city of one million people, the waste water generated would be sufficient to irrigate approximately 1500-3500 ha. area (SIDA,2000). Due to this situation the urban communities are facing water scarcity in the cities which is overburdening the irrigation resources and minimizing the available irrigation area(Choukr-Allah et al.,2001).To address this problem to some extent the idea is to use city sewage effluent and runoff water for agricultural irrigation after giving the proper chemical,biological and physical eco-friendly treatments

(Jamwal and Mittal, 2010). Since natural water resources are limited and a large gap exists between available water supply and the amount required for intensive cropping, appropriate use of wastewater of domestic origin can help in meeting a part of the increased demand of water (Herpin et al., 2007). Treated sewage effluent can be used for irrigation in peri-urban areas for crop production. The challenge is to utilize the physical, chemical, and biological properties of soils as an acceptor with minimum adverse effects on crops to be grown, soil characteristics and ground and surface water quality (Gupta et al., 1998). Innovative and appropriate technologies can contribute to urban wastewater treatment and its reuse (Mourad, 2011). Based on extensive successful experience in Canada and elsewhere on cost effective and environmentally sound practices of sludge application on agricultural land, there is tremendous potential for the safe disposal of sewage sludge on agricultural land (Looker, 1998).

The preliminary survey suggested that the effluent discharged into the drain is treated or untreated. The Nag river is tapped at different locations and pumped through electric motors for irrigation purpose by the farmers who are having the land adjacent the Nag river. Agricultural crops like wheat, rice, vegetables are being irrigated with city sewage effluent by flooding the land, without judging the loading rate or actual requirements. Although majority of the farmers expressed profitability of the use of the effluent for irrigation, some of the respondents reported that the yields are decreasing since last few years while weeds and pest's infestation became severe for some specific crops and vegetables. The farm produce from these areas are sold in Nagpur, which are either consumed by human beings or animals.If the practice of effluent irrigation continues for longer period, without knowing pollutant load, this may lead to chemical degradation of lands and possible entry of pollutants / toxicants in the food chain. Thus, an attempt is made to study the "Impact Of Domestic Treated Sewage Water on Agricultural Soil"

II. MATERIAL AND METHODS

A. Location of field Experiment site

Field experiment was carried out for one year at PG research farm, near Maharajbagh, Nagpur. Sewage effluent from Nag River, Nagpur city to study the "Impact Of Domestic Treated Sewage Water on Agricultural Soil" was treated using Phytorid based sewage treatment plant which comprises wetland engineering technology and this treated sewage was used for irrigating two crops namely Spinach (*Spinacia oleracea*) and Fenugreek (*Trigonella foenum-graecum*).



Fig 1 :- Location of experimental site

B. Sampling of Water and Analysis

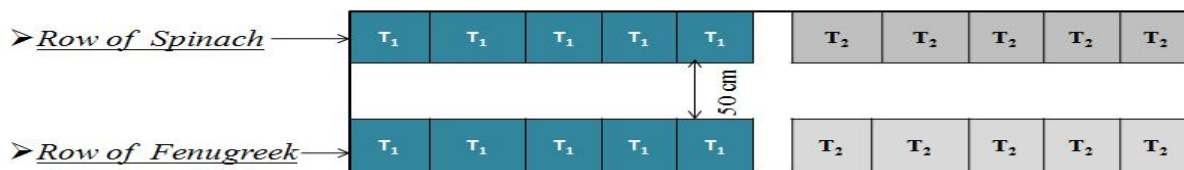
Sewage effluent from Nag River Nagpur is treated by using Nag Nalla Sewage Treatment Plant using Phytorid technology. This Treated water and Water supplied from NMC was collected and analysed for different parameters

C. Soil sample collection and Analysis

Field experiment was carried out at PG research farm, near Maharajbagh, Nagpur to investigate waste water irrigation impact on soil. Soil sample from was collected from site and investigated for different soil micronutrients Zn, Fe, Cu, Mn 4 heavy metals Co, Cd, Cr and Pb and physio-chemical properties (N, P, K, pH, Electrical Conductivity (EC), Organic carbon, Bulk density, Hydraulic conductivity). Total 10 Soil sample at different depth (0-20 cm) was collected from experimental site before seed sowing and after harvesting of crops. Collected soil sample were air dried, crushed, passed through 2 mm sieve and stored in plastic bottles for a analysis

D. Methods

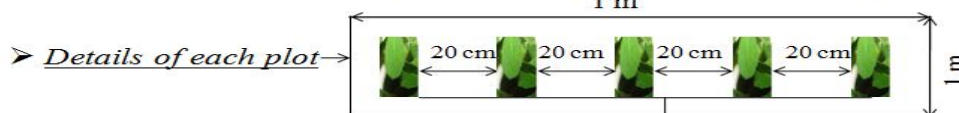
Preparation of Experimental site is done by random statistical design. Site is divided into 20 blocks of 1m X 1 m each. Out of 20 blocks spinach is cultivated in 10 blocks and Fenugreek in another 10. Out of this 10 blocks of each crop 5 blocks is applied with fresh water and 5 with treated water is simultaneously



Where,

T₁ :Irrigation to be done with fresh water

T₂ :Irrigation to be done with treated sewage water



5 Rows of Crops @ 20 cm of Spacing

Following tests were performed to find out the different soil parameters :-

SR. NO.	PARAMETER	NAME OF METHOD	REFERENCE
1	Bulk density	Core method	Black (1966)
2	Saturated hydraulic conductivity	Constant water head method	Kult and Dricksen (1986)
3	pH	Potentiometric method	Jackson (1973)
4	Electrical conductivity(EC)	ELICO conductivity bridge	Jackson (1967)
5	Organic carbon	Walkley and Black rapid titration procedure	Jackson(1967)
6	Nitrogen (N)	Alkaline permanganate method	Subbiah and Asija (1956)
7	Phosphorus (P)	The soil was extracted with Olsen's reagent 0.5m NaHCO ₃ of pH 8.5 and in the extract, available P was estimated calorimetrically.	Jackson (1967)
8	Potassium (K)	Flame photometer method using neutral ammonium acetate as extractant	Jackson (1967)
9	Micronutrients and heavy metals.	DTPA extraction and determination using Atomic Absorption Spectrophotometer	Page(1982)

II. RESULTS AND DISCUSSION

A. Analysis of Water Sample

Sewage effluent from Nag River Nagpur is treated by using Nag Nalla Sewage Treatment Plant using Phytorid technology. This Treated water and Water supplied from NMC was collected and analysed for different parameters.

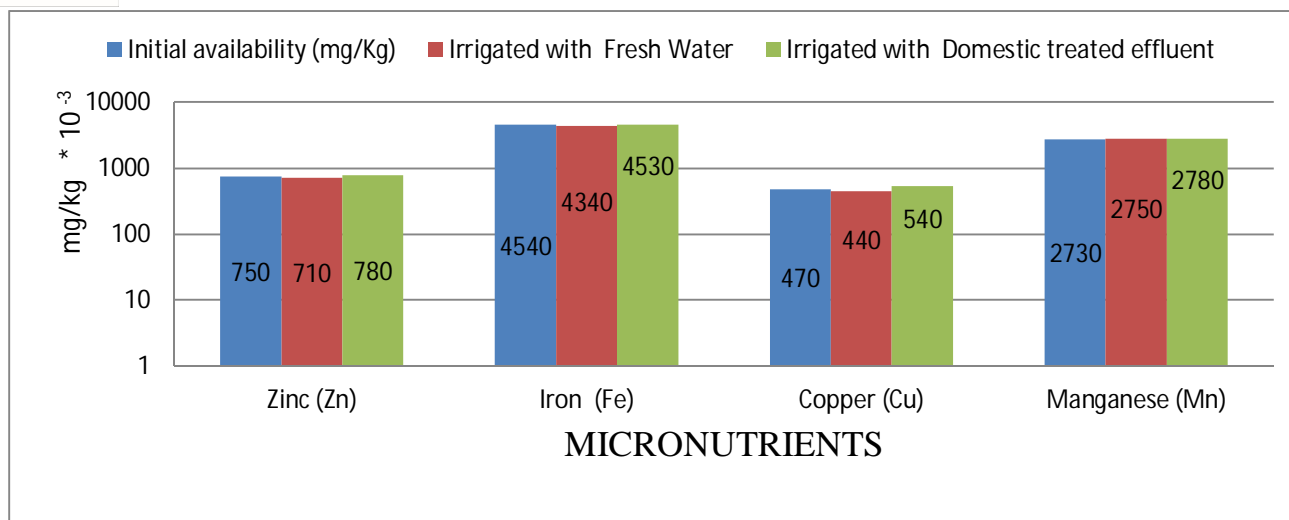
Sr . No.	Parameters	Domestic treated effluent	Fresh water	Permissible Limits (As per FAO)
1	PH	7.1±0.12	7.5±0.76	6.5-8.4
2	EC (dS/m)	0.644±0.18	0.441±0.017	0 - 3
3	SAR	0.702±0.098	0.658±0.056	<3

4	Carbonates (mg/l)	0.619 \pm 0.068	0.321 \pm 0.013	0-3
5	Bicarbonates (mg/l)	4.076 \pm 0.23	3.403 \pm 0.036	610
6	Chlorides (mg/l)	3.938 \pm 0.98	1.584 \pm 0.84	1050
7	Calcium (mg/l)	4.408 \pm 0.096	2.868 \pm 0.09	400
8	Magnesium (mg/l)	1.519 \pm 0.32	0.770 \pm 0.09	60
9	Sodium (mg/l)	1.166 \pm 0.022	0.856 \pm 0.014	920
10	BOD (mg/l)	4.429 \pm 0.32	1.733 \pm 0.084	100
11	COD (mg/l)	16.05 \pm 0.54	6.185 \pm 0.074	250
12	TDS (mg/l)	426.93 \pm 0.67	297.46 \pm 0.85	2000
13	Nitrogen (mg/l)	3.959 \pm 0.24	1.177 \pm 0.098	5
14	Phosphate(mg/l)	1.381 \pm 0.81	0.267 \pm 0.087	2
15	Potassium (mg/l)	0.327 \pm 0.07	0.226 \pm 0.016	2

B. Analysis of Soil Sample

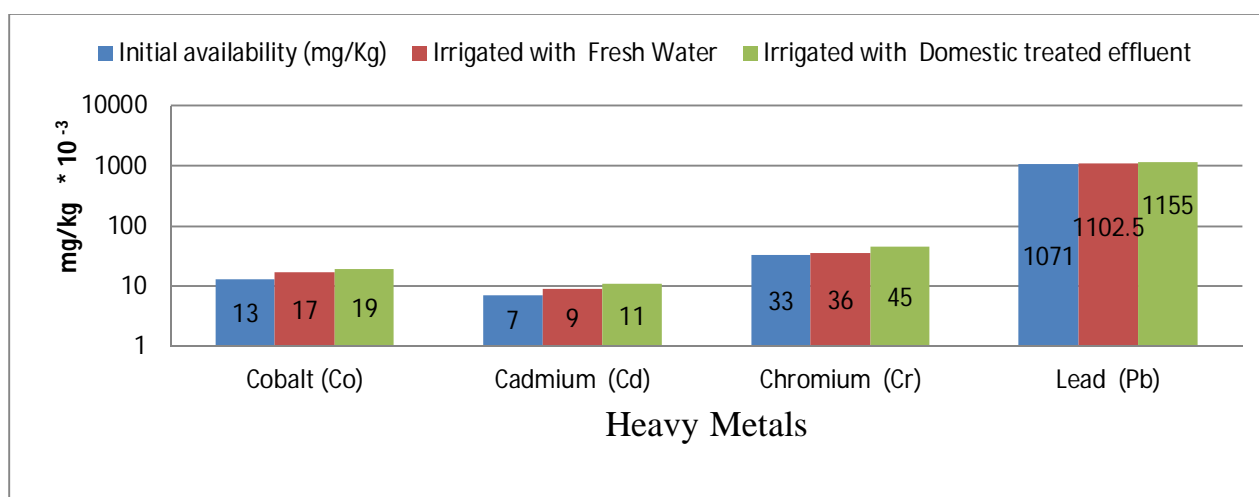
1) Extractable micronutrient status of soil irrigated with fresh water and domestic treated effluent after crop harvesting:

Sr. No.	Micronutrients	Initial availability (mg/Kg)	Irrigated with Fresh Water	Irrigated with Domestic treated effluent	Permissible Limit
1	Zinc (Zn)	0.75	0.71	0.78	2
2	Iron (Fe)	4.54	4.34	4.53	10
3	Copper (Cu)	0.47	0.44	0.54	5
4	Manganese (Mn)	2.73	2.75	2.78	5



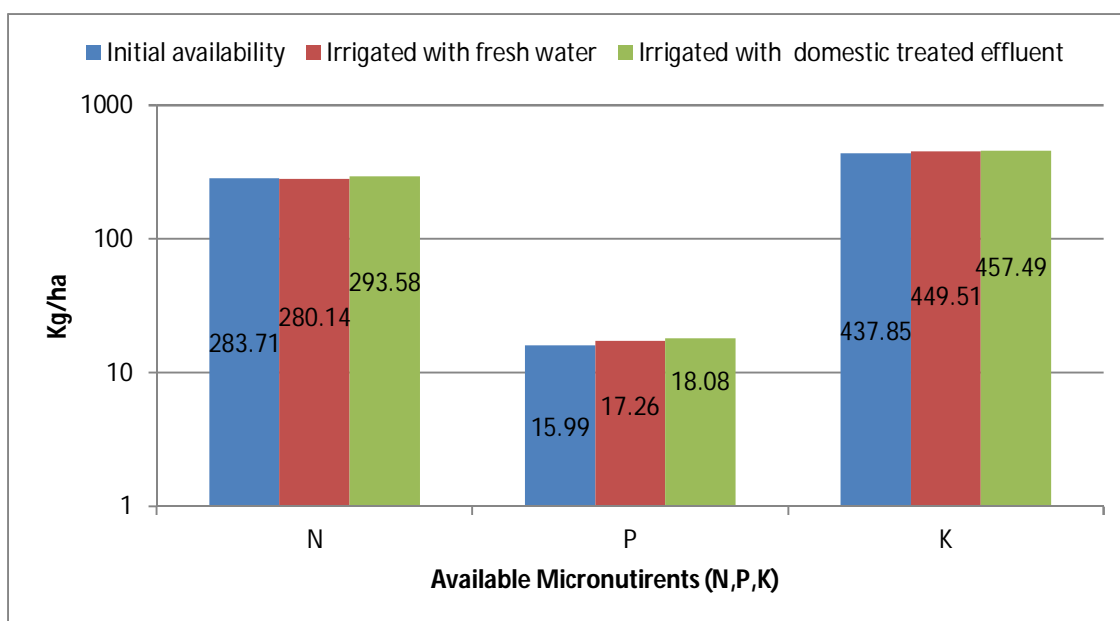
2) Extractable Heavy Metals status of soil irrigated with fresh water and domestic treated effluent after crop harvesting.

Sr. No.	Heavy Metals	Initial availability (mg/Kg)	Irrigated with fresh Water	Irrigated with domestic treated effluent	Permissible Limit
1	Cobalt (Co)	0.013	0.017	0.019	2
2	Cadmium (Cd)	0.007	0.009	0.011	0.500
3	Chromium (Cr)	0.033	0.036	0.045	1.0
4	Lead (Pb)	1.071	1.1025	1.155	5.00



3) Changes in the Physico-Chemical properties of soil irrigated with fresh water and domestic treated effluent after harvesting of the crops.

Sr. No.	Physico-Chemical property		Initial availability	Irrigated with fresh water	Irrigated with domestic treated effluent
1	pH		7.91	7.93	7.85
2	Electrical conductivity (EC) (ds/m)		0.34	0.33	0.45
3	Organic carbon (g/kg)		5.47	5.53	5.68
4	Bulk density (mg/m^3)		1.42	1.49	1.39
5	Hydraulic conductivity(cm /hr)		1.59	1.62	1.58
6	Available micronutrients (kg/ ha)	N	283.71	280.14	293.58
		P	15.99	17.26	18.08
		K	437.85	449.51	457.49



IV. CONCLUSION

It was observed that percentage of organic matter, micronutrients was within safe limits. The concentrations of micronutrients (Zn, Fe, Cu, and Mn) and heavy metals like Co, Cd, Cr and Pb in spinach, Fenugreek and soil irrigated with treated waste water was below the critical limits prescribed for the phytotoxicity of these metals. Electrical conductivity (EC), Organic carbon Content, Nitrogen (N), Phosphorous (P), Potassium (K) of soil was slightly increased after crop harvesting as compared to fresh water



irrigation whereas bulk density, hydraulic conductivity was found to be reduced. Not much difference was found in the micronutrients content of soil irrigated with treated water and fresh water. Accumulation of the heavy metals in soil irrigated with treated effluent was below the safe limits. Treated sewage effluent irrigation can be a good substitute for freshwater irrigation and potential source of plant nutrients. If managed properly it can encounter the problem of water scarcity and fertilizers. Findings indicate that waste water treated by giving tertiary treatment using phytoid treatment plant can be used for irrigation.

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