J. Soils and Crops 27 (1) 253-257, June 2017 ISSN 0971-2836

IMPACT OF TREATED SEWAGE IRRIGATION ON VEGETABLE AND SOIL PROPERIES: A CASE STUDY IN CENTRAL VIDARBHA ZONE

H.R.Mundafale[1], R.M.Ghodpage[2], A.R.Mhaske[3], S.S.Balpande[4] and W.P.Badole[5]

ABSTRACT

Field experiment was conducted during *rabi* season of 2012-13 at Horticulture Farm, College of Agriculture, Nagpur to study the response of treated sewage effluent on soil properties and vegetable. DTPA extractable micronutrients status of Zn and Fe in soil was increased under irrigated with treated sewage water by 1.19 and 1.09 times than soil irrigated with well water, respectively. Mn showed depleted by 0.96 times than the soil irrigated with well water. Interaction effect between treated sewage effluent and cabbage reported higher DTPA extractable ions of Ni due to more intake of substances by soil through quantum of irrigations. DTPA extractable Fe in soil resulted slightly increased with combination of treated effluents and crop of radish over other crops. Content of Ni and Pb resulted more than the Co and Cd in soil as influenced by treated sewage water. Available N and P in soil with treated sewage water resulted slightly increased over soil irrigated with well water. Yield of radish resulted an increase by 8.38% with the use of treated sewage water. From this study, it is inferred that use of treated sewage water with physical, chemical and biological processes enhanced nutrient status of soil and proved the best to reduce the accumulation of heavy metals to some extent. However, there was an increase in concentration of micronutrients with more number of irrigations using sewage effluent. Application of sewage water increased the yield of r*abi* vegetable crops as compared to irrigation with well water.

(Key words: Sewage effluent, micronutrients, heavy metals, vegetable crops)

INTRODUCTION

In India, large quantity of sewage water is generated every year. Whenever, good quality water is not available marginal quality water can be consider for agriculture use. The raw sewage water gets entry into the agricultural fields and may affect the soil, plants and human health, depending upon its composition. Irrigation with waste water is commonly practiced for its instant economic benefit and fulfils the ever increasing food demand, but it may lead to adverse impact on soil qualities and crop growth with potential impact on the human and animal health through food cycle.

Use of wastewater in agriculture could be an important consideration nutrients contained in sewage to grow crops. Nitrogen and phosphorus content of sewage might reduce or eliminate the, requirements for commercial fertilizers.Wastewater also contains a variety of inorganic substances from domestic and industrial sources, including a number of potentially toxic elements such as arsenic, cadmium, chromium, copper, lead, mercury, zinc, etc. Impact of long term use of poor quality water, soil health, ground water pollution and food chain contamination is governed by water quality and site specific soil, climate and crop condition (Minhas and Gupta,1992). Sewage water is being applied directly and indiscriminately without any remedial treatment for instant economic benefits. The importance must be given to the removal of solid matter and toxic metals contents from sewage water. This may be possible through phytorids technique in sewage water. The suitability of this treated sewage for the irrigation to black soils and growth of *rabi* vegetable crops is presently meager studied therefore, the investigation was undertaken to study the effect of treated sewage effluent on soil properties and *rabi* vegetable crops**.**

MATERIALS AND METHODS

The field investigation in relation to "Effect of treated sewage effluent on soil properties and vegetable crops" was conducted during *rabi* season of 2012-13 at Horticulture Farm, College of Agriculture, Nagpur. The field experiment was laid out in factorial randomized block design

1 P.G. Student, SSAC Section, College of Agriculture, Nagpur
2 & 4. Asstt. Professors, SSAC Section, College of Agriculture, Nagpur
3. Assoc. Professor, Agril. Engineering, College of Agriculture, Nagpur
5. Assoc. Professor, SSAC Section, College of Agriculture, Nagpur

with two sources of irrigation water and four *rabi* crops. Soil under the experimental area was medium depth with clay in texture and well drained. The composite soil samples were analyzed for various soil properties in order to assess the initial fertility status of soil. The results of chemical analysis indicated that the soil was highly neutral in reaction with medium in organic carbon-4.60 g kg^{-1} and available nitrogen-201.68 kg ha^{-1}, phosphorus-15.23 kg ha^{-1} and moderately high in available potassium-242.20 kg ha^{-1}.Soil pH was 7.51 and electrical conductivity recorded 0.24 dS m^{-1}. Micronutrients status and heavy metals (Cd, Ni, Pb and Co) in the diacid extract was determined by atomic absorption spectrophotometer (AAS) as described by Page *et al.*(1982).Plant samples were processed and analysed for nutrients status by standard analytical techniques by Piper(1966).

Phytorid sewage treatment plant

Nag nalla is passing from the college farm where the continuous sewage water is flowing. For utilization of sewage water for irrigation to agricultural crops the sewage treatment plant based on wetland Engineering Technolgy was constructed .This is wetland technology in which the treatment of sewage is done by physical, chemical and biological process.

The treatment plant of 100 M^3 day^{-1} capacities was designed in which inlet tank 50 m^3 capacity was provided .The design has hexagonal type in which the sewage was passed through various phytorid beds and finally collected at the outlet tank. The treatment operation takes place due to gravity.The phytorid beds was about 200 M^3 filled by gravel filter media in which the aquatic plants which are helpful in dissolving oxygen in the water and also the lifter of heavy metals has been grown for obtaining the treated water.

The plant species like Kena, Pothas, Typha and Bamboo were grown and established over the filter media. The sewage from the nalla was lifted in the inlet tank and the water from the outlet tank after 24 hours is used for irrigation. The treated water has no smell, no dirty colour, reduce pH and five times less BOD and COD. The total soluble salts as indicated from the EC value is also under permissible limit, i.e 1 dS m^{-1}. It was safe for the irrigation to the plants. Also, the suitability of this treated sewage for the irrigation to black soils and growth of vegetable crops.

RESULTS AND DISCUSSION

Accumulation of heavy metals in soil due to treated and well water

The data pertaining to accumulation of heavy metals content in soil are presented in table 1. The results revealed that the effect of DTPA extractable ions of Cd and Ni with crops was found significant.The highest value of Ni 1.41 mg kg^{-1} was obtained under treated sewage water to cabbage due to intake of substances by soil through quantum of irrigations applied, whereas, lowest value of Ni (1.21 mg kg^{-1}) was obtained with the use of well water under radish crop. The mean values of Ni and Pb content in the soil recorded more than the Co and Cd as influenced by treated sewage and well water. The value of Cd ions varied between 0.014 - 0.025 mg kg^{-1} among the irrigation with treated sewage and well water.

The interaction effect between treated sewage effluent and crops with respect to concentration of Ni represent significant. Whereas, interaction effect with the use of treated sewage effluent and crops for Pb, Cd and Co ions were found non-significant. Significantly higher value of Ni was observed with the combination of treated sewage effluent and cabbage, however, not much variation was observed of Ni content in soil with interaction of treated sewage and other crops. The concentration of heavy metals was well below the reported values of Sen *et al.*(1997) in Nag river ecosystem. Patil *et al.* (2004) observed DTPA extractable ions of Ni 0.124 ppm, Cd 0.042 ppm, Pb 0.26 ppm and Co 0.062 ppm under sewage water treated soil during the month of August.

Accumulation of micronutrients due to treated and well water

The DTPA extractable micronutrient status of Zn in soil (Table 2) found significant with respect to irrigation sources and crops. The mean value of Zn status irrigated with treated sewage water was 1.19 times higher than soil irrigated with well water. Significantly the highest content of Zn (0.63 mg kg^{-1}) was recorded under aster irrigated with treated sewage water followed by radish (0.60 mg kg^{-1}), cabbage (0.48 mg kg^{-1}) and spinach (0.55 mg kg^{-1}) due to application of more number of irrigation of sewage water applied to aster and radish and hence increased the content due to absorption or intake of substance by soil resource. Chinchmalatpure *et al.* (2014) reviewed that the effluent irrigated soil had higher DTPA extractable zinc (0.56 mg kg^{-1}) than BAW (best available water) treatment (0.34 mg kg^{-1}) in surface horizon of soil.

Value of DTPA extractable Fe in treated sewage water irrigated soil was 1.09 times higher than well water irrigated soil. The highest extractable Fe status of soil (7.60 mg kg^{-1}) was recorded under treated sewage water irrigated soil. The higher content extractable metal indicated low mobility of metal in the soil irrigated with treated sewage water showed higher concentration of Fe in soil, possible making clay metal– organic matter complex reported by Saraswat *et al.* (2005). Kharche *et al.* (2011) observed that the mean value of DTPA extractable zinc in 0-30 cm layer in sewage irrigated soil was 1.42 times higher than the well irrigated soil. Also they reported iron content of 11.47 mg kg^{-1} with sewage irrigated water and 7.37 mg kg^{-1} with well water. The DTPA extractable manganese content was found higher in well water (3.80 mg kg^{-1}) as compared to treated sewage water (3.67 mg kg^{-1}) which was decreased by 0.96 times. However, this probably can explain the reason for depletion of Mn in treated sewage irrigated soil may be due to leaching.

Table 1. Effect of treated sewage and well water on accumulation of heavy metal content in soils

Crops/Irrigation source	Heavy metals (mg kg^{-1}) Cd			Ni			Pb			Co		
	I_1	I_2	Mean	I_1	I_2	Mean	I_1	I_2	Mean	I_1	I_2	Mean
Spinach	0.021	0.014	0.017	1.28	1.23	1.25	1.12	1.10	1.11	0.013	0.014	0.013
Radish	0.021	0.017	0.019	1.33	1.21	1.27	1.16	1.14	1.15	0.010	0.012	0.011
Cabbage	0.022	0.025	0.023	1.41	1.27	1.34	1.16	1.14	1.15	0.015	0.013	0.014
Aster	0.020	0.015	0.017	1.33	1.30	1.31	1.21	1.31	1.26	0.012	0.016	0.014
Mean	0.021	0.017		1.33	1.25		1.18	1.14		0.012	0.014	
	Crops		Irrigation source	Crops		Irrigation source	Crops		Irrigation source	Crops		Irrigation source
SE (m)±	0.0015		0.0011	0.0011		0.008	0.047		0.033	0.0009		0.0006
CD at 5%	0.0044		--	0.0323		0.0236	--		--	--		--
	Interaction			Interaction			Interaction			Interaction		
SE (m)±	0.0022			0.016			0.066			0.0012		
CD at 5%	--			0.047			--			--		

Table 2. Effect of treated sewage and well water on DTPA extractable micronutrients status of soil after harvest of *rabi* vegetable crops

Crops/Irrigation source	DTPA-Micronutrients (mg kg^{-1}) Zn			Fe			Mn			Cu		
	I_1	I_2	Mean	I_1	I_2	Mean	I_1	I_2	Mean	I_1	I_2	Mean
Spinach	0.55	0.54	0.54	6.80	6.52	6.16	4.55	4.07	4.31	0.36	0.16	0.26
Radish	0.60	0.51	0.56	7.60	5.71	6.65	3.12	3.25	3.18	0.37	0.28	0.32
Cabbage	0.48	0.45	0.46	6.13	6.27	6.20	4.13	5.13	4.63	0.45	0.21	0.33
Aster	0.63	0.43	0.53	6.54	6.32	5.73	2.86	2.75	2.80	0.43	0.25	0.34
Mean	0.56	0.48	--	6.77	6.20	--	3.67	3.80	--	0.40	0.22	--
	Crops		Irrigation source	Crops		Irrigation source	Crops		Irrigation source	Crops		Irrigation source
SE (m)±	0.026		0.018	0.14		0.10	0.39		0.28	0.019		0.013
CD at 5%	--		0.0529	--		0.294	1.15		--	0.0567		0.0389
	Interaction			Interaction			Interaction			Interaction		
SE (m)±	0.037			0.20			0.56			0.027		
CD at 5%	--			0.591			--			--		

Table 3. Effect of treated sewage and well water on fertility status of soil after harvest of *rabi* vegetable crops

Crops/Irrigation source	Soil fertility status (kg ha^{-1}) Available N			Available P			Available K		
	I_1	I_2	Mean	I_1	I_2	Mean	I_1	I_2	Mean
Spinach	231.01	201.74	216.37	19.20	17.52	18.36	229.93	199.53	214.73
Radish	231.35	205.93	218.64	16.73	15.34	16.03	242.93	244.87	243.90
Cabbage	222.17	178.75	200.46	16.65	15.23	15.94	262.66	230.66	246.66
Aster	246.06	204.04	225.05	18.65	17.32	17.98	265.73	248.66	257.19
Mean	232.64	197.61		17.80	16.35		250.31	230.93	
	Crops	Irrigation source		Crops	Irrigation source		Crops	Irrigation source	
SE (m)±	13.98	9.88		0.67	0.47		9.37	6.62	
CD at 5%	--	29.90		2.00	1.41		28.10	--	
	Interaction			Interaction			Interaction		
SE (m)±	19.77			0.94			13.25		
CD at 5%	--			--			--		

Table 4. Yield of *rabi* vegetable crops as influenced by treated sewage and well water

Crops/Irrigation source	Yield (q ha^{-1}) I_1	I_2	Mean
Spinach	88.09	82.33	85.21
Radish	110.95	102.37	106.66
Cabbage	150.80	142.26	146.53
Aster	31.72	30.22	30.97
Mean	95.39	89.04	--

The interaction effect between treated sewage irrigations and crops with DTPA extractable Fe status of soil found significant. Higher value of Fe in soil was observed with the combination of treated sewage effluent and radish followed by cabbage, aster and spinach. Ramappa Jakanur *et al.* (2015) reported depth wise distribution of manganese content (4.30 to 8.24 mg kg^{-1}) with unpolluted soil. The mean value of DTPA extractable copper under soil irrigated with treated water recorded 1.82 times higher than soil irrigated with well water. The critical limit of Cu for treated sewage water crossed the critical limit (>0.20 mg kg^{-1}) and for well water it was below critical limit (<0.20 mg kg^{-1}) as reported by Lindsay *et al.*(1978).Metal concentration in soil extracts were increased in urban waste treated soils as compared to control as reported by Rao and Devi (2008).

Treated sewage and well water on soil fertility status

The data of soil fertility status are presented in table 3.The highest available N content of soil (246.06 kg ha^{-1}) was found with the application of treated sewage water for Aster followed by Radish (231.35 kg ha^{-1}).The available nitrogen content in soil irrigated with treated sewage water for different *rabi* vegetable crops resulted in an increase between 12.54 to 24.29 per cent over soil irrigated with well water. The possible reason might be that treated sewage water has organic load which may enhanced the availability of nutrient. Interaction effect between treated sewage effluent and crops was found non significant with respect to the available nitrogen, phosphorus and potassium content of soil. Bhanu Prakash *et al.(*2010) observed available N between 289-309, 80-98 and 603-613 kg ha^{-1} in surface and sub-surface polluted soil irrigated with sewage and industrial effluents of average, minimum and maximum sites, respectively. Kharche *et al.* (2011) recorded the available N status of 290 kg ha^{-1} and 169.3 kg ha^{-1} with sewage and well irrigated soil, respectively. Highest available P content of soil was 19.20 kg ha^{-1} with the application of treated sewage water for spinach. The available phosphorus content in soil irrigated with treated sewage water for different *rabi* vegetable crops was found between 7.67 to 9.58% over soil irrigated with well water. Whereas, the soil irrigated with treated sewage water irrigation increased by 8.96% in available K content.

Crop yield

The yield data are presented in table 4 indicates that significantly higher yield was obtained due to application of treated sewage water over well water irrigation. Higher yield of spinach (88.09 q ha^{-1}) was obtained under treated sewage water, whereas, the well water irrigation was recorded 82.33 q ha^{-1} yield. The use of sewage water has specially influenced the yield of vegetables might be due to availability of macro and micronutrients with quantum of irrigations. Tiwari *et al.* (1996) reported that yield of rice increased significantly irrigated with treated sewage water and application of fertilizer levels. The yield of radish was increased by 8.38% with the application of treated sewage water over without treated sewage water (well water).Whereas, the yield of spinach, cabbage and aster increased by 7.00, 6.00 and 5.00 per cent, respectively with the application of treated sewage water over without treated sewage water (well water). Mean of cabbage yield was recorded 146.53 q ha^{-1}.The mean of aster yield was recorded 30.97 q ha^{-1}.

From the present investigation, it is inferred that use of treated sewage water with physical, chemical and biological processes enhanced plant nutrient status of soil and proved the best to reduce the accumulation of heavy metals to some extent. However, there was an increase in concentration of micronutrients with more number of irrigations using sewage effluent. Application of sewage water increased the yield of r*abi* vegetable crops as compared to irrigation with well water.

REFERENCES

Bhanu Prakash, U.H.,V.R.Ramakrishna Parama, Rashmi and Atifa Munavere, 2010. Heavy metal contamination in the soils of peri urban Bangalore irrigated with sewage and industrial effluents. J. Soils and Crops. **20**(1):10-15.

Chinchmalatpure, A. R., G. Gururaja Rao, Sanjay Arora, M.K. Khandelwal and D.K. Sharma, 2014. Impact assessment of Aniline plant treated effluent irrigation in Vertisols surrounding Bharuch. J. Indian Soc. Soil Sci. **62**(2):168-173.

Kharche, V. K., V. N. Desai and A. L Pharande, 2011. Effect of sewage irrigation on soil properties, Essential Nutrient and pollutant element status of soil and plants in a vegetable growing area around Ahemednagar city in Maharashtra. J. Indian Soc. of Soil Sci. .**59** (2) : 177-184.

Minhas, P.S. and R.K. Gupta, 1992.Quality of Irrigation Sewege Water Assessment and Management, Publ. Sec. ICAR, New Delhi, pp. 123 .

Page, A. L., R. H. Miller and D. R. Kenny, 1982. Methods of soil analysis, Part 1 and 2 Am.Soc.Agron., Madison, Wis., USA.

Patil, D. B., P. R. Bharambe, P. W. Deshmukh, P. V. Rane and V. D. Guldekar, 2004. Micronutrient status in soil of Vidarabha : Technical Bulletin. Dr. P. D. K. V., Akola /154/December. Deprtment of Soil Science and Agricultural Chemistry. Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Krishinagar PO, Akola (MS).India.

Piper, C. S. 1966. Soil and Plant analysis. Asian Reprint, Hance Publishers, Bombay, pp. 368.

Ramappa Jakanur, V.R. Ramakrishnaparam and Ganapathi, 2015. Depth wise distribution of heavy metals in soils irrigated wirh sewage and industrial effluents. Green Farming Int. J.**6** (1): 111-113.

Rao, K, Jeevan and Y.S.S. Vimala Devi,2008. Sequential extraction of heavy metals in soil treated with USW of Hyderabad. J. Soils and Crops.**18** (2): 279-281.

Saraswat, P.K., R.C. Tiwari, H.P. Agarwal and S. Kumar, 2005. Micronutrient status of soils and vegetable crops irrigated with treated sewge water. J. Indian Soc. Soil Sci. **53**(1):111-115.

Sen, T.K., P.N. Dubey, S.T. Gaikawad and S. Murali,1997. Soil health and sewage irrigation- A case study in Nagpur district. Agropedology, **7:** 65-70.

Tiwari, R.C., Arvind Kumar and A.K. Mishra,1996. Influence of treated sewage and tubewell water irrigation with different fertilizer levels on rice and soil properties J. Indian Soc. of Soil Sci. .**44** (3) : 547-549.

Rec. on 10.01.2016 & Acc. on 05.02.2016