International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Comparative Study of Physico-Chemical Parameters and Heavy Metal Detection in Agricultural Soil Irrigated By Sewage Water and Tube Well Water in Rewari City Rural

Sunil Kumar Tobriya

S.K. Govt. College, Kanwali, Rewari (Haryana), India

Abstract: ***Present Comparative study revealed that Use of sewage water for irrigation of crops in Agricultural soil change the Physico-Chemical parameters and heavy metals content of the soil as compared to agricultural soil in which the crops are irrigated by tube well water or by canal water in nearby villages of Rewari city. Use of sewage water improves the fertility status of the soil as compare to the soil irrigated by natural sources. The percentage increase of soil samples investigated and analyzed for organic carbon (+49.19%), total nitrogen (+109.09%), available potassium (+49.03%), available phosphorus (+72.08%), electrical conductivity (+58.62%) and also water holding capacity (+22.30).The sewage irrigation show remarkable increase in the concentration of heavy metals in the soil, i.e. Zn (+470.05%) and Cu (+232.27%) and Pb (+106.64%). The results observed does not show much variation in the concentration of Fe (+51.40) and Cd (+27.41) metal in sewage irrigated soil compare to tube well irrigated soil. These are in permissible limits of Indian standard and show good soil quality in experimental site analyzed soil samples irrigated by sewage water but long term use of sewage effluents in the fields will certainly increase the heavy metals content and in future it will affect the human and animals of this area if the use of untreated sewage water continuously used by the farmers for the irrigation of this locality.***

Keywords: buffering property, heavy metals, Sewage effluents, Soil sodicity, Waste Water

1. Introduction

This world has only 4% of freshwater and in India which is second highest populated country in the world [1], there is huge demand of water in India because most of food production depends upon the agriculture. In southern-East of Haryana, the rainfall per annum is very low, so agriculture mainly depends upon the natural resources like tube-well (97.9%) and canal system (2.1%). Rewari has an important place in agricultural production in Haryana. The normal rainfall for the district is 657.3 mm per annum. The rainfall distribution in the district is uneven which results sometimes flood problems and sometimes draught position. As the soil in this district is loamy sand, required large amount of water for irrigation. But due to scarcity of freshwater, use of wastewater in agriculture for irrigation appears to be lucrative option. In which mainly, in nearby villages of Rewari, the use of untreated sewage water effluents for irrigation in agricultural land is most commonly practice. As there is no sewage treatment plant in Rewari, sewage effluents directly goes into nala's and used by the farmers. Although its use increase the crop yield as it contain essential nutrients and organic material for the growth [2], but untreated sewage water also contain undesirable constituents and heavy metals [3] . Soil act as global flux for various pesticides, chemicals and toxic materials [4] but sewage waste water carry appreciable amount of toxic metals [5], [6], [7]. In surrounding village of Rewari, it is about more than ten years of using this untreated sewage water by the farmers but continuous long time use of sewage effluents for irrigation will certainly elevate the level of toxic metals in the soil. These heavy metals like Zinc, copper, Lead Cadmium, Nickel and Chromium are dangerous as they are not biodegradable in nature, enters into the biological cycle by consuming the crops and vegetables as a food by human beings and animals grown in this polluted environment and transformation of these heavy metals in various organo-metallic compounds in the biological system [8]. There toxicity can damage the lungs, liver, kidney, reduces mental and central nervous system, damage to blood composition [9], [10]. The present comparative study was undertaken to observe the effect of untreated sewage water for irrigation on the soil quality in terms of physico-chemical parameters and sensitivity of different toxic heavy metals.

2. Materials and Methods

2.1 Study Area

The study was conducted for four months between Octobers 2013 to January 2014, because at this time period maximum use of sewage water is used for irrigation due to scarcity of rainfall and huge demand of water for irrigation for Rabi crops as Rabi crops are the main economic source of people living here. The analysis of various physico-chemical parameter and heavy metal detection was carried out from the samples collected from village Dohaki, 10 km from the Rewari City where irrigation is done mainly by sewage water from more than last ten years and from the village Phideri, 12 km from the Rewari City where only natural resources i.e. tube well water is used for irrigation. Ten samples across the two villages, five from each were taken from the sites for analysis.

2.2 Soil Analysis

About 0.5 kg composite soil samples from the two sites were collected from the depth of 0-25 cm. The collected soil samples after removing all unwanted material like small stones, leaves and roots of plants present in the samples

were properly air dried at room temperature then grinded properly with wooden roller and pass through 2mm size sieve. The samples were stored in air tight clean polythene bags for analysis with proper labeling. The soil pH was carried out by aqueous suspension of soil using glass-calomel electrode and electrical conductivity meter [11]. Organic carbon content in the soil were determine by wet digestion method [12], total nitrogen content by using Kjeldahl method [13], Potassium(K) by ammonium acetate method [14] , Phosphorous with sodium bicarbonate [15] and water holding capacity by method of Saxena (1990) [16].

2.3 Heavy Metals Analysis

The 2 gm of dried samples were digested in Di acid mixture of HNO_3 and Perchloric acid ($HClO_4$) in the ratio of (10:1) at 80 ^{0} C until transparent solution appears and were kept overnight at room temperature. After digestion of all samples, they were filtered by using Whatman filter paper grade 42 and then the volume of digested samples were made up to 50 ml by adding double distilled water. After that these solution were analyzed by Atomic Absorption Spectrophotometer (model-AAS GBS 932) for heavy metal detection.

3. Results and Discussion

3.1 Physical and chemical parameters of experimental soil

The mean values ± S.E. and the percentage increase and decrease of different physical and chemical parameters like water holding capacity, bulk density, electrical conductivity, pH, organic matter content, available potassium, available phosphorus, and total nitrogen of soil at two experimental sites i.e. village Dohaki (site I) where sewage water is used for irrigation and village Phideri where tube well water is used for irrigation is shown in the Table no. 1

Table 1: Physico-chemical parameters of two different sites in village Dohaki and Phideri

Parameters	Site I Use of Sewage water (Dohaki)	Site II Use of Tube well water (Phideri)	% increase/decrease in parameters	Tolerable Limits	Limits of Indian Standard
pH	7.03± 0.04	7.52±0.07	-6.5159	__	___
WHC	56.65 ±7.03	46.32±3.98	+22.30	___	___
EC(dsm^{-1})	0.92±0.011	0.58±0.013	+58.62	___	___
OC (%)	7.43 ±0.64	4.98±0.26	+49.19	___	___
K(ppm)	46.05±2.98	30.9±5.23	+49.03	___	___
P(mg/100gm)	13.01±3.00	7.56±2.19	+72.08	___	___
Nitrogen (%)	0.23±0.03	0.11 ±0.01	+109.09	___	___

All values are mean ± standard values of 5 observations of each parameter

According to Mezhin[17] neither a high pH above 8.4, nor a lower value below 5.0 is favorable for maximum yield of crops. The optimal pH value of growth of plants is 6.5 to 7.0 [18]. Due to buffering property of soil, change in pH is very low at experimental site and it is almost neutral [19]. The bulk density (BD) decrease where soil is irrigated by sewage waters due to increase in organic matter in the soil which decreases the degree of compactness of the soil [20] & [21]. The soil in experimental sites is loamy, which have limited water holding capacity, but water holding capacity in site I increases due to organic matter added by sewage water. As the level of organic matter increase in soil by use of sewage water, water holding capacity also increases due to affinity of organic matter present in the soil for water. It was found by the studies that long term use of sewage water in soil has been found to increase the available P and K content [22], [23] and [24]. High amount of phosphorus available in soil when irrigated by sewage water plays a significant role in plant growth and strengthening root of plants [25]. Total Available nitrogen is also found to be increase in the soil sample irrigated by sewage water, helps in fast growth and good yield production. In present study irrigation with sewage water resulted in significant increase in electrical conductivity but not increase in large extent which can affect the growth of plants and crops. However for analysis of heavy metal s present in the soil where sewage water is used for irrigation in experimental site I shown in table 2 show the remarkable increase in concentration of Zn and Cu metal in the soil as compare to the site II where only natural resources of water is used. Metal Pb also shows increment but not in great extent. There was no so much variation for Fe and Cd in the soil irrigated by sewage water and is under tolerable limits value.

Table No. 2 Heavy Metal analysis of two different sites in village Dohaki and Phideri

Parameters	Site I Use of Sewage water (Dohaki)	Site II Use of Tube well water (Phideri)	% increase/decrease in parameters	Tolerable Limits	Limits of Indian Standard [26]
Zn (mg/Kg)	232.47±28.3	40.78±5.03	+ 470.05	300	300-600
Cu (mg/Kg)	97.69± 6.39	29.40± 1.59	+ 232.27	100	135-270
Pb (mg/Kg)	50.39± 3.92	29.03± 2.50	+ 106.64	100	250-500
Fe (mg/Kg)	399.45±48.73	263.83±27.12	+ 51.40	--	50000 [27]
Cd (mg/Kg)	4.09± 0.98	3.21± 1.02	+27.41	--	3-6

Figure 1: State Haryana Showing district Rewari region

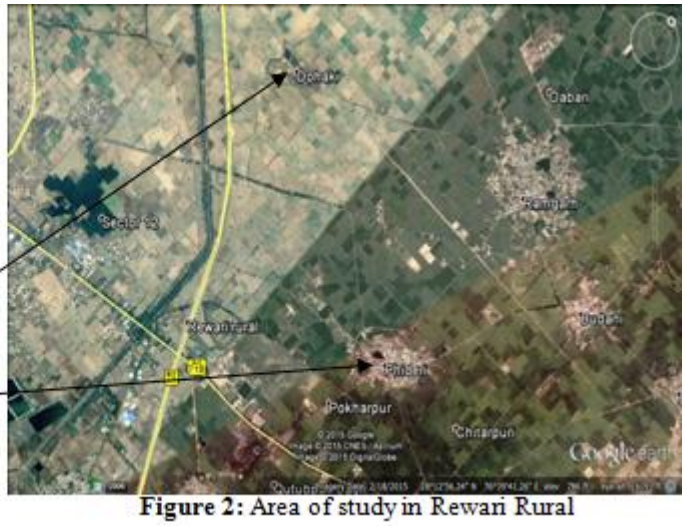

Figure 2: Area of study in Rewari Rural

4. Conclusion

In the present comparative study conclude that the physico-chemical properties of the soil at two experimental sites is different. It is determined that, use of sewage water improve the fertility status of the soil as it increase the yield of Rabi crops compared to irrigation done by tube - well water mainly due to increase in OC (+49.19), K (+49.02), N (+109.09) and P (+72.08), which are essential nutrients for the proper growth of plants and crops. But the main hazard of using sewage water can be seen in increasing percentage of heavy metals content in the soil Cd (+27.41), Fe (+51.40), Pb (+106.64), Cu (+232.27) and Zn (+470.05), which are in the limits of Indian Standard, but long term use of untreated sewage water certainly create risk of accumulation of heavy metals in the soil. Another important aspect is seen by application of sewage water is that the soil in not so productive in this area due to problem of sodicity i.e *Kallar*, but the fields irrigated by the sewage water showing improvement in the yield due to improvement in soil organic carbon status and balancing the alkalinity of soil by induced acidification of sewage. So if proper sewage treatment plant has been set up which can reduce the heavy metal content [28] and then used in the fields and proper drainage is available in the fields, sewage effluents may be used as a good source of both irrigation and plant nutrients.

References

[1] Singh, A.K., 2003. Water resources and their availability. In:Souvenir, National Symposium on Emerging Trends, Indian Society of Agrophysics, New Delhi, 22–24 April 2003, pp. 18–29.

[2] Jimenez B., Irrigation in developing countries using wastewater, *Int. Rev. Environ. Strat*., **6(2)**, 229-250 **(2006).** in AgriculturalPhysics.

[3] FAO., Wastewater Treatment and Use in Agriculture. *FAO irrigation and Drainage paper* ***4.*** Food and Agriculture organization of the United Nation Rome, Italy, 156 **(1992).**

[4] Sanghi, R. and Sasi, K. S. (2001). Pesticides and heavy metals in agricultural soils of Kanpur, India. *Bulletin of Environmental Contamination and Toxicology*, 67: 446 - 454.

[5] Feign, A., Ravina, I. and Shalhevet, J. (1991). Irrigation with treated sewage effluent: management for environmental protection. Springer, Berlin.

[6] Gupta, A.P., Narwal, R.P., Antil, R.S., 1998. Sewer water composition and its effect on soil properties. Bioresour. Technol. 65, 171–173.

[7] Yadav, R.K., Goyal, B., Sharma R.K., Dubey S.K. and Minhas, P.S. (2002). Post irrigation impact of domestic sewage effluent on composition of soils , crops and ground water – A Case study. *Environl. Int.*, 28:481-486.

[8] Cuny, D., Denayer, F. O., Foucault, R., Schumacker, P. and Haluwayn, C. V. (2004). Patterns of metal soil contamination and changes in terrestrial cryptogamic communities. *Environmental Pollution*, *129*, 289–297

[9] Chatterjee, J., Chatterjee, F., 2000. Phytotoxicity of chromium, cobalt and copper in cauliflower. *Environmental Pollution* **109:** 69–74.

[10] Carlton-Smith, C. H., Devis, R. D., 1983. Comparative uptake of heavy metals by forage crops grown on sludge-treated soils. Proc. Int. Conf. Heavy Metals in the Environment. Vol. 1, Heidelberg, CEP consultants Ltd., Edinburgh, U.K. pp 3933.

[11] Chaturvedi, R.K. and Sankar, K. (2006). Laboratory manual for the physico-chemical analysis of soil, water and plant. Wildlife Institute of India, Dehradun. Pp 97.

[12] Chaturvedi, R.K. and Sankar, K. (2006). Laboratory manual for the physico-chemical analysis of soil, water and plant. Wildlife Institute of India, Dehradun. Pp 97.

[13] Bremner, J. M. and Mulvaney, C. S. (1982). Nitrogen-total. In: Page AL et al (eds) Methods of soil analysis. Part 2. Chemical and microbiological properties. American Society of Agronomy, Madison, pp 595–624.

[14] Hanway, J.J. and H. Heidq (1952). Soil analysis methods as used in Iowa state college soil testing laboratory. *Iowa Agri.*, 57:1-31.

[15] Olsen, S.R., C.V. Cole, F.S. Watanabe and L.A. Qean (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate. Cire USQep. Agri. Q 39.

[16] Saxena, M. M. (1990). Environmental analysis water, soil and air. Agro botanical publishers. pp. 125-126.

[17] I .S Mezhin. *Journal of soil science*, **1961**, 89:159.

[18] Smith, S. R. (1994). Effect of soil pH on availability to crops of metals in sewage sludge-created soils. I. Nickel, copper Smith, S. R. (1994). Effect of soil pH on availability to crops of metals in sewage sludge-created soils. I. Nickel, copper
[19] Masto, R .E., Chhonkar P. K. , Singh, D. and Patra, A. K. (2008). Changes in soil quality indicators under long-term sewage irrigation in a sub-tropical environment. *Environ Geol.,* DOI 10.1007/s00254-008-1223-2.
[20] Renukaprasanna, M., Channal, H. T. and Sarangamath, P. A. (2002). Charactrisation of city sewage and its impact on soils and water bodies. 17th WCSS Thailand. Poster Paper No. 70, Symposium no 24.
[21] Anu, Upadhyaya, S.K. and Bajpai Avinash(2010). Seasonal Analysis of Soil Sediment of Shahpura Lake of Bhopal (M.P.). International Journal of Environmental Science and Development, 1 (4): 333 - 335.
[22] Siebe, .C (1998). Nutrient inputs to soils and their uptake by alfalfa through long-term irrigation with untreated sewage effluent in Mexico. *Soil Use Manage.*,13 :1-5.
[23] Ryan, John , Masri, Samir and Manzoor Qadir (2006). Nutrient monitoring of sewage water irrigation: Impacts for soil quality and crop nutrition. *Communications in Soil Science and Plant Analysis*, 37: 2513–2521.
[24] Saha, J. K., Panwar, N., Srivastava , A., Biswas, A. K., Kundu, S. and Subba Rao, A. (2010) Chemical, biochemical, and biological impact of untreated domestic sewage water use on Vertisol and its consequences on wheat (*Triticum aestivum*) productivity. *Environ Monit Assess.*, 161:403- 412, DOI 10.1007/s10661-009-0756-5.
[25] Yadav, R.K., Goyal, B., Sharma R.K., Dubey S.K. and Minhas, P.S. (2002). Post irrigation impact of domestic sewage effluent on composition of soils , crops and ground water – A Case study. *Environl. Int.*, 28:481-486.
[26] Awashthi, S.K. 2000. Prevention of Food Adulteration Act no 37 of 1954. Central and State Rules as Amended for 1999, Ashoka Law House, New Delhi. B
[27] Kabata-Pendias, A. and Pendias, H. (1992). Trace Elements in Soils and Plants, second ed. CRC Press, Boca Raton, FL, USA.
[28] Panicker, P.V.R.C., 1995. Recycling of human waste in agriculture. In: Tandon, H.L.S. (Ed.), Recycling of waste in agriculture. Fert. Dev Consultation organization, New Delhi India, pp. 68–90.