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Assessment of sewage water quality and its effect on soil properties of south eastern cities of Haryana

DEEPAK KUMAR, S.K SINGH* AND SARDUL MANN

Department of Soil Science, Chaudhary Charan Singh Haryana Agricultural University, Hisar (Haryana), 125001

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ABSTRACT

A survey was conducted in Kaithal, Kurukshetra, Karnal, Panipat and Faridabad cities of South-Eastern Haryana State, from where sewage water samples in duplicate were collected and analysed at Deptt. of Soil Science, CCS Haryana Agricultural University Hisar for their chemical characteristics. It was observed from the data that pH, EC and organic carbon ranged from 6.60-7.50, 1.00-3.34 dSm^{-1} and 100-330 mgl^{-1}, respectively. The minimum pH was recorded in Karnal-III, whereas, maximum EC and organic carbon were recorded in Faridabad-I sewage water. The EC of all the sewage water except Faridabad-I and Faridabad-III falls within the medium range of salinity hazards. The basic cations and anions in sewage water followed the order as Na^{+}> Mg^{2+}> Ca^{2+} and HCO^{3-}> Cl^{-}> CO^{3-}> SO^{4-} ,respectively. The residual sodium carbonate (RSC) ranged from 0.40 to 3.46 meql^{-1} and higher values were recorded in Kaithal-II sewage water, Sodium adsorption ratio (SAR) ranged from 1.95-23.19 (meq/l)$^{-1/2}$.The sewage irrigation considerably decreased soil pH at all the locations. Decrease varied among different locations depending upon the composition of sewage electrical conductivity of sewage water irrigated soil was more than non-sewage water irrigated soil at all the locations. The organic carbon content and CEC of sewage water irrigated soils were much higher as compared to soil irrigated with tubewell or canal water at all the locations. The calcium carbonate content was higher in non sewage water irrigated soil than sewage water irrigated soil at Kaithal and Karnal, whereas at Kurukshetra, Panipat and Faridabad the condition was reverse.

Keywords: Sewage water, soil properties, southern cities, Haryana

INTRODUCTION

The constituents and composition of sewage water depends on the composition of municipal water supply, nature of wastes added during the use and degree of treatment of the waste water The composition of sewage water also depends upon the dietary habits of the locality, population density and bi-product impurities of the industrial units which are added in the sewer system Bhat *et al.* (2018) reported that water having high sodium adsorption ratio (SAR) when used for irrigation, increased exchangeable sodium percentage (ESP) in the soil thereby adversely affecting the soil structure leading to decrease in infiltration, hydraulic conductivity, enhance surface runoff and erosion. Moreover, the poor-quality water causes impairment in crop growth as high salt concentration in irrigation water results in osmotic stress and ion toxicity in plants. Unwise use of sewage water may deteriorate soil physical environment due to accumulation of salts. Uncontrolled use of sewage water for irrigation can result in accumulation of the potentially toxic metals in soil and may affect plant growth adversely. Hazarika *et al.* (2007) reported that the content of total exchangeable basic cations (Ca^{2+}, Mg^{2+} , K^{+} and Na^{+}) in effluent irrigated soil was about 4 times higher than those found in the shallow tubewell water irrigated soils. Further, they also revealed that the exchangeable sodium percentage, sodium adsorption ratio and chloride content of effluent irrigated soil were 170%, 120% and 358% more than the soil of STW irrigated field. Kadu *et al* (2016) reported that sewage water collected from village Ghusar near Akola city was alkaline in reaction (pH 8.25 and 7.91) with high EC *i.e.* 2.60-2.85 dS m^{-1}, COD 840 and 820 mgL^{-1}, BOD 160 and 180 mg L^{-1} and TDS (1664 and 1824 mg L^{-1}) which were higher than the permissible limit. Keeping these facts in view, the present study was initiated.

MATERIALS AND METHODS

Sewage water samples were collected from Kaithal, Kurukshetra, Karnal, Panipat and Faridabad cities of Haryana State from sewage

*Corresponding author's address & email ID: Chaudhary Charan Singh Haryana Agricultural University, Krishi Vigyan Kendra, Fatehabad, sksinghphd@gmail.com

water discharge out-lets in duplicate i.e. one already treated with a mixture of 1:1 HNO_3 and distilled water to avoid adsorption of heavy metals on the walls of bottle and in another un-acidified bottle rinsed with only distilled water. Soil samples were collected from these cities irrigated with sewage water. The pH organic carbon and EC were determined by adopting standard procedures. Total solids and total dissolved solids were determined by the procedure mentioned in APHA (1992). Calcium and Mg were determined by titration with EDTA. Carbonate and bicarbonate were estimated by titrating a known volume of the sewage water with standard H_2SO_4. Chloride was determined by titrating with standard $AgNO_3$ solution. Sulphate was determined by EDTA-titration method as described by Jackson (1973). Sodium was determined with the help of flame photometer. SAR and RSC from the soluble cations and anions were computed. BOD was calculated by multiplying organic matter content of sewage water by 0.711. The soils were analysed for pH, EC, organic carbon and CEC by adopting standard procedures (Jackson, 1973).

RESULT AND DISCUSSION

Quality of sewage water

Data in (Table 1) revealed that pH, EC and organic carbon (OC) ranged from 6.60-7.50, 1.00-3.3 dSm^{-1} and 100-330 mgl^{-1}, respectively. The minimum pH was recorded in Karnal-III, whereas, maximum EC and organic carbon were recorded in Faridabad-I sewage water. The EC of all the sewage water except Faridabad-I and Faridabad-III falls within the medium range of 0.75 to 3.00 dSm^{-1}. The total dissolved solids (TDS) and biological oxygen demand (BOD) ranged from 640-2800 and 121-406 mg l^{-1} respectively (Table 1). The mean value of TDS (1527 mg l^{-1}) was found quite high than the ISI permissible limit of 200 mg l^{-1} for irrigation. The BOD values of all the sewage waters were also above the permissible limit prescribed for the effluent to be discharged on land for irrigation (100 mg l^{-1}).These results corroborate with the findings of Karthikeyan and Singh (2004) for sewage waters from different districts of Haryana State. Similar results were also reported by Kadu *et al* (2016) in survey of Akola city. The cations and anions Na^+, $Ca^{2+,}$ Mg^{2+}, CO^{3-} , HCO^{3-} , SO^{-4} and Cl^- ranged from 108-525, 32-70, 90-220, 24-46, 190-878, 4.78-14.70 and 57-350 mg l^{-1}, respectively, and followed the order to Na^+> Mg^{2+}> Ca^{2+} for cations and HCO^{3-}> Cl^-> CO^{3-}> SO^{4-} for anion. The residual sodium carbonate (RSC) ranged from 0.4 to 3.5 meq l^{-1} with a mean value of 0.6 meq l^{-1} (Table 1). The RSC was quite high in Kaithal-II sewage water due to high carbonate and bicarbonate content and low calcium and magnesium content in these water. Sodium adsorption ratio (SAR) is the main property of water classification which ranged from 1.9-23.2 $(meq/l)^{-1/2}$ with a mean value of 7.9 $(meq/l)^{-1/2}$. The SAR of all these sewage waters except Panipat-II and Faridabad-II falls under low sodicity hazards. All these parameters indicate that these waters can be used for irrigation purpose without any adverse effect on soil health. Similar results were also reported by (Minhas, 2005 and Gurjar*et al*, 2017).

Table 1: Composition of raw sewage water in some cities of South-Eastern Haryana (n=12)

Location	pH (1:2)	EC (dSm^{-1})	OC (mg l^{-1})	TDS (mg l^{-1})	BOD (mg l^{-1})	CO_3 (mg l^{-1})	HCO_3 (mg l^{-1})	Cl^- (mg l^{-1})	Ca^{2+} (mg l^{-1})	Mg^{2+} (mg l^{-1})	Na^+ (mg l^{-1})	SO_4 (mg l^{-1})	RSC (mg l^{-1})	SAR
Kaithal-I	6.7	1.5	120	960	150	29	240	140	40	160	252	5.7	-	6.2
Kaithal-II	6.9	2.2	230	1320	285	46	460	90	60	120	378	7.1	3.5	9.9
Kurukshetra-I	6.6	1.2	150	1120	185	26	320	90	52	120	144	6.6	0.7	3.8
Kurukshetra-II	6.6	1.0	220	640	271	24	270	80	40	90	108	4.8	1.2	3.3
Karnal-I	6.7	1.2	100	720	121	24	270	90	40	130	138	7.9	-	3.7
Karnal-II	7.2	2.3	300	840	370	30	240	110	32	120	162	8.8	0.4	4.8
Karnal-III	6.6	1.1	250	2120	306	42	510	350	70	220	384	10.1	0.8	7.9
Panipat-I	7.1	2.5	290	680	356	30	190	70	50	110	372	13.9	-	1.9
Panipat-II	7.5	2.9	260	2560	406	24	460	71	60	190	525	14.7	0.6	23.2
Faridabad-I	7.2	3.3	330	2008	320	31	878	57	70	170	324	10.1	0.44	7.3
Faridabad-II	6.7	2.9	190	2560	235	36	390	180	60	80	414	10.1	-	12.2
Faridabad-III	7.1	3.1	280	2800	344	38	781	85	70	210	438	13.1	-	9.1

Soilproperties

A perusal of the data (Table 2) revealed that the sewage irrigation considerably decreased soil pH at all the locations. The extent of decrease varied among different locations depending upon the composition of sewage water and duration of irrigation. The pH of non-sewage water irrigated soil of Kaithal, Kurukshetra, Karnal, Panipat and Faridabad ranged from 8.2-8.4, 8.8-9.4, 7.2-7.4, 9.3-9.5 and 8.7-9.1 respectively, whereas in sewage water irrigated soil, it varied from 7.5-8.3, 6.2-8.0, 6.1-6.8, 8.0-8.3 and 7.4-8.5, respectively. The decrease in pH was by 0.4, 1.9, 0.8, 1.3 and 0.7 units at Kaithal, Kurukshetra, Karnal, Panipat and Faridabad cities respectively. The maximum change in pH was observed at Kurukshetra where the field has been irrigated with sewage water for the last 28-30 years. The decrease in soil pH with sewage water irrigation might be due to the production of organic acid during decomposition of organic matter and use of low pH water for domestic purposes and ultimately disposed in the sewage (Subramani, *et al.,* 2014,Singh *et al.*, 2017 and Sharma*et al.*, 2019).

Table 2: Physico-chemical characteristics of non-sewage and sewage water irrigated soils

Location	Soil		pH	EC (dS m^{-1})	OC (g kg^{-1})	$CaCO_3$ (g kg^{-1})	CEC (Cmol kg^{-1})
Kaithal	NSWI	Range	8.2-8.4	0.16-0.2	6.5-7.6	13.0-21.3	8.4-11.8
		Mean		0.19	7.0	17.9	10.0
	SWI	Range	7.5-8.3	0.19-0.29	8.2-17.6	Tr.-28.5	8.2-19.3
		Mean		0.25	12.0	14.5	11.01
Kurukshetra	NSWI	Range	8.8-9.4	0.14-0.17	8.0-10.1	Tr.-17.0	8.3-10.0
		Mean		0.16	8.8	5.7	8.9
	SWI	Range	6.2-8.0	0.19-0.29	6.6-28.7	Tr.-25.0	9.0-20.6
		Mean		0.22	16.5	16.2	14.2
Karnal	NSWI	Range	7.2-7.4	0.14-0.17	12.7-12.9	Tr.-32.5	8.4-9.9
		Mean		0.15	12.8	17.2	9.2
	SWI	Range	6.1-6.8	0.20-0.37	12.1-18.5	Tr.-34.3	13.7-22.8
		Mean		0.27	15.2	15.0	17.1
Panipat	NSWI	Range	9.3-9.5	0.11-0.17	8.4-9.8	Tr.-8.2	12.4-13.5
		Mean		0.14	9.1	4.1	12.9
	SWI	Range	8.0-8.3	0.21-0.28	8.0-13.0	7.0-18.0	17.3-19.1
		Mean		0.24	9.2	10.7	17.9
Faridabad	NSWI	Range	8.7-9.1	0.14-0.20	6.8-7.6	Tr.-6.5	8.4-16.3
		Mean		0.17	7.2	3.2	12.4
	SWI	Range	7.4-8.5	0.27-1.26	5.7-14.9	Tr.-16.5	11.3-22.8
		Mean		0.54	10.5	9.3	17.6
Overall	NSWI	Range	7.2-9.5	0.11-0.20	6.5-12.9	Tr.-32.5	8.3-16.3
		Mean		0.17	8.7	10.6	10.4
	SWI	Range	6.1-8.5	0.19-1.26	5.7-28.7	Tr.-34.3	8.2-22.8
		Mean		0.32	12.6	13.2	14.8

The electrical conductivity of sewage water irrigated soil was more than non-sewage water irrigated soil at all the locations (Table 2). The EC ranged from 0.19-0.29, 0.19-0.29, 0.20-0.37, 0.21-0.28 and 0.27-1.26 dSm^{-1} with their mean values of 0.25, 0.22, 0.27, 0.24 and 0.54 dSm^{-1}, respectively. The increase in EC by 0.06, 0.06, 0.12, 0.10 and 0.37 dSm^{-1} at Kaithal, Kurukshetra, Karnal, Panipat and Faridabad cities's soil, respectively. The highest change in EC was observed in Faridabad soils after 35 years of sewage water irrigation. It may be due to the higher salt concentration in sewage effluents. The increase in EC of sewage water irrigated soil might be due to accumulation of soluble salts in soil receiving irrigation with water of higher electrolyte concentration and the source of these salts in the sewage water is domestic activity (Sushil *et al.*, 2019).

The organic carbon content of sewage water irrigated soils were much higher as compared to soil irrigated with tubewell or canal water at all the locations. The organic carbon of non-sewage water irrigated soil ranged from 6.5-7.6, 8.0-10.1, 12.7-12.9, 8.4-9.8, 6.8-7.6 g kg^{-1} whereas of sewage water irrigated soil ranged from 8.2-17.6, 6.6-28.7, 12.1-18.5, 8.0-13.0, 5.7-14.9 g kg^{-1} of Kaithal, Kurukshetra, Karnal, Panipat and Faridabad, respectively (Table 2). The lower organic carbon content was found in Kaithal non-sewage water irrigated soil and higher in Kurukshetra sewage water irrigated soil. Higher amount of organic carbon in sewage fed soils compared to normal soils was also observed by Saraswat *et al.* (2015), Singh *et al.*(2017) and Sushil*et al.* (2019). The higher content of $CaCO_3$ in non-sewage water irrigated soil of Kaithal and Karnal might be due to the poor quality of under ground irrigation water. The increase in $CaCO_3$ content in sewage water irrigated soil was due to precipitation of Ca^{++} exchanged from the soil complex by Na^+ present in the sewer water. The calcium carbonate content was higher in non sewage water irrigated soil than sewage water irrigated soil at Kaithal and Karnal, whereas at Kurukshetra, Panipat and Faridabad the condition was reverse. The $CaCO_3$ content ranged between trace to 32.5 g kg^{-1} per cent in non-sewage water irrigated and trace to 34.3 g kg^{-1} in sewage water irrigated soil with a mean of 10.7 and 13.2 g kg^{-1}, respectively (Table 2). However, there was no specific distribution pattern in both the soil with respect to $CaCO_3$ content. The results are in confirmation with the results of Singh *et al.*(2017) and Sushil*et al.* (2019).The cation exchange capacity of sewage water irrigated soil was found more than that of non-sewage water irrigated soils at all the locations under study. The CEC of sewage water irrigated soil of Kaithal, Kurukshetra, Karnal, Panipat and Faridabad ranged from 8.2-19.3, 9.0-20.6, 13.7-22.8, 17.3-19.1 and 11.3-22.8 cmol kg^{-1} with an average of 11.0, 14.2, 17.1, 17.9 and 17.6 cmol kg^{-1}, respectively. The increase in CEC of sewage water irrigated soil may be due to increase in organic matter content of soil. (Gurjar *et al.*, 2017 and Sushil,*et al.*, 2019).

REFERENCES

APHA (1992) Standard methods for examination of waters and waste waters. 18th Ed. American Public Health Association, New York.

Bhat, M.A, Sheeraz., S.A., Singh, V.A., Sahool. J, Tomar, D., Sanswal, R.(2018) An Overview of the asessment of groundwater quality for irrigation. *Journal of Agricultural Science and Food Research* **9** (1):1-9

Gurjar, O.P., Meena, R., Latare, A.M., Rai, S., Kant, S., Kumar, A., and Sheshama, M K. (2017). Effects of sewage waste water irrigation compare to ground water irrigation on soil physico-chemical properties. *International Journal of Chemical Studies*. **5 (6)**: 265-267.

Hazarika, S., Talukdar, N.C., Borah, K., Barman, N., Medhi, B.K., Thakuria, D. and Barooah, A.K. (2007) Long-term effect of pulp and paper mill effluent on chemical and biological properties of a heavy textured acidic soil in Assam. *Journal of the Indian Society of Soil Science* **55**: 45-51.

Jackson, M.L. (1973) Soil *Chemical Analysis*. Prentice hall of India Pvt.Ltd., New Delhi, pp: 498.

Kadu, P.R., Jadhao, S.M., Kankal, D.S and Agarkar , D.(2016) Behavior of Sewage Water in Soil. 81st Annual Convention: National Seminar on Developments in Soil Science Indian Society of Soil Science, 20-23 October. pp 204.

Karthikeyan, K. and Singh, K. (2004) Chemical composition of some sewage water used for irrigation purpose.*Journal of Industrial Pollution Control* **20**: 211-219.

Minhas, P.S. (2005) Wastewater use for sustainable agriculture–Indian perspective. Proceeding of International Conference on Soil Water and Environmental Quality–Issues and Strategies. 28th Jan. – 1st

Saraswat, P.K., Chaudhary, B., Bhati, A.S and Kumar, S (2015) Effect of sewage water on status of nutrients and heavy metals in soils and vegetable crops. *Annals of Plant and Soil Research* **17**(4):350-355

Sharma, S., Dubey , E and Khanna, S.K (2019). Assessment of waste water quality of sewage treatment plant-A case study. Annals of Plant and Soil Research **21**(2):154-157:

Singh, H., Dahiya, D.S., Devraj, Alam, S., Singh,A.K., and Giri, Y.Y. (2017) Application Fate of Sewage and Industrial Effluents on Soil and Plant Health under Karnal District of Haryana, India. *International Journal of Current Microbiology and Applied Sciences* **6** (9): 2640-2646

Subramani, T., Mangaiyarkarasi, M., Kathirvel, C. (2014).Impact of Sewage and Industrial Effluent on Soil Plant Health Act on Environment.*International Journal of Engineering Research and Applications* **4** (6): 270-273.

Sushil, Garhwal, R.S., Vikas, R.S., & Dinesh, (2019) Influence of sewage water irrigation on soil properties in different districts of Haryana, *Indian Journal of Pure and Applied Bio Science* **7**(4):514-521.