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SD Zodge
Department of Soil Science and Agricultural Chemistry, Post Graduate Institute, Dr. PDKV, Akola, Maharashtra, India

SM Bhoyar
Department of Soil Science and Agricultural Chemistry, Post Graduate Institute, Dr. PDKV, Akola, Maharashtra, India

PW Deshmukh
Department of Soil Science and Agricultural Chemistry, Post Graduate Institute, Dr. PDKV, Akola, Maharashtra, India

AB Age
Department of Soil Science and Agricultural Chemistry, Post Graduate Institute, Dr. PDKV, Akola, Maharashtra, India

SG Zalte
Department of Soil Science and Agricultural Chemistry, Post Graduate Institute, Dr. PDKV, Akola, Maharashtra, India

DP Deshmukh
Department of Soil Science and Agricultural Chemistry, Post Graduate Institute, Dr. PDKV, Akola, Maharashtra, India

Corresponding Author:
SD Zodge
Department of Soil Science and Agricultural Chemistry, Post Graduate Institute, Dr. PDKV, Akola, Maharashtra, India

Heavy metal content in sewage water of different cities alongside of Mumbai local railway track use for crop production

SD Zodge, SM Bhoyar, PW Deshmukh, AB Age, SG Zalte and DP Deshmukh

Abstract
Water is one of the most valuable resource available to man for his domestic and agricultural uses, out of which agriculture claims lion's share accounting for about two-third of water demand. Among others, one of the important irrigation source is municipal sewage water. The use of sewage and other industrial effluents for irrigating agricultural lands is on the rise particularly in peri-urban areas of developing countries. Amounts of wastewater are sharply increasing and the kinds of pollutants are also varied as the world wide industry is being developed incessantly. Hence, a research study was undertaken to assess the content of micro nutrients and heavy metals in sewage water alongside Mumbai local railway track of Maharashtra state (India). The sewage samples were collected in two seasons first in late *kharif* in year 2016 and second in *rabi* 2017 season. The laboratory work was undertaken in Department of Soil Science and Agricultural Chemistry, Dr. PDKV, Akola, during the course of investigation revealed that, sewage water used for irrigation to vegetable crops alongside Mumbai local railway track had Cu (0.04 mgL^{-1}), Zn (0.22 mgL^{-1}), Pb (0.09 mgL^{-1}), Ni (0.11 mgL^{-1}), Cd (0.008 mgL^{-1}) and Co (0.08 mgL^{-1}) were within safer limits, whereas Fe (11.85 mgL^{-1}), Mn (0.39 mgL^{-1}), Cr (0.16 mgL^{-1}) and As (0.46 mgL^{-1}) were beyond the permissible limits. Hence in general sewage water is not suitable for irrigation purpose.

Keywords: Mumbai, sewage, railway track, micronutrients, heavy metals

Introduction

Irrigation through sewage is as old as agriculture itself. The earliest documents sewage farms being in Bunzlan, Germany and Edinburgh, Scotland which were in operation from 1531 and 1650. In India, application of sewage on agriculture farms is an old practice with first sewage farm coming up in the year 1885 at Ahmedabad. Mumbai formerly called Bombay is the commercial capital of the India, and one of the densely populated city in the world. The Mumbai lies on the western coast of India by the bank of Arabian Sea having latitude $18^0$58'30'' N, longitude $72^0$49'33'' E and altitude 14m. Mumbai generally has humid and muggy weather, which is influenced by its proximity to Arabian Sea. This proximity is the main reason for ups and downs of the temperature. The Mumbai suburban railway network is oldest railway network in Asia. The open space near railway track of Mumbai is given to peoples on the basis of lease for crop production. The sewage water which is flows from nallas near railway track of Mumbai is utilized for vegetable production. Earlier number of scientist reported that, sewerage water contains a large variety of wastes ranging from domestic to industrial; therefore, quality of such water is not suitable to irrigate any crop because of presence of many toxic chemicals (Furedy *et al.*, 1999; Zarsky & Hunter, 1999) [8, 23]. Sewage water is polluted mainly by dumping of domestic and industrial wastes into the nallah or sewage. Rattan *et al*. 2002 and 2005 [16] also stated that, due to continuous use of untreated sewage water the agricultural lands, particularly in peri-urban areas often exhibit elevated levels of trace elements.

Materials and methods

The experiment was conducted during two seasons, *viz. kharif* and *rabi* in the year of 2016-2017. The nalas which was flows through Mumbai, Mumbai suburban city's and Navi Mumbai near railway track carries domestic sewage as well as industrial waste water at somewhere.

Which may or may not be treated and directly discharge into the nalas or gutter from all over city's of Mumbai.

The sewage water samples were collected in 1000 ml capacity plastic bottles from the defined place of nalas or gutter near to Central, Western and Harbour railway track of Mumbai and Navi Mumbai by grab sampling method. Grab sampling also called spot or catch sampling. In grab sampling single sample are collected at a specific spot at a site in specified time. Grab samples are to be collected only when the source is known to be constant in composition for an extended period of time. Example are ground water samples, well mixed surface water, large lakes, rivers, waste water stream etc. that are expected in constant in composition over a extended period of time. Before collection of sewage water the bottle should be clean with HNO_3 and distilled water (1:1) to avoid the adsorption of heavy metals on walls of bottles, also to prevent the microbial infection, four to five drops of toluene was added in each bottles. Placed the samples in appropriate labeled bottles and refrigerated at 4 ^{0}C. The samples thus collected were taken to laboratory for further analysis, (American Public Health Association, 1985) [1]. Fe, Mn, Zn, Cu, Pb, Ni, Cd, Co, Cr and As form sewage water were estimated with Di- Acid digestion mixture (9:4 concentrated $HN0_3$:$HClO_4$) by using Atomic Absorption Spectrophotometer (Lindsay and Norvell, 1978) [11].

Results and Discussion

Micronutrient content in sewage water

The Fe content in sewage water of Mumbai was ranged from 5.91 to 24.35 mgL^{-1} with mean value of 11.85 mgL^{-1}, which perceived that, concentration of Fe in sewage water were beyond recommended maximum concentration 5.00 mgL^{-1} given by FAO (1985) [7]. The higher content of Fe may be due to mixing of higher concentration of Fe content industrial wastes or dissolution of metallic compounds from pipes, vessels and washing in households and leaching loss. Brar *et al*. (2000) [5] also reported higher amount of Fe at Jalandhar City (Punjab), however Singh *et al*. (2012) [17] in domestic sewage water of Maharajbag, Nagpur (India). The ranged of Mn content in sewage water was varied from 0.11 to 0.81 mgL^{-1} with mean value of 0.39 mgL^{-1}, which was beyond recommended maximum concentration 0.2 mgL^{-1} given by FAO (1985) [7] and 0.10 mgL^{-1} as per Awashthi (2000) [3], the findings are in accordance with Karthikeyan and Singh (2004) [10] for different location of southern Haryana state 0.20 mgL^{-1} and Chauhan (2014) [6] for different location of Madhya Pradesh 0.23 to 0.37 mgL^{-1}. Zn content ranged from 0.08 to 0.47 mgL^{-1} with mean value of 0.22 mgL^{-1}, which were below permissible limits of 2.00 mgL^{-1} given by Awashthi (2000) [3] and 5.00 mgL^{-1} given by WHO/FAO (2007) [21]. The data pertaining Cu content ranged from 0.02 to 0.13 mgL^{-1} with mean value of 0.04 mgL^{-1}, which was under recommended

Table 1: Micronutrient and Heavy metal content in sewage water alongside Mumbai local railway track

Sr. No.	Railway track	Name of Location	Mean of *kharif* and *rabi* season (2016-17)									
			Fe	Mn	Zn	Cu	Pb	Ni	Cd	Co	Cr	As
			(mgL^{-1})									
1.	Central line	Kalyan	6.31	0.33	0.45	0.03	0.07	0.07	0.002	0.06	0.06	0.27
2.		Thakurli-I	8.58	0.39	0.40	0.03	0.09	0.07	0.002	0.08	0.18	0.09
3.		Thakurli-II	5.91	0.38	0.31	0.03	0.08	0.07	0.002	0.08	0.18	0.23
4.		Kalwa	7.01	0.27	0.25	0.03	0.07	0.08	0.007	0.08	0.13	0.24
5.		Bhandup	17.61	0.25	0.18	0.04	0.10	0.12	0.004	0.08	0.16	0.08
6.		Kanjurmag	12.40	0.36	0.21	0.04	0.13	0.10	0.005	0.08	0.16	0.46
7.		Ghatkopar	11.53	0.35	0.28	0.04	0.10	0.09	0.005	0.09	0.21	0.52
8.		Vikhroli	14.17	0.23	0.16	0.05	0.08	0.08	0.002	0.09	0.15	0.47
9.		Kurla	17.13	0.38	0.16	0.04	0.09	0.09	0.002	0.10	0.16	0.88
10.		Sion	12.65	0.77	0.13	0.03	0.09	0.09	0.001	0.10	0.16	0.23
11.	Western line	Mahim-I	7.81	0.49	0.21	0.03	0.10	0.09	0.003	0.09	0.17	0.37
12.		Mahim-II	10.74	0.15	0.17	0.04	0.11	0.08	0.003	0.09	0.17	0.30
13.		Malad-I	8.33	0.50	0.28	0.04	0.32	0.45	0.003	0.09	0.18	0.55
14.		Malad-II	8.78	0.28	0.18	0.04	0.08	0.08	0.005	0.08	0.14	0.57
15.		Malad-III	8.68	0.35	0.11	0.04	0.06	0.09	0.004	0.09	0.14	0.55
16.		Dahisar-I	6.91	0.44	0.15	0.03	0.08	0.08	0.003	0.08	0.07	0.39
17.		Dahisar-II	7.52	0.25	0.26	0.03	0.06	0.09	0.002	0.10	0.15	0.62
18.		Kandivali-I	10.69	0.39	0.10	0.03	0.08	0.12	0.014	0.06	0.15	0.90
19.		Kandivali-II	13.24	0.81	0.21	0.03	0.04	0.11	0.014	0.06	0.15	0.57
20.		Mera road	10.40	0.37	0.22	0.03	0.06	0.12	0.016	0.07	0.14	0.49
21.	Harbour line	Airoli	24.35	0.42	0.15	0.04	0.11	0.11	0.016	0.07	0.17	0.52
22.		Rabale	18.92	0.28	0.47	0.05	0.06	0.15	0.014	0.07	0.21	0.61
23.		Ghansoli	21.20	0.51	0.27	0.03	0.08	0.10	0.014	0.07	0.18	0.66
24.		Koparkhairne	8.85	0.47	0.40	0.03	0.06	0.11	0.016	0.07	0.15	0.72
25.		Turbhe	15.78	0.24	0.11	0.03	0.27	0.15	0.017	0.09	0.17	0.47
26.		Juinagar	14.54	0.60	0.26	0.13	0.06	0.13	0.014	0.08	0.14	0.49
27.		Nerul	10.29	0.65	0.22	0.08	0.04	0.13	0.015	0.08	0.16	0.31
28.		Belapur	7.77	0.11	0.09	0.02	0.04	0.11	0.016	0.06	0.16	0.46
29.		Kharghar	13.78	0.18	0.27	0.02	0.07	0.11	0.015	0.08	0.18	0.52
30.		Khandeshwar	13.51	0.50	0.08	0.02	0.05	0.11	0.016	0.07	0.15	0.39
Range			5.91-24.35	0.11-0.81	0.08-0.47	0.02-0.13	0.04-0.32	0.07-0.45	0.001-0.017	0.06-0.10	0.06-0.21	0.08-0.90
Mean			11.85	0.39	0.22	0.04	0.09	0.11	0.008	0.08	0.16	0.46

maximum concentration 0.20 mgL^{-1} given by FAO (1985) [7]. The result of Cu content in sewage water was in agreement with findings of Bao *et al.* (2014) for southeastern suburbs of Beijing and Chauhan (2014) [6] for different location of Madhya Pradesh.

Heavy metal content in sewage water

The Pb content in sewage water alongside of Mumbai local railway track was ranged from 0.04 to 0.32 mgL^{-1} with mean value of 0.09 mgL^{-1}, which was below the permissible limits of 5.00 mgL^{-1} as given by WHO/FAO (2007) [21], whereas Awashthi (2000) [3] was prescribed it 0.10 mgL^{-1}. The source of lead accumulation in Mumbai sewage water may also Pb-batteries and ink used for newspaper printing which are find their ways in the sewage systems. Ni content ranged from 0.07 to 0.45 mgL^{-1} with mean value of 0.11 mgL^{-1}, which was below permissible limits 0.20 mgL^{-1} as given by FAO (1985) [7]. The presence of Ni in sewage water may be due to nickel is present in environment in the form of nickel oxides, complexes with sulphides, hydroxides, chlorides and ammonia ATSDR (1995) [2]. It is also found in stainless steel, coins, non-ferrous alloys, alloys used in food processing and sanitary installations, rechargeable batteries and protective coatings, pigments, electronic products, nickel-cadmium batteries and in emissions from fossil fuel combustion (WHO 2005b) [20]. Similar observations about nickel content in city sewage was also reported by Vazhacharickal *et al*. (2013) [19] for Mumbai and Usharani *et al.* (2014) [18] for sewage water of Musi river basin of Hyderabad. Cd content ranged from 0.001 to 0.017 mgL^{-1} with mean value of 0.008 mgL^{-1}, which was below permissible limits 0.01 mgL^{-1} given by Indian standard Awashthi (2000) [3] as well as WHO/FAO (2007) [21]. Cadmium has many applications, *e.g.* in batteries, pigments, plastics and metal coatings and is widely used in electroplating (Martin & Griswold, 2009) [12]. Cadmium and its compounds are highly water soluble compared to other metals. Cr content ranged from 0.06 to 0.21 mgL^{-1} with mean value of 0.16 mgL^{-1}. It was beyond permissible limits 0.05 mgL^{-1} as given by Awashthi (2000) [3], as well as 0.1 mgL^{-1} given by WHO/FAO (2007) [21]. Cr-III is immobile in its reduced form and is insoluble in water, whereas, Cr -VI in its oxidized state is highly soluble in water and thus mobile (Wolinska *et al.*, 2013) [22]. Similarly Cr content in sewage water was also reported by Mastiholi (2005) [13] for Hadapsar city of Pune and Omron *et al*. (2012) for Al Hassa area of Saudi A*rabi*a. Arsenic content ranged from 0.08 to 0.90 mgL^{-1} with mean value of 0.46 mgL^{-1}, which was higher to the limit 0.1 mgL^{-1} as given by FAO (1985) [7], It may be due to addition of waste water in sewage line which is coming from arsenic compounds are also used in the manufacture of wood preservatives, some fungicides, pesticides and industrial activities such as in the fabrication of transistors, lasers and semiconductors, glass, pigments, textiles, paper, hide tanning and metal adhesives. Similar content of arsenic in sewage water of New Delhi 0.19 mgL^{-1} was observed by Chhibba and Nayyar (2005), Whereas, Co ranged between 0.06 to 0.10 mgL^{-1} with mean value of 0.08 mgL^{-1}.

Conclusion

From present data it can be concluded that, sewage water alongside of Mumbai railway track contains some high amount of micro nutrients and heavy metals which are toxic to plants as well as human being who are consuming it and are hazardous for human health beyond a certain limit. Sewage water used for irrigation to vegetable crops alongside Mumbai local railway track had Fe, Mn, Cr and As were beyond the permissible limits. Hence in general sewage water is not suitable for irrigation purpose.

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