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Assessment of soil quality in the Avaniapuram sewage farm of Madurai municipal corporation

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Abstract
Madurai City Corporation is one among the ten metropolitan cities in Tamil Nadu. Madurai city has two numbers of sewage treatment plants located one at Avaniyapuram and another at Sakkimangalam. This study aimed to study the soil quality of the treated sewage water received sewage farm of Avaniapuram, Madurai Municipal Corporation. In present study, the soil pH of 7.15 and 7.29, EC of 1.28 and 1.20 dSm^{-1}, organic carbon content of 7.9 and 6.3 g/kg, Available N of 555 & 546 $kgha^{-1}$, Available P of 41 & 34 $kgha^{-1}$ and Available K of 559 & 491 $kgha^{-1}$ in surface soil and sub-surface soil respectively in Avaniyapuram sewage farm.

Keywords: pH, EC, organic carbon and available NPK

Introduction
In India, total waste water generated per annum from 200 cities is about 2600 Mm^3 (Kaul *et al.*, 1989) [2] and also the use of sewage effluents for irrigating agricultural lands is on the rise especially in the peri-urban area. These waste waters carry appreciable amounts of toxic metals (Brar *et al*., 2000; Yadav *et al*., 2002) [10] and concentrations of trace metals in sewage effluents vary from city to city. Although the concentration of heavy metals in sewage effluents are low, long-term use of these waste waters on agricultural lands often results in the build-up of the elevated levels of these metals in soils (Rattan *et al.*, 2002) [5]. Madurai city corporation is one among the ten metropolitan cities in Tamil Nadu. Having located at almost in the southern part of the state, it is the city for education and business. City covers an area of 148.99 square kilometre.

Wastewater is the part of the drainage water after the water supply to the community or to the industry which has been used for different purposes and has been mixed with solids either suspended or dissolved. Sewage indicates the liquid waste from the community. It includes sludge, discharge from latrins, urinals, stable industrial waste and also the ground surface water that may be admitted into the sewer. In India, municipal committees are utilizing partly treated sewage water per day for irrigating about 1740 hectares of agricultural land. Sewage water contains about 6 - 10% N, 3- 4% P and 3- 4% K. while sludge contains about 1.5 - 3.5% N, 0.75 - 4% P and 0.3 - 0.6% K. Most of the sewage generated in the towns and cities on the banks of a river is conveniently allowed to flow into the river. The sewage treatment plants located at Avaniyapuram, Madurai has 125 MLD capacity. Hence, the study is taken up to assess the soil quality in the sewage farm, Madurai Municipal Corporation.

Materials and Methods
Collection of soil samples
Soil samples collected from Avaniapuram sewage farm, treated sewage water irrigated fields were collected from 2 depths i.e. 0-15 cm depth in polythene bags. The soil collected from each depth was mixed, dried, crushed and sieved with a 2 mm sieve. The prepared soil samples were then stored in polyethylene bags for analysis. The Soils were analysed for pH and EC by potentiometry and conductometry by Jackson (1973) [1], Organic carbon by chromic acid wet digestion method (Walkley and Black, 1934) [9], Available Nitrogen by Alkaline $KMnO_4$ method (Subbiah and Asija, 1956) [7], Available Phosphorus by Colorimetric, 0.5M $NaHCO_3$ extraction method (Olsen *et al.*,1954) [4] and Available Potassium by Neutral normal NH_4OAc method (Stanford and English,1949) [8].

Results and Discussion

Sewage irrigated soil chemical properties of Avaniapuram farm (Table 1 & 2)

Twenty five surface and sub-surface soil samples are collected from Avaniyapuram sewage farm. The most unique characteristic of the soil solution is its reaction. It significantly affects the availability of most the chemical elements of importance to plants. In present study, soil surface soil pH was lower in sewage irrigated soil, with a mean value of 7.15 and sub-surface soil pH was higher mean value of 7.29 in Avaniyapuram. The results indicated there is no alarming level of pH even with the application of sewage water irrigation. A continuous irrigation of sewage water increase the soil pH in subsurface soil, the reduced bulk density (fine texture) in subsurface soil has also helped in settlement of CO3 and HCO3 which is in turn influence the increase in pH. These results are similarly noticed by Khurana *et al*. (2012) [3].

Soil Electrical conductivity ranged from 0.20 to 2.55 dSm^{-1} in surface soils 0.18 to 2.44 dSm^{-1} in sub-surface soils of Avaniyapuram farm. The decrease of soil EC increased with the depth of soil. The EC was normal to slightly saline in range and hence the cultivation of crops will not be a problem even after continuation application of the sewage water. The mean organic carbon content is high in surface soil (7.9 g/kg) and medium in sub surface soil (6.3 g/kg). The organic carbon content of sewage irrigated soil was high which is ascribed to the addition of organic matter through long term application of sewage effluent. Thus sewage application to soils is a carbon building/sequestrating and soil quality sustaining practice.

Table 1: Soil reaction (pH), electrical conductivity (EC) and organic carbon (OC) content of sewage farm soils of Avaniyapuram

Sample No.	pH		EC (dS/m)		Organic carbon (g/kg)	
	Depth (0-15 cm)	Depth (15-30 cm)	Depth (0-15 cm)	Depth (15-30 cm)	Depth (0-15 cm)	Depth (15-30 cm)
1	7.47	7.5	1.57	1.53	6.7	4.4
2	7.56	7.62	1.86	1.76	6.2	5.0
3	7.19	7.32	2.04	1.83	6.4	5.2
4	7.39	7.43	0.9	0.89	6.3	5.3
5	7.4	7.42	0.96	0.92	8.1	6.3
6	7.54	7.55	0.81	0.73	9.6	7.5
7	7.39	7.43	0.9	0.89	6.3	5.3
8	7.22	7.38	0.89	0.83	9.2	6.6
9	7.19	7.36	0.9	0.88	10.3	8.3
10	7.22	7.37	1.02	0.97	9.4	7.3
11	7.09	7.36	0.84	0.72	9.8	8.4
12	7.68	7.72	0.2	0.18	9.8	7.6
13	7.05	7.14	1.42	1.19	8.8	6.3
14	7.05	7.17	1.19	1.12	8.7	7.2
15	7.11	7.22	0.96	0.90	8.8	6.4
16	7.08	7.28	1.65	1.56	8.9	6.2
17	7.17	7.53	0.59	0.54	7.5	6.4
18	7.23	7.24	2.06	1.97	6.8	6.5
19	7.24	7.45	0.83	0.77	9.1	7.1
20	6.87	7.09	1.18	1.12	7.3	6.2
21	6.58	6.89	2.55	2.44	7.5	6.2
22	6.74	6.95	1.79	1.61	6.8	5.3
23	6.78	6.80	1.75	1.58	6.8	5.2
24	6.80	6.95	1.89	1.83	6.4	5.5
25	6.74	7.00	1.31	1.18	6.7	5.2
Min	6.58	6.80	0.20	0.18	6.2	4.4
Max	7.68	7.72	2.55	2.44	10.3	8.4
Mean	7.15	7.29	1.28	1.20	7.9	6.3
Std. Err	0.05	0.04	0.07	0.09	0.2	0.5
SD	0.30	0.27	0.46	0.58	1.3	1.6

The sewage irrigated soils recorded higher available N, P and K indicating their significant addition through sewage suggesting use of sewage water as a low grade cheap fertilizer in agriculture which can markedly reduce the cost due to substitution of chemical fertilizer. The sewage irrigation resulted maximum mean value of available NPK in surface soil (555, 41 and 559 kg/ha) and minimum mean values recorded in sub surface soil (546, 34 and 491 kg/ha) in Avaniyapuram farm respectively. The higher nitrogen content in liquid sewage and sewage sludge could have caused an increase in soil available nitrogen. Phosphorus, mostly in organically bound form in combination with high amounts of plant residues in soil, could have enhanced the phosphorus status of sewage farm soil. Available phosphorus content decreased with increased soil depth and also distance from the sewage farm. Available potassium content of soil increased with an increased sewage water irrigation and potassium content in soil decreased as the distance and soil depth. Similar, findings were observed by Rusan *et al*. (2007) [6].

Table 2: Soil available N, P and K in sewage soil farm soils of Avaniyapuram

Sample No.	Available N (kg/ha)		Available P (kg/ha)		Available K (kg/ha)	
	Depth (0-15 cm)	Depth (15-30 cm)	Depth (0-15 cm)	Depth (15-30 cm)	Depth (0-15 cm)	Depth (15-30 cm)
1	518	512	36	32	680	672
2	486	470	46	39	370	365
3	560	554	46	42	415	384
4	572	564	43	29	482	465
5	520	516	40	36	428	381
6	496	486	39	32	322	185
7	510	489	36	18	327	293
8	545	528	46	42	485	366
9	565	554	42	40	497	272
10	552	548	51	45	492	348
11	574	562	50	42	491	465
12	460	456	48	42	512	492
13	574	568	38	32	691	479
14	575	571	45	40	586	549
15	569	552	64	43	847	768
16	578	568	56	47	725	688
17	576	568	50	45	597	576
18	582	574	61	43	444	356
19	570	565	49	44	482	416
20	585	578	35	32	532	409
21	568	556	28	26	568	541
22	592	584	20	17	641	584
23	588	576	19	15	742	714
24	590	578	16	13	965	891
25	576	569	15	13	652	608
Minimum	460	456	15	13	322	185
Maximum	592	584	64	47	965	891
Mean	555	546	41	34	559	491
Std. Error	8.6	8.8	2.5	3.4	23.78	22.6
SD	38.6	40.5	11.4	12.3	146.2	112.5

Conclusion

The treated effluent in the Avaniapuram has been discharged mainly for the sewage farm where it was cultivated with CN hybrid for which high load of organic carbon and other nutrients are highly useful since it is a voracious feeder and quick grower. The analysed soil samples revealed that it has no problem with pH, EC and other nutrient parameters and harmless for the growth of grasses.

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