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Impact of Industrial Effluent on Physico-Chemical Properties of Soil in Unnao District of Uttar Pradesh, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A study was carried out during 2021-22 considering various vegetable growing farmers in Unnao District (U.P.) to find out the effect of using industrial effluents as the only source of irrigation to their crops. 250 surface soil samples collected from farmer's field were analyzed for physical as well as chemical parameters. The physical properties of soils improved due to industrial effluent irrigation. Among the physical properties bulk density ranged from 1.15 to 1.55 Mg m^{-3} and particle density ranged between 2.61 to 2.86 Mg m^{-3}. Chemical Parameters of soil such as pH , EC, OC, Available N, P &K were also analyzed and the results indicated that soils had a mean pH of 8.1, E.C. of 1.25 dSm^{-1}, O.C. of 0.756 %, available nitrogen ranged from 377 – 1035 kg ha^{-1} with mean of 658.26 kg ha^{-1}.The Phosphorus availability was found ranging from 20.5 – 48.80 kg ha^{-1} with a mean of 35.97 kg ha^{-1}, while Potassium was found with a mean of 204.12 kg ha^{-1} in range of 163 – 302.2 kg ha^{-1}.

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1. INTRODUCTION

Water and nutrients are the major inputs for crop production. With the rapid growth in industrialization in different countries, the pollution problem is also on the increase, which have resulted in utilization of significant quantities of fresh water available for agriculture. It is predicted that most of the Asian countries will face severe problem related to water availability by 2025 [1]. This has resulted in the application of waste water/ effluents to agricultural soil are a useful source of plant nutrients, particularly nitrogen and phosphorous and also organic matter that can potentially improve soil fertility and physical properties [2-4]. However, in addition to these beneficial effects, effluents often contain appreciable amounts of both organic and inorganic toxic materials. Many organic pollutants, being biodegradable, are less persistent, and presumably have transient and less serious effects as they are eventually metabolized to carbon dioxide and other inorganic substances [5-7].

In many areas of developing countries, untreated wastewater flows through channels into rivers where it is diverted by subsistence farmers to small plots of vegetables including tomato, cabbage, beetroot and others which are easily consumed as salad [8-10]. The public health risks of using such contaminated streams for irrigation are obvious [11] (WHO 2004).However, treated effluents can be used for irrigation under controlled conditions to minimize the transfer of pathogenic and toxic contaminants into agricultural products, soil surfaces and groundwater [12].

Since, industrial effluent is a pool of various elements, it may be beneficial in enhancing the fertility status of soil as it contains appreciable amount of essential plant nutrients that are taken up by crops during plant growth and development [13,14]. Amount of available nitrogen, phosphorus and other nutrients also increase in the soil but excess of them can leach and pollute groundwater under continuous effluent use for long periods [15].

2. MATERIALS AND METHODS

Unnao is the second township across the river Ganga, located between the rivers Ganga and Sai, roughly 22 km from Kanpur. The District is located between Latitudes 26°8' and 27°2' North and 80°3' and 81°3' east. It is divided from Kanpur and Fatehpur by the Ganga on the west, Lucknow on the east, Rae Bareli on the south, and Hardoi on the north. It covers 4589 sq. km of land. The Ganga, which forms the district's western and southern boundaries, and the Sai, which forms the district's northern and eastern boundaries, are its two principal rivers. About twenty or so tanneries are located in the district of Unnao, which is adjacent to Kanpur.

In the present investigation total 250 soil samples (0-20 cm) were collected from farmer’s field with the help of tube auger randomly from field during rabi season nearby effluent outlet who engage in irrigating their crops with industrial effluents.

3. RESULTS AND DISCUSSION

Particle density was not changed in effluent irrigated soil. This can be attributed to improvement in total porosity and aggregate stability in the effluent irrigated soils due to addition of organic matter which plays an important role in improving soil physical environment. Rattan *et al.* [16] observed enhanced available water content in the soils due to continuous application of effluents and sewage. In case of industrial effluent irrigated soils; the bulk density increase in comparison to sewage irrigated soil; the reason being abundant load of metal in soil causes deflocculation of soil aggregates by the activity of Na. Similar conclusions were suggested by Rai *et al.* (2011).

The pH of soils irrigated with industrial effluents was not much influenced. The electrical conductivity in sewage irrigated soils was high due to salt content of sewage of domestic origin (Khurana *et al.* 2004). However, it was below the threshold limit to cause salinity hazard to the soil. The organic carbon content of industrial effluent irrigated soils was high which is ascribed to the addition of organic matter through long-term application of effluents. Improvement in soil quality is also evident from the improved physical properties of effluent-fed soils. This also corroborate the farmers view in this peri-urban area who express that the industrial effluent application is useful for improving soil quality, good crop growth and higher crop yields in absence of addition of any organic manures in these soils. The carbon sequestration resulting due to increase in soil organic carbon (SOC) on

Table 1. Effect of industrial effluents on physical properties of soil

Bulk Density (Mg/m^3)					Particle Density (Mg/m^3)					Porosity (%)				
E_1	E_2	E_3	E_4	E_5	E_1	E_2	E_3	E_4	E_5	E_1	E_2	E_3	E_4	E_5
1.15	1.38	1.25	1.33	1.35	2.62	2.61	2.68	2.65	2.68	44.28	49.54	51.48	47.18	47.39
1.33	1.45	1.33	1.48	1.44	2.66	2.65	2.75	2.72	2.83	47.55	52.69	55.33	49.55	51.25
1.27	1.53	1.41	1.35	1.39	2.63	2.78	2.63	2.68	2.75	45.83	50.35	52.76	48.23	48.93
1.19	1.49	1.29	1.44	1.42	2.67	2.63	2.71	2.63	2.84	46.39	51.78	54.89	47.95	50.76
1.35	1.35	1.35	1.39	1.38	2.72	2.72	2.65	2.81	2.79	45.27	53.42	53.25	48.69	49.44
1.22	1.47	1.28	1.41	1.51	2.65	2.68	2.74	2.75	2.81	47.83	49.35	54.62	49.83	51.86
1.18	1.51	1.42	1.37	1.47	2.68	2.75	2.62	2.69	2.69	48.65	50.72	53.85	50.25	47.69
1.31	1.48	1.39	1.45	1.43	2.64	2.71	2.73	2.83	2.77	44.89	53.28	55.44	49.72	50.23
1.24	1.55	1.27	1.38	1.38	2.69	2.64	2.69	2.77	2.86	48.23	51.63	51.97	48.98	49.78
1.32	1.39	1.43	1.42	1.52	2.67	2.74	2.65	2.74	2.72	46.78	52.59	54.33	47.68	51.85

Where, E_1 to E_5 denotes five effluent irrigated soils from which sample has been taken into consideration

Table 2. Effect of industrial effluents on chemical properties of soil

pH					Electrical Conductivity (dS/m)					Organic Carbon (%)				
E_1	E_2	E_3	E_4	E_5	E_1	E_2	E_3	E_4	E_5	E_1	E_2	E_3	E_4	E_5
7.95	8.02	8.05	8.02	7.93	1.07	1.24	1.05	1.13	1.35	0.44	0.87	0.88	0.64	0.56
8.08	8.08	8.08	8.06	8.05	1.11	1.37	1.22	1.27	1.42	0.48	0.56	0.76	0.76	0.45
7.97	8.05	8.15	8.11	7.99	1.09	1.28	1.08	1.15	1.39	0.76	0.84	0.56	0.87	0.92
8.12	8.03	8.11	8.08	8.07	1.15	1.33	1.17	1.21	1.47	0.86	0.76	0.67	0.80	0.87
8.07	8.11	8.07	8.15	7.94	1.13	1.29	1.25	1.19	1.33	0.75	0.97	0.83	0.85	0.65
7.99	8.07	8.04	8.07	8.11	1.08	1.32	1.18	1.32	1.47	0.64	0.67	0.91	0.67	0.46
8.05	8.15	8.12	8.16	7.97	1.14	1.35	1.09	1.28	1.35	0.87	0.90	0.77	0.93	0.70
8.02	8.12	8.09	8.13	8.03	1.12	1.41	1.16	1.17	1.44	0.98	0.56	0.64	0.99	0.98
8.14	8.09	8.11	8.18	8.08	1.17	1.39	1.13	1.24	1.37	0.94	0.89	0.56	0.66	0.64
8.09	8.14	8.16	8.14	8.15	1.15	1.27	1.27	1.29	1.41	0.76	0.76	0.86	0.89	0.84

Where, E_1 to E_5 denotes five effluent irrigated soils from which sample has been taken into consideration

Table 3. Effect of industrial effluents on chemical properties of soil

Available Nitrogen (kg/ha)					Available Phosphorus (kg/ha)					Available potassium (kg/ha)				
E_1	E_2	E_3	E_4	E_5	E_1	E_2	E_3	E_4	E_5	E_1	E_2	E_3	E_4	E_5
383	738	930	377	653	32.4	34.3	20.5	40.2	27.5	215	206	168	163	185
394	745	948	385	678	39.7	38.5	26.2	46.8	31.8	258	211	173	175	193
387	763	967	394	694	45.2	37.9	24.7	45.3	29.4	293	217	175	168	188
403	774	984	408	686	48.8	35.2	23.4	41.9	33.9	245	208	169	173	197
398	812	1035	423	702	37.5	36.7	29.2	43.5	32.7	302	215	174	169	194
425	795	992	389	679	43.9	39.4	25.9	44.6	35.3	277	212	171	175	191
443	784	1021	411	713	42.2	41.2	21.5	47.4	34.5	285	219	178	177	189
457	833	975	447	708	38.7	38.8	28.8	42.9	28.5	269	214	165	184	195
413	825	1013	435	725	46.4	40.5	27.3	43.7	30.8	234	213	177	178	192
468	847	989	397	668	33.9	37.3	22.9	46.5	32.6	298	218	182	181	198

Where, E_1 to E_5 denotes five effluent irrigated soils from which sample has been taken into consideration long-term effluent use is thus beneficial not only in mitigating the pollution problem but also in improving the soil quality [16].

The amount of available N content in industrial effluent irrigated soil was 658.3 kg ha^{-1} and was higher than amount of available N in normal water irrigated soil due to abundant presence of raw organic matter content in the effluent irrigated soil. Similar findings were suggested by Kumar et al. [17]. The available P_2O_5 in industrial effluent and sewage irrigated soils were 35.97 & 23.9 Kg ha^{-1} respectively, and it was in high category as per fertility rating. The tannery effluent contains decomposed bone materials which is the constituent of raw bone meal phosphoric fertilizer. Potassium content in industrial effluent irrigated soils & sewage irrigated soils were 204.1 and 205.3, kg ha^{-1} respectively. Similar findings are supported by Mitra and Gupta [18] and Kharche *et al.* [19].

4. CONCLUSION

Continuous use of industrial effluent irrigation recorded improvement in soil physical properties like bulk density, water retention, organic carbon and build-up of soil available N, P, K, status. The industrial effluent irrigated soils had higher electrical conductivity and organic carbon as compared to the ground water irrigated soils. The electrical conductivity although increased due to effluent, it was within the tolerance limit to cause any soil salinity hazard. Available macronutrients including Nitrogen, Phosphorus and Potassium were also found to be higher than the normal level which lead to enhanced growth of vegetable crops thereby benefiting the farmers.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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