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Assessment of Physico-Chemical Properties of Soil from Different Areas of Sri Ganganagar District, Rajasthan

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ABSTRACT

Municipal wastewater is water and pollutants that arise from households, for instance, laundry, cooking, and toilets. It also consists of stormwater and water from industries and hospitals. Municipal wastewater contains BOD, nutrients (mainly nitrogen and phosphorus), persistent chemicals, metals, and oil. The reuse of treated effluent (for agriculture and as a supplement for drinking water needs) is currently receiving attention as a reliable water source. This paper is aimed at reviewing the environmental and health impacts of untreated or inadequately treated wastewater effluents. The quality of wastewater effluents is responsible for the degradation of the receiving water bodies. This is because untreated or inadequately treated wastewater effluent may lead to eutrophication in receiving water bodies and also create environmental conditions that favour the proliferation of waterborne pathogens of toxin-producing cyanobacteria. Since large amounts of wastewater effluents are passed through sewage treatment systems daily, there is a need to remedy and diminish the overall impacts of these effluents on receiving water bodies. In order to comply with wastewater legislation and guidelines, there is a need for adequate treatment before discharge. This can be achieved through the application of appropriate treatment processes, which will help to minimize the risks to public health and the environment. To achieve unpolluted wastewater discharge into receiving water bodies, careful planning, adequate and suitable treatment, regular monitoring, and appropriate legislation are necessary.

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KEYWORDS: Moisture Content, pH Value, Micro nutrient, Available Phosphorus, Electrical Conductivity.

1. INTRODUCTION

The effluents generated from domestic and industrial activities constitute the major sources of the natural water pollution. This is a great burden in terms of wastewater management and can consequently lead to a point-source pollution problem, which not only increases treatment cost considerably but also introduces a wide range of chemical pollutants and microbial contaminants to water sources. Industrial activities and urbanization in developing countries have gradually led to the deterioration of the environment in recent years. This situation has invariably increased the problem of waste disposal. Untreated wastes from processing factories located in cities are discharged into inland water bodies, resulting in stench, discoloration, and a greasy, oily nature of such water bodies.

The analysis of wastewater from different locations in Amritsar city has shown that the concentration of Fe, Mn, Cu, Zn varies several-fold and in certain cases were present in toxic range (Singh *et al.*)[2]. J. R. Sanders and T. M. Adams[3]: The effects of pH on concentrations of zinc, copper, and nickel extracted by calcium chloride from a clay loam and two sandy loam soils that had been treated with sewage sludge were studied. The data collected in Punjab indicate that the disposal of this wastewater on agricultural lands can prove highly harmful because, with time, a sizeable amount of heavy and toxic elements will accumulate in soil through which they reach the plants, animals, and human beings (Twana *et al.*)[4]. Jallan[5] studied the composition of domestic sludge in Raipur, Madhya Pradesh, the main factor responsible for pollution of water bodies in Urban India. Agarwal and Panday[6] studied the soil pollution by spent discharge and depletion of Mn (II) and impairment of its oxidation. Limpitlaw *et al.*[7] observed that many soils are impacted by activities such as intensive agronomic practices or surface mining activities. These soils are newly created substrates/growth media, and are often inhospitable to vegetation due to a combination of physical, chemical, and microbiological factors. McCray *et al.*[8] used a numerical flow and transport model to provide a brief description of the transport and transformation of N and P contaminants in a soil-based wastewater treatment system. Singh, Sarolia, and Shekhawat monitored the quality of underground water of the semi-arid tract and its impact on soil. They observed that the EC of irrigation water has a significantly positive correlation with the EC of the solid and a weak positive correlation with the pH of the soil. Singh Jasbir, Bora Indrani[10] studied the physicochemical attributes of soil under Jhumurivation in Amphengiri (Burnihat), Meghalaya. He found that the soil pH significantly increased immediately after burning, while it declined during the cropping and harvesting cycle. Mc Dowell and Sharply[11] have observed that soil AMC and soil erosion were associated in affecting the potential loss of soil nutrients within the catchment areas. Adhikari S, Gupta S.K.[12], worked on the quality of sewage effluents of the dry weather flow channel, which was assessed in order to utilize it for irrigation. Different methods of waste treatment have been developed for reasons of public health and conservation, which result in the destruction of pathogens and the mineralization of the organic components of sewage before discharge. Anaerobic wastewater treatment using a granular sludge reactor is one of two such methods (Boadi and Kuitunen).[13] Meena *et al.*[14] have studied the status of macro and Micronutrients in Some Soils of Tonk District of Rajasthan, Sharma R. K. *et al.* [15] have stated that heavy metal contamination of soil resulting from wastewater irrigation is a cause of serious concern due to the potential health impacts of consuming contaminated produce. Sushanta Saha *et al.*: The effects of sewage[16] water on the accumulation of heavy metals (Zn, Cu, Pb, Cd, and Ni) in soils and commonly grown plants were evaluated by monitoring the fields along the water channel running some 30 km eastward of Kolkata, West Bengal, India. Sharma D. K. *et al.*[17] told that salt-induced land degradation adversely affects the productivity of ~1000 million hectares of agricultural land worldwide. Salt-affected soils occupy 6.73 M ha area in India, of which ~56% are sodic and the remainder 44% saline. Pushpanjali *et al.*[18] studied that agricultural land near to industries, often unnoticed, accumulates a lot of harmful chemicals and heavy metals. Bhaduri D. *et al.*[19] experimented on cowpea-groundnut rotation to study the effect of saline irrigation water on the availability of micronutrient cations (Fe, Zn, Cu, and Mn) in soil and in plants with the effect of a gradual imposition of irrigation salinity. An Assessment of Physico-chemical properties of soil from different blocks of Visakhapatnam district, Andhra Pradesh was carried out by Sahua R. K. *et al.*[20]

2. MATERIALS AND METHODS

2.1 Study Areas

Sri Ganganagar is the northernmost district of Rajasthan. It is considered an irrigated desert and is dominated by agriculture and agriculture-based industries. Historically, it was the estate of Maharaja Ganga Singh, and its name was given as Sri Ganganagar by Maharaja Ganga Singh. Some documents provide evidence that Maharaja Ganga Singh established this city on the theme of Paris. Sri Ganganagar is also known as the food basket of Rajasthan because of its crop potential. The samples collected from the major sector of Sri Ganganagar district, which are namely: 1. Meera Chonk SSB road, 2. Suratgarh Road, 3. Karanpur Road, Bharat Nagar, 4. Gurunanak Basti, the old sugar mill area.

Description of sampling points

S. No.	Sampling station code	Nearby sites	Description of sampling station
1.	L1	S1, S2, S3	Meera Chonk SSB road
2.	L2	S1, S2, S3	Suratgarh Road
3.	L3	S1, S2, S3	Karanpur Road, Bharat Nagar
4.	L4	S1, S2, S3	Guru Nanak Basti, old sugar mill area

2.2 Soil sampling

Polythene bags of 2 kg capacity were used for the collection of samples. Before the bags were used, they were labelled as follows: Sample number, name or place of sampling station, date and time, name of the district/city/village and state, name of the sample collector, temperature, and depth below surface. When soil was collected from the area influenced by the sewage In the water of municipal areas, a sufficient quantity of soil was removed before collecting the sample from it.

2.3 Details of instruments used

Conductivity meter

Conductivity denotes the capacity of a substance or solution to conduct an electric current. The conductivity of a cube with

each side of 1 cm at 25°C is called specific conductance. It is generally measured with the help of a conductivity meter, Systronic model 335. The main feature of most conductivity meters is a conductivity cell containing electrodes of platinum coated with Pt black or carbon. These electrodes are mounted rigidly and placed parallel at a fixed distance. Most conductivity meters work on the principle of the stone bridge, in which the cell forms an arm of the bridge. The instrument and cell are calibrated using a 0.005 M KCl solution.
Conductance K = 1/Ra/L.
The conductivity depends upon the area of the metallic plates in the cell and the distance between them. To convert the observed conductance into specific conductance, the values are multiplied by the factor called the cell constant, which is generally supplied by the manufacturer.

Spectrophotometer
A spectrophotometer is used for measuring absorption in the UV and visible regions.

Analysis of Mn, Cu, and Zn
Stock standard solution
The standard solution of different micronutrient cations (Fe, Mn, Cu, Zn) was prepared by using their foil or wire (AR grade). 0.1 g of the foil was dissolved in dil. HCl. (1+1) and made the volume to one liter with demineralized water to obtain a 100 µg/ml solution of every micronutrient cation.

Working standard solution
Manganese: 0, 1, 2, 3, 4, 6, and 8 ml of the stock solution (100 µg/ml or 100 ppm Mn) were transferred to a series of 100 ml volumetric flasks and diluted to the mark with DTPA extracting solution. The standard solution thus prepared had Mn concentrations of 0, 1, 2, 3, 4, 6, and 8 µg/ml (ppm).
Copper: 0, 1, 2, 4, 6, 8 ml of stock solution containing 100µg/ml (100) ppm Cu were transferred to a series of 100 ml volumetric flasks and diluted to the mark with DTPA extracting solution. It gave standard solutions having Cu concentrations 0, 1, 2, 4, 6, and 8 µg/ml (ppm).
Zinc: 10 ml of stock standard solution was transferred to a 100 ml volumetric flask and diluted up to the mark with DTPA extracting solution to have a stock solution of 10 µg/ml (10 ppm). Took 0, 1, 2, 4, 6, and 8 ml of stock solution (10 µg/ml) to a series of 100 ml volumetric flasks and diluted each to the mark with DTPA extracting solution. This gave a standard solution having zinc concentrations 1.0.1, 0.2, 0.4, 0.6, 0.8 µg/ml (ppm).

Extract of soil samples for Mn, Cu, and Zn: Weighted 10g air-dried and thoroughly processed soil sample. It was transferred to a 100 ml narrow-mouth polythene or 100 ml conical flask. An additional 20 ml of DTPA-extracting solution was added. Stopper the bottle and shake on an electric shaker for 2 hours at 25° C. Filter the content with Whatman No. 1 or 42. Kept the filtrate in bottles for the analysis of Fe, Mn, Cu, and Zn. The micro nutrient cations in soil extracts were determined with the use of AAS. Set the zero of the instrument to blank. Fed Standards belonging to the element to be determined to AAS to standardize the instrument to read absorbance and concentration. In the samples having the given element within the standardized range. Then, we fed the DTPA extract and recorded the absorbance/concentration of the element. The steps were reported for every element. Then, a standard curve had to be prepared for the known standard and the absorbance reading to get the value of micro nutrient cations (Fe, Mn, Cu, and Zn).

3 RESULTS AND OBSERVATIONS

3.1 Moisture content: The soil analyzed for the location L2 showed a minimum mean value of moisture content, i.e., 6.89%. The minimum mean value of moisture content was followed by the locations L1 and L3, having values 7.02% and 8.69% respectively. The maximum mean value was observed at location La, i.e., 10.19%. The percentage difference of mean values for the moisture content of locations L1, L2, L3, and L4 was 32.42%. The mean values at different locations for moisture content had no significance with respect to each other. The soil analyzed for location L1 showed that the minimum moisture content was observed at site S2, i.e., 6.85%. The minimum value was followed by 7.08% at site S1, and the maximum value was observed at site S3, i.e., 7.14%. The values for moisture content at sites S1, S2, and S3 had no significance with respect to each other at location L1. The soil analyzed for location L2 showed that the minimum moisture content was observed at site S3, i.e., 6.19%. The minimum value of moisture content was followed by 6.96% at site S1, and the maximum value was observed at site S2, i.e., 7.51%. The values for moisture content at sites S1, S2, and S3 had no significance with respect to each other at location L2. The soil analyzed for location L3 showed that the minimum moisture content was observed at site S1, i.e., 8.51%. The minimum value of moisture content was followed by 8.68% at site S3, and the maximum value was observed at site S2, i.e., 8.87%. The values for moisture content at sites S1, S2, and S3 had no significance with respect to each other at location L3. The soil analyzed for location L4 showed that the minimum moisture content was observed at site S1, i.e., 9.85%. The minimum value of moisture content was followed by 10.31% at site S2, and the maximum value was observed at site S, i.e., 10.43%. These values at different sites also did not show any significance with respect to each other at location L4. The values of different sites of locations L1, L2, L3, and L4 are shown in the figure. The formula used for the moisture content is given below.

$$\text{Moisture Content (\%)} = \frac{I - F}{I} \times 100$$

I = Initial weight of sample (g), F = Final weight of dried sample.

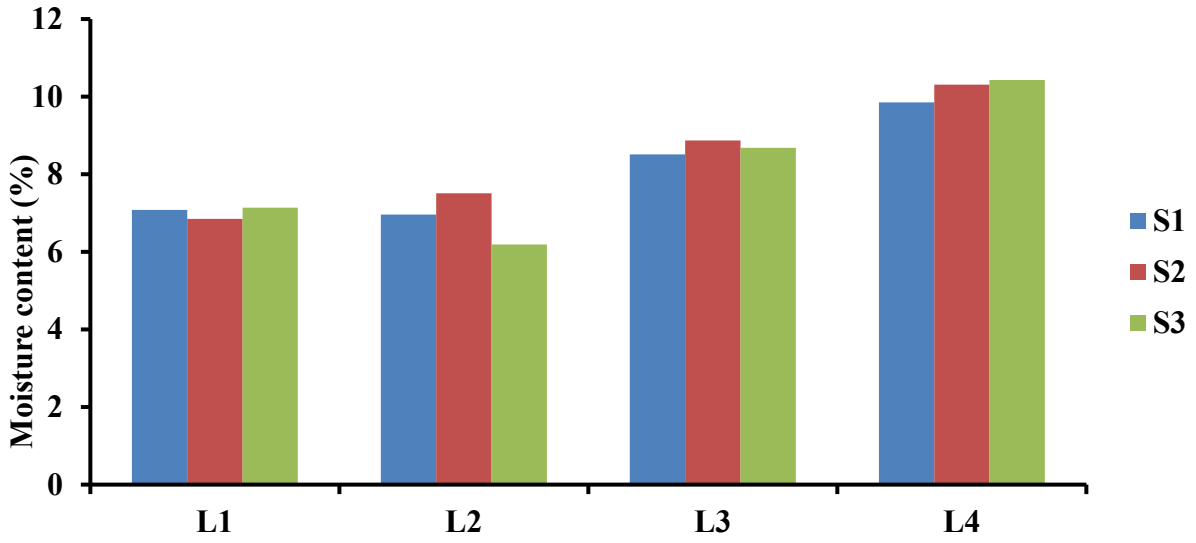

Figure 1: Shows the values of Moisture Content (%) of different samples of Locations L1, L2, L3, and L4.

3.2. Electrical Conductivity: The soil analyzed for the location L3 showed the minimum mean value for electrical conductivity, i.e., 0.2 ds/m. The minimum value of electrical conductivity was followed by 0.22 ds/m and 0.26 ds/m for locations L1 and L4, respectively. The maximum value was observed at location L2, i.e., 1.14 ds/m. The percentage difference of mean values for the electrical conductivity of locations L1, L2, L3, and L4 was 82.46%. The maximum mean value for electrical conductivity at location L2 was significant in comparison to all other values of location L1, L3, and L4, while the mean values for L1, L3, and L4 did not show any significance with respect to each other. The soil analyzed for location L1 showed the minimum electrical conductivity was observed at site S2, i.e., 0.17 ds/m. The minimum value for EC was followed by 0.18 ds/m at site S3, and the maximum value was observed at site S1, i.e., 0.32 ds/m. These values of sites S1, S2, and S3 did not show any significance with respect to each other at location L1. The soil analyzed for location L2, it showed that the minimum EC was observed at site S2, i.e., 0.62 ds/m. The minimum value for EC was followed by 1.38 ds/m at site S1 and the maximum value was observed at site S3 i.e., 1.41 ds/m. The value of EC at site S2 was significant in comparison to the value of EC at sites S1 and S2, while S1 and S3 values were not significantly different from each other. The soil analyzed for location L3 showed that the minimum value of EC was observed at site S1, i.e., 0.17 ds/m. The minimum value for EC was followed by 0.20 ds/m at site S2, and the maximum value was observed at site S3, i.e., 0.23 ds/m. These values of EC did not significantly differ from each other. The soil analyzed for location L4 showed that the minimum value of EC was observed at site S3, i.e., 0.22 ds/m. The minimum value for EC was followed by 0.23 ds/m at site S2, and the maximum value was observed at site S3, i.e., 0.32 ds/m. These values were also not significant in comparison to each other. The values of different sites of locations L1, L2, L3, and L4 are shown in Figure -2.

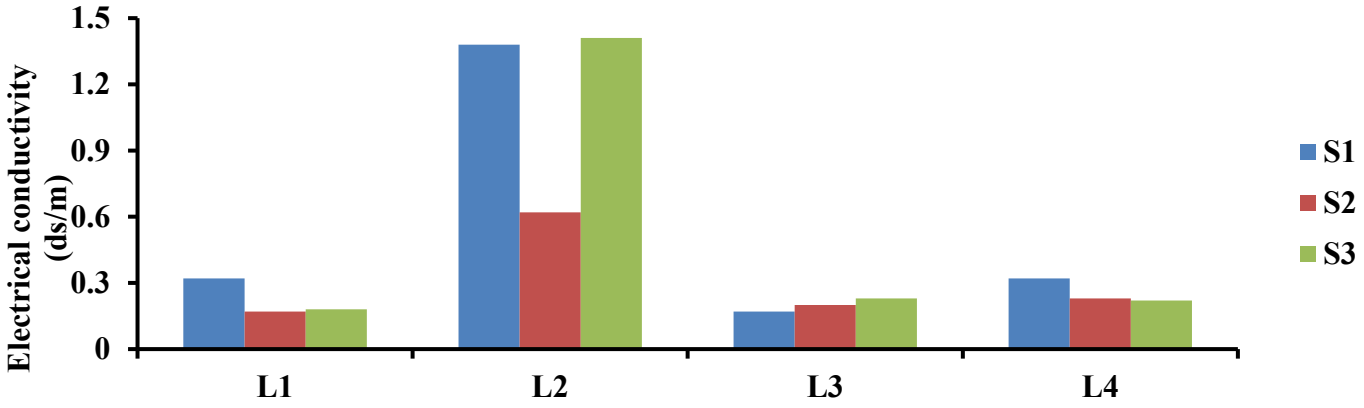

Figure 2: Shows the values of EC (ds/m) of different Samples of Locations L1, L2, L3, and L4.

3.3 Manganese: The soil analyzed for location L2 showed the minimum mean value of Mn, i.e., 0.95 ppm. The minimum mean value of Mn was followed by 1.33 ppm and 2.13 ppm at locations L4 and L3, respectively, and the maximum mean value of Mn was observed at location L1, i.e., 4.66 ppm. The percentage difference of the mean value of Mn of locations L1, L2, L3, and L4 was 79.61%. The mean value of Mn at locations L1, L2, L3, and L4 was not significant with respect to. Each other. The soil analyzed for location L1 showed that the minimum value of Mn was observed at site S3, i.e., 2.11 ppm. The minimum value of Mn was followed by 2.29 ppm at site S3, and the maximum value was observed at site S1, i.e., 9.58. The maximum value of Mn at site S1 was significant in comparison to the values at sites S2 and S3 of location L1. The value of Mn at site S2 was not significant with respect to the value at site S3 of location L1.

The soil analyzed for location L2 showed that the minimum value of Mn was observed at site S1, i.e., 0.81 ppm. The minimum value of Mn was followed by 0.93 ppm at site S2, and the maximum value was observed at site S3, i.e., 1.11 ppm. The values of sites S1, S2, and S3 were not significantly different from each other at location L2. The soil analyzed for location L3 showed that the minimum value of Mn was observed at site S1, i.e., 1.61 ppm. The minimum value of Mn was followed by 2.07 ppm at site S2, and the maximum value was observed at site S3, i.e., 2.70 ppm. The values of sites S1, S2, and S3 did not show significance with respect to each other when statistically analyzed. The soil analyzed for location L4 showed that the minimum value of Mn was observed at site S2, i.e., 0.93 ppm. The minimum value of Mn was followed by 1.03 ppm at site S1, and the maximum value was observed at site S3, i.e., 2.03 ppm. The values of sites S1, S2, and S3 of location L4 were not significantly different from each other. The values of different sites of locations L1, L2, L3, and L4 are shown in Table 1.

Table 1: Showing the values of Mn (ppm) of different Samples of Locations L, L2, L3, and L4.

Location	S1	S2	S3	Mean
L1	9.58	2.29	2.11	4.66
L2	0.81	0.93	1.11	0.95
L3	1.61	2.07	2.70	2.13
L4	1.03	0.93	2.03	1.33

3.4 Cupper: The soil analyzed for location L1 showed the minimum mean value of Cu, i.e., 0.74 ppm. The minimum mean value of Cu was followed by 2.95 ppm and 5.61 ppm at locations L4 and L3, respectively, and the maximum mean value of Cu was observed at location L2, i.e., 6.28 ppm. The percentage difference of the mean value of Cu at locations L1, L2, L3, and L4 was 88.21%. The minimum value at location L1 showed significance with respect to the value at locations L2 and L3, and the value 2.95 ppm at location L4 was significant in comparison to L2 and L3. While the values at location L2 and L3 were not significant with respect to each other. The soil analyzed for location L1 showed that the minimum value of Cu was observed at site S1, i.e., 0.59 ppm. The minimum value of Cu was followed by 0.71 ppm at site S2, and the maximum value of Cu was observed at site S2, i.e., 0.93 ppm. These values at sites S1, S2, and S3 of location L1 were not significantly different from each other. The soil analyzed for location L2 showed that the minimum value of Cu was observed at site S1, i.e., 5.01 ppm. The minimum value of Cu was followed by 6.09 ppm at site S2, and the maximum value of Cu was observed at site S3, i.e., 7.73 ppm. When statistically analyzed, the minimum value at site S1 showed significance in comparison to site S3 but was not significant with respect to site S2. Also, values at S2 and S3 were significant with respect to each other. The soil analyzed for location L3 showed that the minimum value of Cu was observed at site S1, i.e., 4.61 ppm. The minimum value of Cu was followed by 5.09 ppm at site S2, and the maximum value of Cu was observed at site S3, i.e., 7.13 ppm. The minimum value at site S1 showed significance with respect to the maximum value at site S3 of location L3. The value of S2 and S3 sites was non-significant in comparison to each other. The soil analyzed for location L4 showed that the minimum value was observed at site S2, i.e., 2.70 ppm. The minimum value of Cu was followed by 2.81 ppm at site S1, and the maximum value of Cu was observed at site S3, i.e., 3.34 ppm. These values at sites S1, S2, and S3 of location L4 were not significantly different from each other. The values of different sites of locations L1, L2, L3, and L4 are shown in Table 2.

Table 2: Showing the values of Cu (ppm) in different Samples of locations L1, L2, L3, and L4**.**

Location	S1	S2	S3	Mean
L1	0.59	0.71	0.93	0.74
L2	5.01	6.09	7.73	6.28
L3	4.61	5.09	7.13	5.61
L4	2.81	2.70	3.34	2.95

3.5 Available Phosphorus: The soil analyzed for location L1 showed a minimum mean value of average Phosphorus, i.e., 133.33 kg/ha. The minimum mean value of the average Phosphorus was followed by 202.50 kg/ha and 214.17 kg/ha. For locations L4 and L2, respectively, and the maximum value of the average

Phosphorus was observed at location L3, i.e., 240 Kg/ha. The percentage difference of mean values for the average Phosphorus of locations L1, L2, L3, and L4 was 44.44%. The mean values for average Phosphorus at locations L1, L2, L3, and L4 were not significant with respect from each other. The soil analyzed for location L1 showed that the minimum value of average Phosphorus was observed at site S1, i.e., 110 kg/ha. The minimum value of average Phosphorus was followed by 115.00 Kg/ha at site S2, and the maximum value was observed at site S3, i.e., 175.00 kg/ha. These values of sites S1, S2, and S3 were not significantly different from each other. The soil analyzed for location L2 showed that the minimum value of average Phosphorus was observed at site S1, i.e., 190 kg/ha. The minimum value of average Phosphorus was followed by 212.50 kg/ha at site S2, and the maximum value was observed at site S3, i.e., 240.00 kg/ha. There was no significance between the sites S1, S2, and S3 of location L2. The soil analyzed for location L3 showed that the minimum value of average Phosphorus was observed at site S2, i.e., 205 kg/ha. The minimum value of average Phosphorus was followed by 235.00 kg/ha at site S1, and the maximum value was observed at site S3, i.e., 280.00 Kg/ha. The values of sites S1, S2, and S3 were not significantly different from each other. The soil analyzed for location L4 showed that the minimum value of average Phosphorus was observed at site S1, i.e., 190.00 kg/ha. The minimum value of average Phosphorus was followed by 200.00 kg/ha at site S2, and the maximum value was observed at site S3, i.e., 217.50 kg/ha. These values did not show significant differences with respect to each other. The values of different sites of locations L1, L2, L3, and L4 are shown in Table 3.

$$\text{Av. Phosphorus (Kg/ha)} = \frac{\text{Reading x Volume make x Volume of extract}}{\text{Weight of aliquote x Weight of soil}} \times 22.4 \times 10^6$$

Table 3: Showing the values of average Phosphorus (Kg/ha) of different Samples of Locations L1, L2, L3, and L4.

Location	S1	S2	S3	Mean
L1	110.00	115.00	175.00	133.33
L2	190.00	212.50	240.00	214.17
L3	235.00	205.00	280.00	240.00
L4	190.00	200.00	217.50	202.50

3.6 Zinc: The soil analyzed for location L1 showed the minimum mean value of Zn, i.e., 1.28 ppm. The minimum mean value of Zn was followed by 2.12 ppm and 2.65 ppm at locations L4 and L2, respectively, and the maximum mean value of Zn was observed at location L3, i.e., 2.76 ppm. The percentage difference of the mean value of Zn at locations L1, L2, L3, and L4 was 53.62%. The maximum mean value of Zn at location L3 was significant in comparison to the minimum value at location L1. While the L2 location was not significantly different from the values of locations L3 and L4. The soil analyzed for location L1 showed that the minimum value of Zn was observed at site S2, i.e., 0.99 ppm. The minimum value of Zn was followed by 1.04 ppm at site S1. The maximum value was observed at site S3, i.e., 1.80 ppm. The values of Zn of sites S1, S2, and S3 of location L1 were not significantly different from each other when they were statistically analyzed. The soil analyzed for location L2 showed that the minimum value of Zn was observed at site S1, i.e., 2.50 ppm. The minimum value of Zn was followed by 2.71 ppm at site S2. The maximum value was observed at site S3, i.e., 2.73 ppm. The values of Zn at sites S1, S2, and S3 of location L2 were not significantly different from each other when they were statistically analyzed. The soil analyzed for location L3 showed that the minimum value of Zn was observed at site S1, i.e., 2.71 ppm. The minimum value of Zn was followed by 2.76 ppm at site S2, and the maximum value was observed at site S3, i.e., 2.82 ppm. The values of sites S1, S2, and S3 of location L3 were not significantly different from each other. The soil analyzed for location L4 showed that the minimum value of Zn was observed at site S2, i.e., 1.99 ppm. The minimum value of Zn was followed by 2.12 ppm at site S3, and the maximum value of Zn was observed at site S1, i.e., 2.25 ppm. The value of Zn at sites S1, S2, and S3 was statistically analyzed; it was observed that they were not significantly different from each other. The values of different sites of locations L1, L2, L3, and L4 are shown in Table 4.

Table 4: Showing the values of Zn (ppm) in different Samples of Locations L1, L2, L3, and L4.

Location	S1	S2	S3	Mean
L1	1.04	0.99	1.80	1.28
L2	2.50	2.71	2.73	2.65
L3	2.71	2.76	2.82	2.76
L4	2.25	1.99	2.12	2.12

CONCLUSION

The toxic chemicals are discharged by industry into the air, water, and soil. They get into the human food chain from the environment. Once they enter our biological system, they disturb the biochemical processes, leading in some cases to fatal results. The high pH value of the soil may be due to the presence of sodium salts in the soil. The mean values of average P, average K, Cu, and Zn at different locations are more than the normal values. The mean value of Mn at location L1 is less than the normal value, but the value of Mn at all other locations is more than the normal value. The values that are more than normal values may cause many problems, e.g., a higher Mn value is toxic to plants, a moderate value of Cu is toxic to plants, a high value of Zn is toxic to plants, and a high value of Mn also causes nerve damage/damage to the reproductive system. At last, it may be concluded that the quality of soil has an impact on public health standards through the human food chain. The environmental health aspects of soil deserve serious attention in the near future.

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Conflict of Interest: No

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