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Evaluation of Oudh sugar mill effluent impact on soil properties and heavy metal accumulation in the soil of Rosa, Shahjahanpur (U.P.)

Kapil Kumar Yadav, Arun Alfred David, Narendra Swaroop, Tarence Thomas, Amreen Hasan and Mohd Noman

Abstract
The soil samples were collected from Bhavalkhera block of the Shahjahanpur district (U.P.) from three depths *viz.* 0-15 cm, 15-30 cm and 30-45 cm. Twenty seven samples were selected from nine different sites for analysis with the help of completely randomized design. The results revealed that the soil colour changed from Olive yellow to Yellow colour in the dry condition while dark grey brown colour predominant in the wet condition. Soil texture in bhavalkhera was clay loam. The bulk density varied from 1.05 to 1.21 Mg m^{-3}, particle density from 1.5 to 2.85 Mg m^{-3}, specific gravity from 1.74 to 2.84. The water holding capacity ranged from 64 to 88%, pore space was 47 to 66%. The pH ranged from 6.45 to 8.20, electrical conductivity from 0.046 to 0.239 dS m^{-1}. Organic carbon ranged from 0.87 to 1.725% suitable for sustainable farming. Available nitrogen ranged from 202 to 424 kg ha^{-1}, available phosphorus ranged from 38 to 49 kg ha^{-1} and available potassium ranged from 67 to 168 kg ha^{-1}, all of which showed decreased value with increased in depth. Exchangeable Calcium varied from 1.3 to 1.9 [cmol (p^{+}) kg^{-1}], exchangeable magnesium from 0.9 to 1.6 [cmol (p^{+}) kg^{-1}], available sulphur ranged from 10 to 19 ppm, available iron ranged from 4.5 to 12 ppm, available manganese ranged from 5 to 13 ppm, available copper ranged from 0.2 to 0.8 ppm and available zinc ranged from 0.5 to 1.1 ppm, all of which varied significantly with depth. This study revealed that the untreated wastewater discharged from the sugar industry is found polluted and exceeds the prescribed limits for irrigation and public use.

Keywords: Soil properties, heavy metal, sugar mill effluent etc.

Introduction
The sugar industry is a very important agro-based industry in India and it discharges large amount of effluent into water bodies and cultivated land to create high pollution which affects the plants and other living organisms (Vaithiyanathan *et al.*, 2017) [30]. It is a seasonal Industry operating for maximum of 4-5 month in one season. India is the largest producer of sugarcane in the world. Sugar production processing requires huge water for a number of steps and released almost equal quantity of effluent which contains toxic material. There recent studies have indicated that the effluent discharge from sugar consist of a number of organic and heavy metal pollutant in dissolved or suspended form that can bring about changes in the physical, chemical and physiological sphere of the biota. The effluents of industries has ultimate disposal in agriculture field (Bhatt *et al.*, 2016) [6]. Sugar mills across the country have produced 306.65 lakh tonnes of sugar. In Uttar Pradesh, sugar production stood at 110.61 lakh tonnes till June 15 of 2020-21 as against 126.30 lakh tonnes in the corresponding period of the previous year (Indian Sugar Mills Association 2021) [13]. The effluent that is generated from the sugar industry, if used directly for irrigation then it will disturb the Soil fertility as well as affect the growth of plants. The sugar mill's effluent reduces the soil quality. These effluents also distress the soil Bacteria and fungi which maintain the soil fertility will be in danger by the highly toxic chemicals releases from sugar industry (Khan *et al.*, 2019) [16]. Use of industrial effluent and sewage sludge on agricultural land has become a common practice in India as a result of which these toxic metals can be transferred and concentrated into plant tissues from the soil. These metals have damaging effects on plants themselves and may become a health hazard to man and animals (Samuel *et al.*, 2014) [21]. Non-stop use of SME harmfully affects the crops when used for irrigation.

As a result, various elements including heavy metals get deposited in the soil and pollute it, and this polluted soil reduces both the quality of soil as well as the production of crops and also cause corrosion in water pipes (Sangeeta *et al.*, 2017) [22].

Materials and Methods

The present study entitled "Evaluation of Oudh Sugar Mill effluent impact on Soil properties and Heavy Metal accumulation in the Soil of Rosa, Shahjahanpur, (U.P.)", was carried out during 2020-21 in Department of Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture Technology And Sciences, Prayagraj - 211 007, (U.P.), India.

Details of the study site

The latitudinal and longitudinal extent of the district Shahjahanpur is 27°35' to 28°20' N and 79°37' to 80°23' E. The total area of the district Shahjahanpur is 4575 sq. km (Survey of India, 2001) [28] and total population is 25, 49,458 persons, according to 2001 census.The study site is Oudh Sugar Mills Limited (OSML) Rosa, incorporated on July 26, 1932, belongs to the renowned K. K. Birla Group of companies. The K. K. Birla Group is a major player in key industries like fertilizers, chemicals, heavy engineering, textiles, shipping and media etc. apart from sugar from a modest beginning in 1932, OSML has grown to become the pioneers in the sugar industry. Oudh Sugar Mills Limited reports (September 2020)].

Soil Sampling

Soil samples were collected from the fields where sugar mill effluent was used as irrigation water. Soil samples were collected from irrigated fields of 9 sites of 3 different farmers of Rausar village comes under Bhavalkhera block. The profile depths were 0-15cm, 15-30cm and 30-45cm. Twenty seven samples were collected from 9 sites of 3 farmers of Rausar village of Bhavalkhera block, Shahjahanpur. Samples were collected using Soil auger and Khurpi by random selection. The samples were air dried and all the unwanted materials were removed. Grinding was followed by sieving for which 2.0 mm sieve was used. Sieved soil samples were stored in air-tight plastic bags and tagged for estimation of physico-chemicals and heavy metals properties.

Table 1: Sampling sites of Oudh Sugar Mill, Rausar, Shahjahanpur

District	Block	Village	Farmers	Site	Depth (cm)
Shahjahanpur	Bhavalkhera	Rausar	Mr. Aneesh	S_1	D_1 D_2 D_3
Shahjahanpur	Bhavalkhera	Rausar	Mr. Aneesh	S_2	D_1 D_2 D_3
Shahjahanpur	Bhavalkhera	Rausar	Mr. Aneesh	S_3	D_1 D_2 D_3
Shahjahanpur	Bhavalkhera	Rausar	Mr. Mahesh	S_1	D_1 D_2 D_3
Shahjahanpur	Bhavalkhera	Rausar	Mr. Mahesh	S_2	D_1 D_2 D_3
Shahjahanpur	Bhavalkhera	Rausar	Mr. Mahesh	S_3	D_1 D_2 D_3
Shahjahanpur	Bhavalkhera	Rausar	Mr. Shubhash	S_1	D_1 D_2 D_3
Shahjahanpur	Bhavalkhera	Rausar	Mr. Shubhash	S_2	D_1 D_2 D_3
Shahjahanpur	Bhavalkhera	Rausar	Mr. Shubhash	S_3	D_1 D_2 D_3

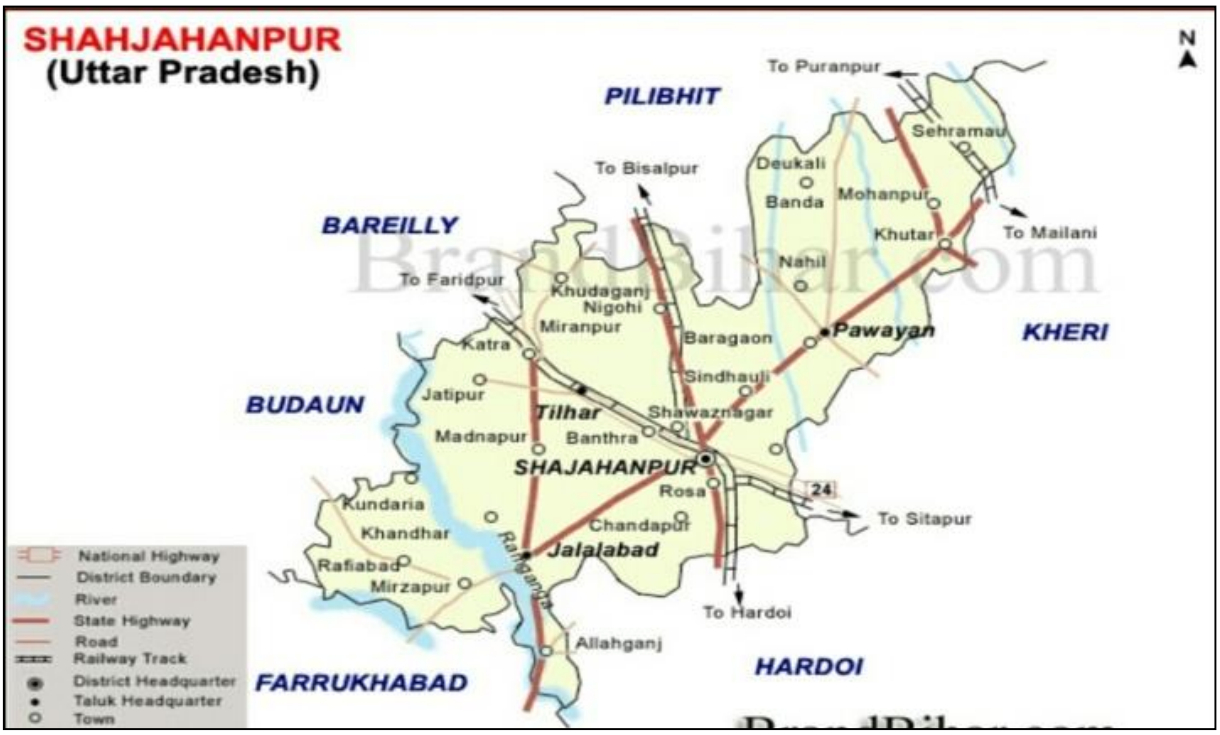

Table 2: Analysis of physic-chemical parameters

S. No.	Parameters	Method	Scientist (Years)
1	Soil textural	Hydrometer method	Bouyoucos, (1927) [8]
2	Soil colour	Munsell soil colour chart	Munsell, (1971)
3	Bulk density	Graduated Measuring Cylinder	Muthuvel *et al.*,(1992) [18]
4	Particle density	Graduated Measuring Cylinder	Muthuvel *et al.*,(1992) [18]
5	% pore space	Graduated Measuring Cylinder	Muthuvel *et al.*,(1992) [18]
6	Water holding capacity	Graduated Measuring Cylinder	Muthuvel *et al.*,(1992) [18]
7	Specific gravity	Pycnometer method	Black, (1965) [7]
8	Soil pH (1:2.5)	pH meter	Jackson, (1958)
9	EC (dS m^{-1})	EC meter	Wilcox, (1950) [32]
10	Organic carbon	wet oxidation method	Walkley & Black, (1947) [31]
11	Available Nitrogen	Kjeldahl method	Subbiah & Asija, (1956) [26]
12	Available Phosphorus	Spectrophotometric method	Olsen, *et al.* (1954) [19]
13	Available Potassium	Flame photometer method	Toth and Prince (1949) [29]
14	Heavy metals (Pb, Cd, Cr, Cu, Ar and Ni)	DTPA method	Lindsay and Norwell, (1975)

Statistical analysis

The data recorded during the course of investigation was subjected to statistical analysis by the method of analysis of variance (ANOVA) technique (Fisher, 1960) [12]. The implementing design of experiment in the analysis done will be CRD (completely randomised design) CRD is the most simplest and flexible design. It is used when experimental units are homogenous as it involves only two basic principle of the design of experiment namely replication and randomisation. CRD is used for laboratory purpose only. Loss of information due to missing data is small compared to other due to the larger no. of degree of freedom for the error source of variation.

Results and Discussion

The soil texture in village Rausar is dominantly Clay loam with relative proportion of Sand 26.72%, Silt 35.50% and clay 37.78%. Most of the crops are grown in these soils. Similar finding were reported by Khadka *et al.*, (2016) [15]. As depicted in table 3 statistical accumulations on bulk density Mg m^{-3} of soil in village Rausar. Significant difference was found due to depth and site. The bulk density was found from 1.05 to 1.21 Mg m^{-3}. The highest value found in F_3S_1 (30-45cm) 1.21 Mg m^{-3} and the lowest value found in F_1S_2 (0-15cm) 1.05 Mg m^{-3}. The bulk density increases with the increase in soil depth. Similar finding were reported by Soil Survey Staff (2014) [25]. The particle density Mg m^{-3} was found no significant difference due to depth and significant difference due to site. The particle density was found from 1.5 to 2.85 Mg m^{-3}. The highest value found in F_2S_3 (30-45cm) 2.85 Mg m^{-3} and the lowest value found in F_3S_3 (0-15cm) 1.5 Mg m^{-3}. Density of soil particles not shows too much variation according to the depth of soils. Maximum particle density will be less than 2.65 Mg m^{-3}. Similar finding were reported by Suleiman (2016) [27]. The Pore space % was found no significant difference due to depth and site. The Pore space was found from 47 to 66%. The highest value found in F_2S_3 (0-15cm) 66% and the lowest value found in F_3S_3 (30-45cm) 47%. It shows that 0-15cm depth soils are having high amount of macro and micro pores. Similar finding were reported by Dee and Bauder (1994) [11]. As depicted in table 4 statistical accumulations on Water holding capacity % of soil in village Rausar. No significant difference was found due to depth and site. The Water holding capacity % was found from 64 to 88 (%). The highest value found in F_1S_3 (30-45cm) 88% and the lowest value found in F_3S_3 (0-15cm) 64%. Increasing

with depth Water holding capacity will decrease the amount of macro pores will get decreased. Similar finding were reported by Schoeneberger and Wysocki, (2012) [23]. The Specific gravity was found significant difference due to depth and non-significant difference due to site. The Specific gravity was found from 1.74 to 2.84. The highest value found in F_3S_3 (0-15cm) 1.74 and lowest in F_3S_2 2.84.

Table 3: Assessment of Bulk density, Particle density and Pore space of Soil from different depth 0-15, 15-30 and 30-45 cm of village Rausar, Oudh Sugar Mill, Shahjahanpur

Farmer site	Bulk density (Mg m $^{-3}$)			Particle density (Mg m $^{-3}$)			Pore space (%)		
	0-15cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15cm	15-30cm	30-45 cm
F_1S_1	1.11	1.17	1.11	2.22	2.33	2.85	64	61	50
F_1S_2	1.05	1.11	1.11	2.22	2.25	2.33	66	50	47
F_1S_3	1.11	1.12	1.11	1.81	1.61	2.00	52	60	55
F_2S_1	1.08	1.11	1.11	2.33	2.85	2.85	66	61	61
F_2S_2	1.14	1.05	1.05	2.33	2.66	2.85	65	60	63
F_2S_3	1.08	1.11	1.05	2.65	2.85	2.85	62	61	63
F_3S_1	1.11	1.17	1.21	2.45	2.67	2.33	66	52	57
F_3S_2	1.11	1.17	1.17	2.61	2.65	2.00	61	64	64
F_3S_3	1.14	1.17	1.17	1.5	2.65	2.85	64	63	64
	F-test	S. Ed. (±)	C.D.@0.05%	F-test	S.Ed. (±)	C.D.@0.05%	F-test	S.Ed. (±)	C.D.@0.05%
Due to depth	S	0.01113	0.032482	NS	0.303493	0.000275	NS	3.483205	0.128586
Due to site	S	0.033546	0.402454	S	0.167358	3.24	NS	2.477886	0.219762

Table 4: Assessment of Water holding capacity and Specific gravity of Soil from different depth 0-15, 15-30 and 30-45 cm of village Rausar, Oudh Sugar Mill, Shahjahanpur

Farmer site	Water holding capacity (%)			Specific gravity		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
F_1S_1	*62.12*	*75*	65	*2.18*	*2.25*	2.29
F_1S_2	70.58	81	68	2.21	2.13	2.22
F_1S_3	77.00	75	88	2.15	2.19	2.26
F_2S_1	67.00	62	60	1.69	2.23	2.45
F_2S_2	69.00	77	68	2.27	2.34	2.35
F_2S_3	65.00	60	67	2.26	2.41	2.44
F_3S_1	*70.00*	*67*	67	*2.21*	*2.27*	2.28
F_3S_2	68.00	70	64	2.14	2.43	2.84
F_3S_3	64.00	65	68	1.74	2.11	2.24
	F-test	S. Ed. (±)	C.D. @ 0.05%	F-test	S. Ed. (±)	C.D. @ 0.05%
Due to depth	NS	5.031019	0.402454	S	0.131534	0.004623
Due to site	NS	1.097491	0.032482	NS	0.140916	0.082321

As depicted in table 5 statistical accumulations on Soil pH in village Rausar. The Soil pH range was found from 6.45 to 8.20. The highest value found in F_3S_2 (30-45cm) 8.20 and the lowest value found in F_1S_2 (0-15cm) 6.45, its increase in soil depth. Similar finding were reported by Abdel-Ghaphor, (1982). The EC dS m^{-1}, No significant difference was found due to depth and site. The EC range was found from 0.046 to 0.239 dS m^{-1}. The highest value found in F_2S_2 (0-15cm) 0.239 dS m^{-1} and the lowest value found in F_1S_2 (30-45cm) 0.046 dS m^{-1}, Organic carbon was found due be significant to depth and non-significant difference was found due to site. The Organic carbon was found from 0.87 to 1.725%. The highest value was found in F_1S_1 (0-15cm) 1.725% and the lowest value found in F_1S_3 (30-45cm) 0.87%. Highest amount of organic carbon present on surface soils 0-15cm depth compared to 15-30cm and 30-45cm depth. The bulk density at 30-45cm depth shown high compared to 0-15cm depth. Similar finding were reported by Soil Survey Staff, (2014) [25]. As depicted in table 6 statistical accumulations on Available Nitrogen (kg ha^{-1}) in village Rausar. Significant difference was found due to depth and non-significant difference was found due to site. The Available Nitrogen was found from 202 to 424 kg ha^{-1}. The highest value found in F_3S_1 (0-15cm) 424 kg ha^{-1} and the lowest value found in F_1S_3 (30-45cm) 202 kg ha^{-1}. Compared to 15-30cm and 30-45cm depth soils 0-15cm depth soils are containing highest amount of Available Nitrogen. Similar finding were reported by Adaikwu and Ali, (2013). The Available Potassium kg ha^{-1} was found significant difference due to depth and non-significant difference due to site. The Available Potassium was found from 67 to 168 kg ha^{-1}. The highest value found in F_1S_1 (0-15cm) 168 kg ha^{-1} and the lowest value found in F_2S_3 (30-45cm) 67 kg ha^{-1}. Presence of Available Potassium is high at 0-15cm depth compared to 15-30cm, and 30-45cm. Potassium fixation will be high at 30-45cm compared to 0-15cm and 15-30cm depth soils. Similar results were reported by Singh *et al.* (2018) [24]. The Available Phosphorus kg ha^{-1} was found no significant differences due to depth and site. The Available Phosphorus range was found from 38 to 49 kg ha^{-1}. The highest value found in F_1S_2 (0-15cm) 49 kg ha^{-1} and the lowest value found in F_3S_2 (30-45cm) 38 kg ha^{-1}. It shows high amount of Phosphorus at 0-15cm depth. Similar finding were reported by Adaikwu and Ali, (2013). As depicted in table 7 statistical accumulations on Exchangeable Calcium [cmol (p^+) kg^{-1}] in village Rausar. Significant difference was found due to depth and site. The Exchangeable Calcium was found from 1.3 to 1.9 [cmol (p^+) kg^{-1}]. The highest value found in F_2S_3 (30-45cm) 1.9 [cmol (p^+) kg^{-1}] and the lowest value found in F_2S_1 (0-15cm) 1.3 [cmol (p^+) kg^{-1}]. The Exchangeable Magnesium [cmol (p^+) kg^{-1}] was found significant difference was found due to depth and site. The Exchangeable Magnesium range was found from 0.9 to 1.6 [cmol (p^+) kg^{-1}]. The highest value found in

F_3S_1 (30-45cm) 1.6 [cmol (p^+) kg^{-1}] and the lowest value found in F_1S_1 (0-15cm) 0.9 [cmol (p^+) kg^{-1}]. The Sulphur ppm was found significant difference due to depth and site. The Sulphur range was found from 10 to 19 ppm. The highest value found in F_3S_2 (30-45cm) 19 ppm and the lowest value found in F_1S_1 (0-15cm) 10 ppm.

Table 5: Assessment of Soil pH, Electrical conductivity and Organic carbon of Soil from different depth 0-15, 15-30 and 30-45 cm of village Rausar, Oudh Sugar Mill, Shahjahanpur

Farmer site	Soil pH (1:2.5)			EC (dS m^{-1})			Organic carbon (%)		
	0-15cm	15-30cm	30-45cm	0-15cm	15-30cm	30-45 cm	0-15cm	15-30 cm	30-45 cm
F_1S_1	6.50	6.90	7.40	0.139	0.089	0.083	1.725	1.575	0.975
F_1S_2	6.45	6.80	7.45	0.24	0.198	0.170	1.245	1.020	1.02
F_1S_3	6.67	7.10	7.61	0.213	0.201	0.198	1.425	1.245	0.87
F_2S_1	6.60	6.95	7.65	0.156	0.136	0.124	1.395	1.020	1.02
F_2S_2	6.55	7.25	7.80	0.239	0.210	0.198	1.140	1.050	1.05
F_2S_3	6.73	7.40	7.78	0.189	0.167	0.134	1.575	1.00	1.02
F_3S_1	6.88	7.42	7.78	0.069	0.052	0.046	1.545	1.245	0.87
F_3S_2	7.40	7.65	8.20	0.081	0.066	0.056	1.425	1.245	1.05
F_3S_3	7.24	7.45	7.86	0.089	0.078	0.054	1.575	1.425	1.05
	F-test	S. Ed. (±)	C.D.@0.0%	F-test	S. Ed. (±)	C.D.@0.05%	F-test	S. Ed. (±)	C.D.@0.05%
Due to depth	NS	0.473326	1.05	NS	0.063466	1.88	S	0.229228	0.016431
Due to site	NS	0.27595	2.31	NS	0.01974	1.1	NS	0.114695	0.635906

Table 6: Assessment of Available Nitrogen, Available Phosphorus and Available Potassium of Soil from different depth 0-15, 15-30 and 30-45 cm of village Rausar, Oudh Sugar Mill, Shahjahanpur

Farmer site	Available Nitrogen (kg ha^{-1})			Available Phosphorus (kg ha^{-1})			Available Potassium (kg ha^{-1})		
	0-15cm	15-30cm	30-45cm	0-15cm	15-30cm	30-45cm	0-15cm	15-30cm	30-45cm
F_1S_1	408	282	204	48	47	46	168	157	134
F_1S_2	392	282	267	49	48	46	145	134	101
F_1S_3	377	282	202	47	47	45	168	145	134
F_2S_1	377	345	251	48	46	44	157	145	130
F_2S_2	345	251	204	46	45	41	145	134	101
F_2S_3	392	345	267	47	46	45	130	101	067
F_3S_1	424	330	392	42	42	40	112	089	089
F_3S_2	408	314	267	40	39	38	134	112	089
F_3S_3	392	330	314	43	41	39	130	112	101
	F-test	S. Ed.(±)	C.D.@0.05%	F-test	S. Ed.(±)	C.D.@0.05%	F-test	S.Ed. (±)	C.D.@0.05%
Due to depth	S	33.96076	6.86	NS	3.090208	3.85	S	20.85	4.71
Due to site	NS	64.66791	0.014002	NS	1.467059	1.2	NS	19.06	2.16

Table 7: Assessment of Exchangeable Calcium, Exchangeable Magnesium and Sulphur of Soil from different depth 0-15, 15-30 and 30-45 cm of village Rausar, Oudh Sugar Mill, Shahjahanpur

Farmer site	Exch. Calcium [cmol (p^+)kg^{-1}]			Exch. Magnesium [cmol (p^+)kg^1]			Sulphur (ppm)		
	0-15cm	15-30cm	30-45cm	0-15cm	15-30cm	30-45cm	0-15cm	15-30cm	30-45cm
F_1S_1	1.5	1.6	1.8	0.9	1.0	1.2	10	15	17
F_1S_2	1.4	1.5	1.7	1.0	1.1	1.2	11	14	16
F_1S_3	1.6	1.6	1.8	1.1	1.2	1.3	12	13	14
F_2S_1	1.3	1.5	1.6	0.8	1.3	1.4	15	16	18
F_2S_2	1.5	1.6	1.7	1.0	1.3	1.5	13	15	17
F_2S_3	1.4	1.6	1.9	1.2	1.3	1.4	14	16	16
F_3S_1	1.5	1.7	1.8	1.1	1.4	1.6	13	14	16
F_3S_2	1.6	1.6	1.7	1.2	1.4	1.5	15	17	19
F_3S_3	1.4	1.7	1.8	1.3	1.5	1.5	14	15	17
	F-test	S. Ed. (±)	C.D.@0.05%	F-test	S. Ed. (±)	C.D.@0.05%	F-test	S. Ed. (±)	C.D.@0.05%
Due to depth	S	0.066202	6.95	S	0.133449	2.58	S	1.280191	7.92
Due to site	S	0.144587	0.041525	S	0.16863	0.000666	S	1.835857	0.000986

Table 8: Assessment of Iron, Manganese of Soil from different depth 0-15, 15-30 and 30-45 cm of village Rausar, Oudh Sugar Mill, Shahjahanpur

Farmer Site	Iron (ppm)			Manganese (ppm)		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
F_1S_1	4.5	6	9	6	7	9
F_1S_2	5.0	8	10	5	8	10
F_1S_3	6.0	7	9	6	9	12
F_2S_1	7.0	8	11	7	10	11
F_2S_2	6.0	8	10	6	8	10
F_2S_3	8.0	8	9	8	8	9
F_3S_1	7.0	9	12	7	9	13

F_3S_2	6.0	7	10	6	7	10
F_3S_3	8.0	9	9	7	9	11
	F-test	S. Ed. (±)	C.D.@ 0.05%	F-test	S. Ed. (±)	C.D.@0.05%
Due to depth	S	0.843457	6.24	S	0.83333	1.03
Due to site	S	1.762375	0.02808	S	2.057807	0.036451

Table 9: Assessment of Copper and Zinc of Soil from different depth 0-15, 15-30 and 30-45 cm of village Rausar, Oudh Sugar Mill, Shahjahanpur

Farmer Site	Copper (ppm)			Zinc (ppm)		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
F_1S_1	0.2	0.4	0.6	0.6	0.8	0.9
F_1S_2	0.3	0.5	0.7	0.7	0.9	1.0
F_1S_3	0.3	0.6	0.7	0.7	0.8	1.1
F_2S_1	0.4	0.5	0.8	0.8	0.9	0.9
F_2S_2	0.2	0.3	0.5	0.5	0.6	0.7
F_2S_3	0.3	0.4	0.6	0.6	0.7	0.9
F_3S_1	0.4	0.5	0.6	0.6	0.8	0.9
F_3S_2	0.2	0.3	0.5	0.5	0.7	0.8
F_3S_3	0.4	0.6	0.7	0.7	0.8	1.0
	F-test	S. Ed. (±)	C.D.@ 0.05%	F-test	S. Ed. (±)	C.D.@ 0.05%
Due to depth	S	0.91961	7.81	S	0.09542	3.45
Due to site	S	0.16679	4.93	S	0.138926	8.27

Conclusion

It was concluded that the soil of Rausar Shahjahanpur, U.P. are found to be significant in physical and chemical conditions due to use of effluent discharge from the sugar mill in agriculture field. The soils are acidic to neutral and were found to be fertile with slight toxicities of metals. It will be helpful for farmers to adopt organic and low budget farming in the region for sustainable farming.

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