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RESEARCH ARTICLE

Physico-chemical properties of soils of Muzaffarnagar district as influence by the discharge of paper mill and distillery effluents

■ **SUSHIL KUMAR, G.R. SINGH, H.K. YADAV AND K.S. NEHRA**

SUMMARY

The influence of effluents of paper mill and distillery present work is based on the physico- chemical analysis of effluents released from sugar factory, distillery paper mills and fertilizers industry. It was found that different industries the consume huge amount of water and throw back almost an equal amount of effluents containing highly toxic materials in solids and dissolved form. The colour of the effluent from sugar mills, paper mills and other effluent was dark brownish with unpleasant smell, the temperature of untreated effluent was recorded 43^0C. The temperature of the discharge should not exceed 35^0C. The high temperature *i.e.* 43^0C of the untreated effluent has adversely affected the process, pH range from (6.8 to 9.0), EC (0.39 to 5.82 dSm^{-1}) mean value 1.28, total cat ion range from 79.0 to 1226.0 mean value 260.6 and total anions range from 249.8 to 3137.4 mean value 715.0 whereas back ground of physico-chemical properties of soil profile data showed in Table 2. According to the permissible levels suggested by APHA standard all the water quality parameters in the sugar effluents have been found to be very high and well above the permissible limits.

Key Words : Effluents from sugar factory, Paper mills, Fertilizers industry, Soil profile

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MEMBERS OF THE RESEARCH FORUM

Author to be contacted :
SUSHIL KUMAR, Department of Agricultural Chemistry and Soil Science, C. C. R. D. College, MUZAFFARNAGAR, (U.P). INDIA
Email: sushil.ash30@gmail.com

Address of the Co-authors:
G.R. SINGH, Department of Agricultural Chemistry and Soil Science, C. C. R. D. College, MUZAFFARNAGAR, (U.P). INDIA

H.K. YADAV, Department of Soil Science, C.C.S. Haryana Agricultural University, HISAR (HARYANA) INDIA

K.S. NEHRA, Department of Agricultural Chemistry and Soil Science, Kishan (P.G.) College SIMBHAOLI (U.P.) INDIA

A sugar industry consumes substantial volume of water and chemicals in different processing units. All chemicals used wash away with the waste water discharged through industrial outlet. Thus, effluents consist of all types of chemicals which contain toxic heavy metals. Effluents store pond is highly contaminated. Effluents moves along with heavy metals and reach in shallow water table by leaching processes and contamination may disperse in a wide range of the region. Contamination of soils of close areas occurs when the effluents or polluted water with soil makes the sodic soils

and alters the physico-chemical characteristics, texture and profile of soil stratum (Deshmukh, 2014). Sugar industries is one of the most important agro based industries in India and highly responsible for creating significant impact on rural economy in particular and countries in general. Sugar industries rank second among the agro based industries in India. Sugar industries are seasonal in nature and operate only for 120 to 200 days in a year. A significant large amount of waste generated during the manufacture of sugar and contains a high amount of production load particularly in items of suspended solids, organic matter, effluent, sludge, pressmud and bagasses (Muthusamy *et al.*, 2012).

Presently India has nearly 650 sugar mill that produce about 15 million tons of sugar and 13 million tons of molasses. Sugar mill account in the industries which discharge huge amount of effluent per day without any or partially treatment during the crushing season. Paper industries is an agro based industries, effluents generating from this industries contain considerable amount of organic and inorganic chemical components such as fibre, cellulose, wastes, wood dust, chlorine compounds, carbonates and bicarbonates. Direct discharge of effluents from these industries may have profound influence on soils physico- chemical and biological properties Prabakaran and Udayasoorian (2008). Though health of soil is wealth of a nation and any change in its physico- chemical properties may alter its quality. In this direction, an attempt has, therefore, been made to find out the effect of effluents from paper industries on physico-chemical and biological properties of soils. Ground water is the primary source of water for drinking, domestic, agricultural and industrial purpose in most of the countries. It plays an important role enhance the economy of India and ensure food security. Only about 1 per cent of all fresh water is available in rivers, ponds and lakes, out of which 0.03 per cent water require for survival of many form of animal and plant life on the earth surface. India accounts for 2.2 per cent of the global land and 4 per cent of the world water resource and 16 per cent of the world population.

MATERIAL AND METHODS

Muzaffarnagar is an important district in western Uttar Pradesh and the town Muzaffarnagar is the district Headquarter. It lies between latitude $29^0$11'N and $29^0$43'N and longitude $77^0$04'E and $78^0$07'E. It forms a part of the Saharanpur division and is situated in the interfluves of Ganga and Yamuna rivers between the districts of Saharanpur on the north and Meerut on the south. On the west, the Yamuna separates it from district Karnal of Haryana and on the east, the Ganga forms the boundary between this district and the district of Bijnor. Almost all the villages of the area are approachable by motarable roads. The collection of effluent Rohana sugar mill (TW), Titawi sugar mill (TW), Triveni sugar mill, Khatauli), Morna sugar mill (TW), Ticolla sugar mill (TW), Muzaffarnagar. Effluents samples were collected from the irrigation pipes installed (Table 3 and Fig. 1) temporarily at different locations across the district. Analyzed for their chemical properties *i.e*. pH, total salt (electrical conductivity), Anions (Cl^-, CO_3^-, HCO_3^-, SO_4^- and NO_3^-), Cations (Ca^{++}, Mg^{++}, Na^+, K^+). All the analysis of ground water was carried out in the laboratory of Department of Soil Science, CCRD College, Muzaffarnagar district (U.P), India by adopting the standard methods. Sukanya and Meli (2005)

RESULTS AND DISCUSSION

In the present study, pH value of disposal sites of paper mill, sugar mill and other effluents from the study area varies from 6.8 to 9.0 indicating normal to moderately alkaline nature of effluents (Table 1 and 3). These low values of effluents sample is due to usage of phosphoric acid and sulfur dioxide during the process of cleaning of sugar juice. High values of pH are related to higher ionic content in effluents. If such effluent water is used for irrigation for a longer period the soil become acidic to alkaline resulting in poor growth and yield (APHA, 2002). The recent studies by Piper (1966) have indicated that the moisture content of soil.

Electrical conductivity :

The conductivity measurement is an indicator of ionic concentration of water. It depends upon temperature and concentration and type of ions present (Hem, 1991). The electrical conductivity of the effluents and other disposal wastes varied from 0.39 to 5.82 d Sm^{-1}. High electrical conductivity is observed in the low laying alluvial part of the basin and near sugar factory area where stream is flowing along with effluents. Higher electrical values suggest existence of highly mineralized ground water. Mineralization is possibly due to higher residence time, sluggish movement of ground water and intensive water – rock interaction in the alluvial aquifers. Low electrical conductivity found are upstream part along

foothills or on the plateau top covered by non-irrigated agriculture. Rolling topography, relatively higher gradient and higher rate of flushing of salts provide less time for water rock interaction leads to lower electrical conductivity from the study area (Deshmukh, 2014). Table 3 shows the relationship between various indices of tube well irrigation water and soil properties at different depths.

Spatial variation in the cationic constituents :

Total cation in the sugar mills, paper mills and other discharge effluent from the study area range from 79.0 to 1226.0 mgl^{-1} (Table 1 and Fig. 1) (Deshmukh, 2014). Which located in the nearby sugar mill regions. The higher cations concentrations in the Mansurpur (FE) suggest that the effluent carrying stream and plagioclase feldspar as the dominant source. Similar results reported by (Hem, 1991). The higher concentration of cation in sugar mills, paper mills and other discharge effluent of Muzaffarnagar district due to the high concentration of cationic constituents in the discharge of wastes from the study area.

Spatial variation in the anionic constituents :

The concentration of anions range from 249.8 to 3137.4 mgl^{-1} (Table 1 and Fig. 1). The high anions concentration observed in the Mansurpur (FE), Tehsil

Table 1 : Chemical characteristics of water samples collected from the various disposal sites

Location	pH	EC (d Sm^{-1})	Total cations mg/ l	Total anions mg /l
Rohana sugar mill (TW)	7.1	1.36	258.9	747.9
Nirana Tannery (TW)	7.6	0.74	146.1	423.0
M.P.(Unit) Nirana (TW)	7.4	0.94	188.8	552.7
Ankur fertilizers (TW)	8	0.39	82.1	249.8
Khalapar (H.P.)	6.9	1.28	224.8	751.4
Shakumbri paper mill (TW)	7.8	2.25	416.2	1137.9
Titawi sugar mill (TW)	7.2	1.58	303.2	907.3
Rana paper mill (TW)	7.9	0.96	189.2	533.0
Begrajpur (TW)	6.8	1.02	191.3	546.0
Mansoorpur distillery (TW)	7.1	1.25	216.3	727.6
Sonta (TW)	7.1	1.12	196	657.1
Triveni sugar mill, Khatauli)	6.9	3.00	660.5	1696.9
Mansurpur (FE)	8	5.82	1226	3137.4
Morna sugar mill (TW)	7.5	0.39	79.1	252.6
Ticolla sugar mill (TW)	7.6	0.72	141.2	441.4
Kandela Drain, Kandela	7.7	1.20	273.4	680.2
Monnet sugar mill (TW)	7.8	0.52	97.9	293.4
Shamli Drain, Shamli	7.6	1.10	256.1	613.6
Sikka Nalla, Sikka	7.8	0.90	215.7	530.0
Kandela Nalla, Silpa	7.7	1.00	216.8	595.3
Shamli sugar mill	8	0.40	100.1	267.9
Lagoon water	9	0.90	211.8	335.9
Shamli paper mill	7.6	0.77	139.5	442.9
Bajaj sugar mill	7.2	1.16	228.5	657.7
Uttam sugar mill	7.4	1.25	257.5	698.4
Mean	-	1.28	260.6	715.0
Range	6.8-9.0	0.39-5.82	79.0-1226.0	249.8-3137.4

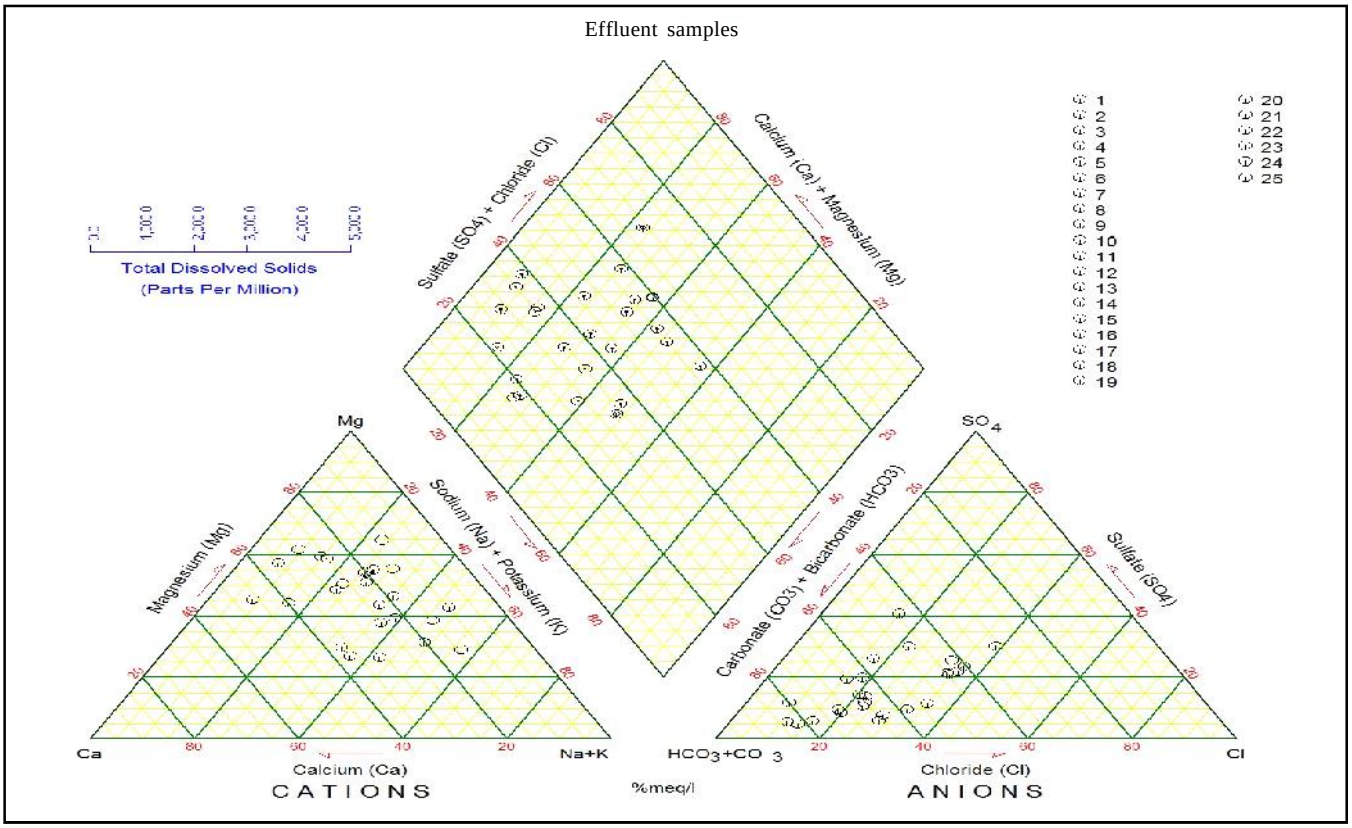

Fig. 1 : Chemical facies of irrigation water samples collected from disposal sites of effluents

Table 2 : Physico- chemical properties of soils of different depth

Location	Soildepth (cm)	Bulk density (gcm^{-3})	Texture	pH	EC ($d\ Sm^{-1}$)	CEC (me/100 g)	ESP (%)
Rohana sugar mill	0-15	1.41	Sandy	7.5	0.40	10.8	7.87
(TW)	15-30	1.45	loam	7.4	0.42	10.6	8.3
	30-45	1.43		7.3	0.40	10.2	8.92
Nirana Tannery (TW)	0-15	1.63	Clay	7.8	0.16	11.7	3.93
	15-30	1.67	loam	7.9	0.17	11.9	4.03
	30-45	1.65		7.6	0.18	11.3	4.6
MP (Unit), Nirana	0-15	1.56	Loamy	7.8	0.23	8.4	5.35
(TW)	15-30	1.63	sand	7.7	0.20	8.6	5.58
	30-45	1.58		7.6	0.21	8.2	5.97
Ankur fertilizers (TW)	0-15	1.3	Silt	8.3	0.13	10.9	3.33
	15-30	1.32	clay	8.1	0.14	10.4	3.55
	30-45	1.23		8.2	0.15	10.7	2.89
Khalapar (H.P.)	0-15	1.51	Silt	7.3	0.29	11.9	4.36
	15-30	1.53	loam	7.2	0.3	11.5	4.78
	30-45	1.49		7.0	0.28	11.2	5.08
Shakumbri paper mill	0-15	1.47	Silt	7.6	0.60	12.26	11.09
(T.W.)	15-30	1.54	loam	7.7	0.61	13.29	10.68
	30-45	1.42		7.5	0.63	14.87	9.75
Titavi sugar mill (TW)	0-15	1.39	Silt	7.5	0.35	11.2	6.78
	15-30	1.4	clay	7.4	0.37	10.8	7.22
	30-45	1.38		7.3	0.36	10.6	6.79

Table 2 : Contd……..

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Rana paper mill (TW)	0-15	1.48	Clay	7.8	0.20	10.5	5.8
	15-30	1.51	loam	7.7	0.21	10.5	6
	30-45	1.47		7.5	0.22	9.9	5.85
Begrajpur (TW)	0-15	1.67	Silt	6.9	0.25	11.8	4.4
	15-30	1.71	loam	7.0	0.26	11.2	5.44
	30-45	1.7		7.2	0.25	10.9	5.22
Mansoorpur distillery	0-15	1.64	Loam	7	0.30	11.4	6.66
(TW)	15-30	1.68		7.1	0.31	10.9	7.52
	30-45	1.65		7.1	0.29	10.9	7.24
Sonta (TW)	0-15	1.51	Clay	7.3	0.31	12.5	4.88
	15-30	1.53	loam	7.2	0.32	10.6	6.32
	30-45	1.5		7.4	0.33	10.2	6.86
Triveni sugar mill, Khatauli	0-15	1.61	Silt	7.1	0.80	13.7	8.02
(TW)	15-30	1.65	loam	7.0	0.82	13.1	9.54
	30-45	1.59		6.8	0.83	12.9	7.59
Mansoorpur (FE)	0-15	1.44	Clay	8.2	1.41	13.7	10.51
	15-30	1.51	loam	8.3	1.43	12.3	10.97
	30-45	1.39		8.4	1.41	11.8	10.67
Morna sugar mill	0-15	1.61	Sandy	8	0.13	9.7	3.81
	15-30	1.65	loam	8.1	0.14	9.5	4.1
	30-45	1.59		7.9	0.12	9.5	3.78
Ticolla sugar mill (TW)	0-15	1.4	Loam	7.7	0.18	10.6	3.11
	15-30	1.43		7.5	0.19	10.5	3.52
	30-45	1.39		7.8	0.20	10.7	3.73
Kandela Drain, Kandela	0-15	1.45	Loamy	7.9	0.31	9.8	6.22
	15-30	1.49	sand	8.0	0.32	9	6.33
	30-45	1.44		8.1	0.33	9	6.44
Monnet sugar mill (TW)	0-15	1.57	Sandy	7.4	0.14	10.8	4.63
	15-30	1.61	loam	7.5	0.15	11.2	4.82
	30-45	1.54		7.3	0.15	9.5	6.1
Shamli Drain, Shamli	0-15	1.51	Sandy	7.3	0.33	11.9	5.63
	15-30	1.53	loam	7.2	0.35	10.3	5.92
	30-45	1.5		7.1	0.36	10.7	5.98
Sikka Nalla, Sikka	0-15	1.35	Clay	7.5	0.27	11.9	4.03
	15-30	1.38	loam	7.4	0.26	13.2	5.76
	30-45	1.39		7.6	0.29	13.5	5.11
Kandela Nalla, Silpa	0-15	1.24	Sandy	7.2	0.25	9.8	6.32
	15-30	1.2	loam	7.3	0.35	10.2	5.1
	30-45	1.19		7.4	0.30	11.4	5.53
Shamli sugar mill	0-15	1.41	Silt	8.1	0.13	11.8	2.2
	15-30	1.45	loam	8.2	0.14	12.9	2.32
	30-45	1.39		7.9	0.15	13.6	2.5
Lagoon water	0-15	1.67	Sandy	8.7	0	10.7	4.11
	15-30	1.69	loam	8.5	0.21	11.6	4.31
	30-45	1.63		8.6	0.22	12.3	4.39
Shamli paper mill	0-15	1.66	Sandy	7.3	0.18	8.9	3.14
	15-30	1.69	loam	7.2	0.19	9.2	3.69
	30-45	1.63		7.4	0.20	10.7	2.8
Bajaj sugar mill	0-15	1.32	Clay	7.5	0.28	13.4	3.88
	15-30	1.35	loam	7.6	0.29	12.8	4.38
	30-45	1.31		7.4	0.27	11.9	3.86
Uttam sugar mill	0-15	1.29	Loam	7.0	0.36	12.3	6.26
	15-30	1.32		70.	0.41	12.7	5.35
	30-45	1.3		7.1	0.38	12	5.33

Table 3 : Relationship between various indices of irrigation water of effluent sites and soil properties at different depths

Indices correlated			Depth of soil	r^2	Regression equation
Water	Vs	Soil	(cm)		
EC	X	EC (1:2)	0-15	0.985	Y=0.224x + 0.014
			15-30	0.978	Y=0.246x + 0.027
			30-45	0.975	Y= 0.243x+ 0.028
SAR	X	ESP	0-15	0.320	Y=0.749x + 3.552
			15-30	0.311	Y=-0.740x + 3.941
			30-45	0.224	Y= 0.590x + 4.221
RSC	X	ESP	0-15	0.059	Y= -0.187x + 5.503
			15-30	0.038	Y= - 0.151x + 5.600
			30-45	0.091	Y= -0.218x +5.778

Jansth and minimum concentration was observed in the Lagoon water Kairana is possible due to flat topography, providing sufficient length of time for the aquifer material to interact with the ground water (Nikumbh and Pawar, 2000).

Ground water quality for drinking water :

Ground water is the only source of drinking water for more than 80 per cent of the population in India. As a part of this dependency, most effort is directed in locating the ground water reservoir ignoring the quality aspect. The seriousness of the chemical contamination remains often neglected as the toxic chemical do not so acute health effects unless the enter into the body in appreciable amount. However, the adverse health effect may be sugar factory continuing its operation without taking environmental precaution may cause serious health problem. Such health related problems are observed in the sugar factories and other effluents sites region where the people used to drink and irrigate ground water. In view of this, it was decide to study the impact of sugar mill and other effluent sites on the ground water resource in the study area. Table 3 shows the relationship between various indices of tube well irrigation water and soil properties at different depths Table 1 showes the critical parameters exceeding the Indian Standard and BIS, drinking water specification - permissible limit along with the permissible limit for these parameter (Singh, 2002).

Conclusion :

On the basis of chemical analysis of ground water samples, it is conclude that the waste water discharge from the sugar and other industry is highly polluted, as it exceeded the prescribed limits for irrigation and public use.

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