Physico-Chemical analysis of sugar industry effluents

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ABSTRACT:

A large volume of waste water is generated during sugar manufacturing process. Normally, it is discharged into nearby land and water resource, practically without any treatment. The discharge of waste water causes the pollution of soil, water and air. This study includes the Physicochemical analysis of untreated and treated sugar industry effluents and its impact on soil properties and seed germination. For this study samples of waste water were collected from Rajarambapu Patil Co-operative Sugar industry Ltd., Rajaramnagar in Sangli district of Maharashtra.The samples were collected 2 -3 times in a week during sugar producing season (January to March) in a year. The analyses were carried out for the parameters namely pH, Total Solids (TS), Total Dissolved Solids (TDS), Suspended Solids (SS), Biological Oxygen demand (BOD), Chemical oxygen demand (COD), Oils and Greases. The effect of various concentrations (0%,20%,40%,60%,80% and 100%) of effluents used for crop irrigation and its impact on seed germination was investigated. The study indicated the effects of untreated and treated effluents on the properties of soil and the germination of seeds. The percentage of seeds germination decreased and the soil properties were negatively affected.

Key Words: Sugar industry effluent, Physiochemical parameters, Seed germination, Soybean

INTRODUCTION:

The Sugar industries playing an important role in the economic development of country. Though industrialization contributing for economic development, most natural resources like water and soil gets polluted by effluent disposed. Sugar industry is a seasonal industry operating for minimum 4-5 month in a season. India is the largest producer of sugarcane in the world. Sugar manufacturing process requires more quantity of water for a number of steps and produces more quantity of effluent. The effluent of sugar industry consist of a number of organic and heavy metal pollutants which causes the changes in the physical, chemical and physiological sphere of the biota. Industrial effluent containing heavy metals poses a threat to the ecosystem[1]. Toxic elements present in the effluent accumulate in the soil and induce a potential contamination

food chain and endanger the ecosystem safety and human health[2]. The waste water generated from sugar industry with its high BOD, COD and TDS rapidly depletes available oxygen when discharged into water bodies and have adverse impact on aquatic life [3]. Sugar industry effluent that has not been treated properly has significant concentration of suspended solids and high BOD, COD. Farmers using these effluent for irrigation to reduce water demands but it is found that plant growth and crop yield were reduced and soil health was contaminated. Hence, it is essential to determine how crops are responding when exposed to industrial effluent. In this regards, efforts have been made to determine the effects of sugar effluent on seed germination. Seed germination is a critical stage which ensures reproduction and controls the dynamics of plant[4]. The present laboratory experiment was designed to determine the effects of effluent on soil properties and effect of different concentrations (0-100%) of sugar industry effluent on seed germination in soil.

MATERIALS AND METHODS:

Sampling Site: The Rajarambapu Patil Co-operative Sugar industry Ltd. Rajaramnagar located in Sangli district.

Collection of Sample: The samples of effluent and contaminated soil were collected in pre-cleaned, acid washed, plastic bottles and containers which was later stored in refrigerator below 5^0C to maintain its original characteristics.

Analysis Method: Sugar Effluent-The pH, electrical conductivity (EC) and temperature were measured by the method of pH meter and electrical conductivity meter and thermometer respectively. The analysis was carried out in the laboratory by using the procedures given by APHA. Using tritrimetric methods, the analysis of chloride(Cl), Magnesium, Calcium was performed. While nitrate, iron and sulphate were analyzed by spectrophotometric method. The biological oxygen demand (BOD), which indicates the amount of biologically degradable organic matter in the waste water. The BOD of waste water samples were measured by titration method Physicochemical properties such as BOD, COD, TDS, Chlorides, Calcium, Magnesium, Sulphates, phosphates and heavy metals were measured using standard methods[5].

Soil Analysis:The soil samples were suspended in distilled water (1:4 w/v) and allowed to settle down the particles. The pH of the suspension was determined using the pH meter. Electrical conductivity (EC) of soil was determined in the filtrate of the water extract using conductivity meter. % organic carbon (OC) content was determined by adopting chromic acid wet diagram as standard procedure of walkey and Black method, available nitrogen was estimated by alkaline permanganate method. Available phosphorus determined by volumetric method. Available potassium content in the soil was determined by using turbiditimetric methods, calcium and magnesium can be determined by titration with standard potassium permanganate solution,

magnesium can be determined by precipitation in alkaline medium as magnesium ammonium phosphate, carbonate in soil was determined by rapid titration method.

Germination Studies Experiment:

Petri dish Experiments (Thamizhiniyan et al., 2009)

Culture Experiment (Ezhilvannan et al., 2011)

Germination Percentage: Germination Percentage = $\frac{\text{Number of seeds germinated}}{\text{Total number of seeds sown}}$ x 100

RESULTS AND DISCUSSION:

The Physicochemical analysis was carried out for untreated and treated sugar industry effluent and contaminated soil (Table 1 Table 2).Some of the physicochemical parameters of untreated effluent found to exceed those permissible limits while after treatment at effluent treatment plant (ETP) parameters are having value below permissible limits. The pH of untreated effluent is relatively low due to the use of phosphoric acid and sulphur dioxide during clarification of Juice[7]. The pH is important for the algal bloom formation that makes the water unfit for irrigation. If such water is used for irrigation, the soil becomes acidic. The untreated effluent has high values for other parameters like BOD (1020mg/lit), COD (6050 mg/lit) while the recommended level as per the BIS is 250 mg/lit and TDS (3150mg/lit) indicates the high organic load. While the treated effluent has low values for most of the parameters than permissible limits. Thepresence of higher amount of suspended and dissolved solids, high value of biological oxygen demand (BOD) and Chemical oxygen demand (COD) severely affects the plant growth. While the treated effluents favor the plant growth.

The germination percentage, Plumule length and radicle length with different concentrations of sugar mill effluent in the soil (Table 3). The lower concentrations of irrigated untreated effluent (20%) has 75% germination with high plumule and radicle length. The higher concentrations of effluents (60%,80%,100%) has decreasing plumule and radicle length. For treated effluent has shown favourable growth at different concentrations of effluents. These results were in agreement in agreement with the findings of Kaushik et al.[18] Who reported toxicity of sugar factory effluent on the growth and soil quality.

Table 1: Physicochemical properties of Sugar industry effluent

Sr. No.	Untreated effluent		Treated effluent	
	Parameters	**Value**	**Parameters**	**Value**
1	Colour	Brown	Colour	Slight Blakish
2	Odour	Decaying Smell	Odour	Not decaying smell
3	Temperature	35^0C	Temperature	25^0C
4	Suspended Solids	450	Suspended Solids	190
5	pH	4.27	pH	7.5
6	EC(cm-1)	2.10	EC(cm-1)	0.69mmhos/cm
7	DO	10.25	DO	4.5
8	BOD	1020.00	BOD	46
9	COD	6050.00	COD	95
10	TS	3200	TS	235
11	TDS	3150.00	TDS	210
12	Chloride (Kg/ha)	550.00	Chloride	55
13	Alkalinity	120.00	Alkalinity	100
14	Hardness	800.00	Hardness	450
15	Calcium (Kg/ha)	420.00	Calcium	120
16	Magnesium (Kg/ha)	510.00	Magnesium	15
17	Sulphate (Kg/ha)	320.56	Sulphate	65
18	Phosphate (Kg/ha)	20.00	Phosphate	15
19	Iron (ppm)	0.05	Iron	.03
20	Oil & grease	14.00	Oil & grease	06

Table 2: Physicochemical properties of contaminated Soil

Sr. No.	Untreated effluent		Treated effluent	
	Parameters	**Value**	**Parameters**	**Value**
1	pH	5.20	pH	7.2
2	EC	0.45	EC	0.62 mmhos/cm
3	N (Kg/ha)	82.00	N (Kg/ha)	0.031
4	K (Kg/ha)	120.00	K (Kg/ha)	0.86
5	P (Kg/ha)	42.00	P (Kg/ha)	0.021
6	Iron (ppm)	18.50	Iron (ppm)	12.50
7	Lead (ppm)	0.45	Lead (ppm)	0.32
8	Copper(ppm)	0.64	Copper(ppm)	0.58
9	Zinc(ppm)	6.65	Zinc(ppm)	5.62

Table3: Effect of treated and untreated effluents on seed germination percentage, plumule length and radicle length

Sr. No.	Untreated effluent				Treated Effluent		
	Effluent Concentration	**Germination %**	**Plumule Length (cm)**	**Radicle Length (cm)**	**Germination %**	**Plumule Length (cm)**	**Radicle Length (cm)**
1	Control (0%)	80%	12.65	6.95	95%	10.65	6.50
2	20%	75%	10.25	5.65	92%	11.35	5.65
3	40%	70%	6.25	4.10	85%	12.30	7.10
4	60%	55%	3.65	2.65	78%	14.50	8.65
5	80%	60%	2.15	1.25	80%	72%	15.65
6	100%	30%	0.80	0.65	100%	68%	11.65

CONCLUSION:

The results of present study indicated that untreated Sugar industry effluent used for irrigation changed the properties of the soil due to the presence of higher amount of TDS, BOD and COD etc. It is severely affecting the crop growth. It has been observed that there is gradual decrease in plumule and radicle length as effluent concentrations goes on increasing, while the lower concentrations of irrigated effluent (20%) has higher

plumule and radicle length than other concentration of effluent. If treated effluent used for irrigation, it has been observed that there is no harmful effect on soil properties and crop growth.

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