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Physico-chemical analysis of Sugar mill Effluent and their Impact on Changes of Growth of Wheat (*Triticum aestivum)* and Maize (*Zea mays* L.)

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Abstract: *The physico-chemical characteristics of the content in the effluents from sugar mill of Haridwar district have been explored and its impact on the germination and growth patterns of wheat and maize has been studied. Physico-chemical characteristics included color, odour, temperature, pH, electrical conductivity, total hardness, BOD,COD, TSS, TDS, K, P, Na, Ammonia and Chloride concentration. The seeds of Wheat and Maize were incubated with concentration of effluent dilution ranging from control, 0%, 25%, 50%, 75% and 100%. It was found that concentration of 25% and 50% has stimulatory effects on germination rate and further increase in concentration (beyond 50%) showed inhibitory effects on germination percentage and initial growth of Wheat (Triticum aestivum) and Maize (Zea mays L.).*
Keywords: *Effluent, Haridwar, Physico-chemical parameters, Seed Germination.*

I. Introduction

Sugar industry is one of the most important agro-based industries in India and has significantly contributed to countries economy [6, 25, and 26].As India is the largest producer of sugarcane in the world with 550 sugarmills and 220 million tons cane per year and total sugar production 13.5 million tons per year. Sugar production processing require huge water for a number of steps and released almost equal quantity of effluent which contain toxic material [8, 10].The recent studies have indicated that the effluent discharge from sugarmill 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 [8, 21]. The effluents of industries has ultimate disposal in agriculture field, which can alter the soil properties and crop yielding [4, 6, 22&26].
Sugar industries effluents are commonly used for irrigation, so it is significant to determine the response of industrial effluents on crops. Seed germination studies have been made on many crops such as rice, wheat, pine, green-gram, Sorghum, Moong, Raphanus & Sugarcane[6, 25,26].The present paper deals with the estimation of Physico-chemical parameters of sugarmill effluent collected from sugarmill located at district Haridwar. The study was conducted during a period from Nov.2012 to Jan 2013 and an attempt has been made to study the physico-chemical properties of sugar factory effluent and determine the effects of different dilution (0-100%) on seed germination of Wheat (*Triticum aestivum*) and Maize (Zea *mays*).

II. Materials And Methods

2.1 Seed materials

Seeds of Wheat (*Triticum aestivum*) and Maize (*Zea mays L.*) were purchased from market; uniformity was maintained regarding size, color and weight for better interpretation.

2.2 Collection of effluent from the sugarmill

The effluent samples were collected in a pre- cleaned, plastic container from the point of disposal from a sugarmill located in Haridwar district, Uttarakhand, India. The collected effluent was stored at 4^{o}C to maintain its original characteristics [27].

2.3 Physico-chemical characterization of the effluent

Physico-chemical parameters like Color, Odour, Temperature, and pH were determined immediately at the site of collection. Electric conductivity (EC), Total Hardness (TH), Biological oxygen demand (BOD), Total solids (TS), Total suspended solids (TSS), Total dissolve solids (TDS), Phosphate, Potassium and Sodium were determined in the laboratory as per standard protocol [1].

2.4 Effect on seed Germination

The different concentration of the effluents, 25%, 50%, 75% and 100% were prepared by diluting the effluent with distilled water. Petri plate method was used for germination experiment.

The seed of Wheat (*Triticum aestivum*) and Maize (*Zea mays L.*) were surface sterilized with 0.1% w/v $HgCl_2$ solution for 2min and then washed three times with sterile distilled water. Seeds were spread on sterilized Petri dish lined with blotting paper and then irrigated with 5ml of the different concentration of sugar industry

effluent. Each treatment consisted of three plates with 10 seeds /plate and was examined regularly for germination of seeds at an interval of 24 hours [14, 17 & 25].

The germination of seed was assessed in percentage and the root and shoot length of the plants recorded every 24h for 10 days. The fresh and total dry masses of maize and wheat were determined after 10 days of the experiment. The plants were washed thoroughly with distilled water and were dried for 2h under natural conditions at an open roof. The fresh weights were taken and then the plants packed in paper envelopes and oven dried for 36 h at 70^{o}C. The dry weight of each plant was also recorded [2].

III. Result And Discussion

Physico-chemical characters of sugar mill effluent are presented in Table-1. The effluent released from the main outlet of sugar mill was brown in color and had a smell of decaying molasses. Its brown color could be due to the presence of melanoidin, the product of sugar amine condensation and unpleasant smell due the presence of indole and other sulphur compound [19].The pH was acidic in nature because of the use of phosphoric acid and sulphuric acid during clarification of sugarcane juice [2, 12].It contained fewer amounts of suspended solids (132 mg/ml) and total dissolved solids (1453 mg/ml). The Biological oxygen demand (BOD) and Chemical oxygen Demand (COD) of the effluent were found 90mg/ml and 317mg/ml, respectively. Effluent also contained other elements such as Chloride (60mg/ml), Phosphate (1.2mg/ml), Ammonia (4.4mg/ml), potassium (16.0 mg/ml) and sodium as NaOH (794.8mg/ml). The presence of considerable high value of BOD, COD, TDS, and Sodium, whereas, Temperature, TSS, Phosphate, Chloride and Total hardness were below permissible limits noticed in the effluent. This is in conformity with the earlier finding of [2, 7, 20. 23 & 27].
Variation in germination percentage, root length and shoot length with variation in concentration of sugar industry effluent utilized for treatment of seeds clearly revealed that effluent exhibits profound effect on the above mentioned physiological parameters. Observation made from the experiments conducted indicate that with gradual increase in concentration of effluent (50-100 %), a gradual decrease in both germination rate as well as in root and shoot length was observed. Among various concentrations of effluent which were utilized during the study 25% concentration of effluent was found to be most effective in increasing the germination rate and other parameters in wheat plant (Fig.1&2) and in maize plants (Fig.3-5). The results are in concordance with the work done by [7, 14, 25 & 28], which also indicated that lower concentration of effluent favored the plant growth as well as increasing chemical content.

Germination rate of 90% was observed in wheat seeds treated with 25% effluent concentration with an average root length, shoot length, fresh weight and dry weight of 5.4cm, 6cm, 0.154g and 0.045g respectively(Fig.6,7&8). Similarly germination rate in maize seed was also maximum (96%) in seed treated with effluent of concentration 25%, having average root length, shoot length, fresh and dry weight of 10.2cm, 6.4 cm, 0.799g and 0.159grespectively(Fig.9,10&11). The same effects on germination percentage of maize are also reported in literature [9, 15, 16 & 18].

However, germination percentage decrease to 70-40% in wheat and 80 % in maize when seed were treated with higher concentration of effluent (75-100%) [18]. A similar decrease was also observed in root and shoot length on higher concentration of effluent. (Table-2 & 3).The growth and germination percentage of seed inhibited at higher concentration of effluent may be due to osmotic pressure of high dose, which make imbibitions more difficult and reduce oxygen uptake by seedling [2, 3&11].While diluting the effluent enhance the plant activities by providing required amount of nutrient present [27].The effect of different effluent concentration varies from crop to crop because each plant has its own tolerance capability [13, 17&23].

IV. Figures and Tables

Table.1-Physico-chemical Parameters of Effluent.

S.no	Parameters	Effluent	IS
1.	Colour	Brown	Colourless
2	Odour	Decaying Smell	Odourless
3	Temperature(^{o}C)	24	40
4	Total Suspended Solid	132	200
5	Total Dissolved Solid	1453	1000.0
6	Total Hardness	52	600.0
7	pH	6.4	6.5-8.5
8	Electric conductivity	2.20	300.0
9	BOD	90	30.0
10	COD	317	250
11	Phosphates (as P)	1.2	10.0
12	Potassium	16.0	-
13	Na (as NaOH)	794.8	200
14	Ammonia	4.4	-
15	Chloride	60	600

All values are expressed in mg/L, except Temperature, Color, Odour pH and EC

Table-2: Effect of effluent on various growth parameters of Wheat (*Triticum aestivum)*

S.No	Dilution %	Rate of Germination (%)	Length of root(cm)	Length of shoot(cm)	Fresh weight(g)	Dry weight(g)
1	Control(0)	80	5.3	5.8	0.143	0.044
2	25	90	5.4	6.0	0.154	0.045
3	50	80	4.0	4.0	0.128	0.039
4	75	70	4.0	3.6	0.139	0.042
5	100	40	3.3	3.4	0.130	0.040

Table-3: Effect of effluent on various growth parameters of Maize (*Zea mays*)

S.No	Dilution %	Rate of Germination (%)	Length of Root (cm)	Length of Shoot (cm)	Fresh weight (g)	Dry weight (g)
1	Control(0)	93	7.5	5.6	0.616	0.123
2	25	96	10.2	6.4	0.799	0.159
3	50	90	8.3	4.8	0.734	0.146
4	75	90	5.8	4.1	0.701	0.140
5	100	80	3.5	2.0	0.610	0.122

Figure.1 Germination pattern of Wheat plant

Figure.2 Root and Shoot length of wheat plant

Figure.3 Growth pattern of maize plant.

Figure.4 Root length of maize plant.

Figure.5 Shoot length of maize plant.

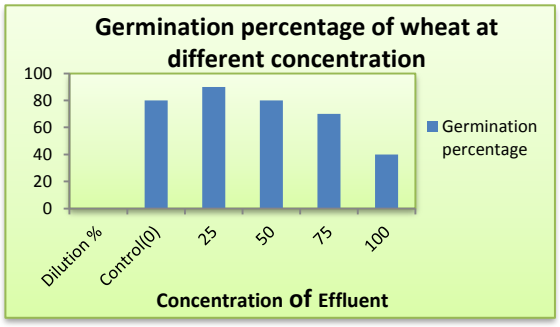

Figure.6 Germination percentage of Wheat at different concentration of effluent

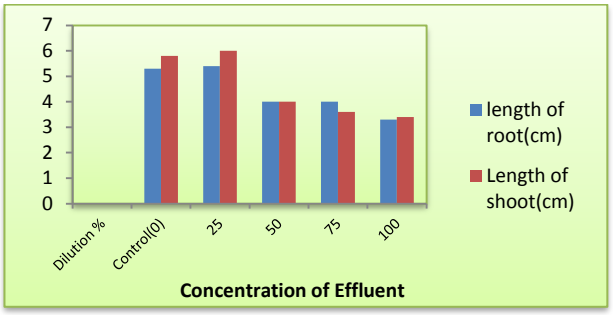

Figure.7 Length of Root and Shoot of Wheat plant at different concentration of effluent

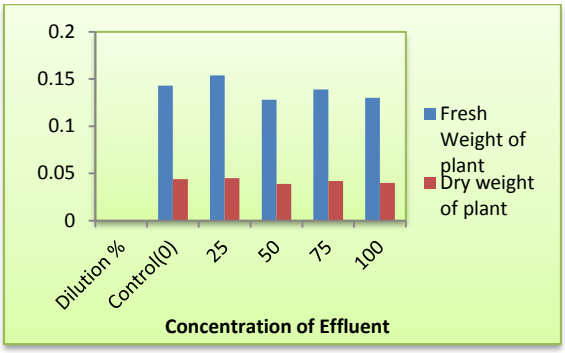

Fig.8 Fresh and dry weight of Wheat plant at different concentration of effluent

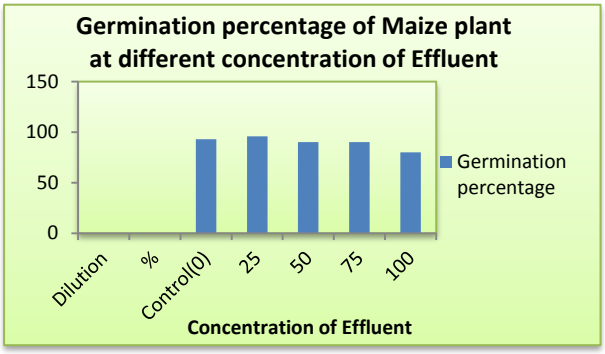

Figure.9 Germination percentage of Maize plant at different concentration of effluent

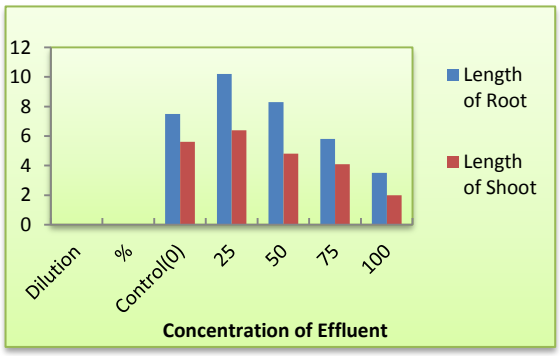

Figure.10 Length of root and shoot of Maize plant at different concentration of effluent

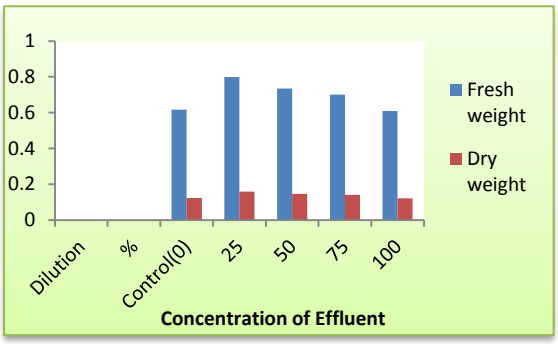

Figure.11 Fresh and dry weight of Maize plant at different concentration of effluent

V. Conclusion

The physico-chemical parameters, such as TDS, BOD, COD and Sodium were observed to be higher in sugar mill effluent and it severely affected the plant growth. The results indicates that the sugar industry effluent in low concentration (25%) has beneficial effect on germination rate and growth parameters such as root length, shoot length, fresh and dry weight of both the plants as compared to control. However adverse effects were indicated in all growth parameters in both plants maize and wheat, when irrigated with various higher effluent concentrations from 50% to 100%. Thus, effluent with controlled physico-chemical parameters can be utilized for irrigation with promising effects on plants growth and yield.

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