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Research Article – Environmental Science

The effect of sugar mill effluent on seed germination of green gram (*Vigna radiatia* L.)

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Abstract

Sugar industry is an agro-based industry in India which released lot of effluent into the environment during sugar production. The formers used this effluent in agriculture for scarcity of water. The effluent contained large amount of organic and inorganic materials which affects the water, soil and living organisms especially plants. The present study was the analysis of sugar mill effluent and different concentrations (10, 25, 50, 75 and 100%) of sugar mill effluent effects on germination and growth development of green gram (*Vigna radiata* L.). As a result the lower concentration (10%) of sugar mill effluent promoted the germination and growth of the seedlings but higher concentrations of sugar mill effluent inhibited the germination and growth of the green gram seedlings. The lower concentration of effluent contained may be better nutrients of plant which used for irrigation purposed for high growth and yield.

Key words: Agriculture, effluent, germination, green gram and sugar industry

Introduction

Sugar industry plays a significant role in Indian economy and making of employment. The many industries are used raw materials from the by-products of sugar mills. However sugar industries have a great environmental impact upon the surrounding environment. The sugar mills released huge amount of wastewater as effluent into nearby water bodies during sugar production and it change of water chemistry. Generally, the effluent is generated from mill house, waste water from boiling house, waste water from boiler blow- down, condenser cooling water and soda and acid wastes (Kisku *et al.*, 2000). The effluents are causing odor nuisance during decomposition. It contains high Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) which reduce available oxygen supply into water and it adversely affects the aquatic ecosystems (Jagannathan *et al.*, 2014). High amount of organic and inorganic compounds were presented in sugar mill effluent which deposited the soil and it alter the soil quality as well as affect the plants and consumers. The sugar mill effluent has high amount of suspended solids and dissolved solids that reduce penetration capability of light into the water (Singh and Bhati, 2005). Sugar industries second rank among the agro based industries in India and it seasonal in nature and operates only for 120 to 200 days in a year. Sugar mill effluent creates unpleasant odour when released into the environment without proper treatment. Farmers have been using these effluents for irrigation to alternative the scarcity of water which results reduced growth and yield of crops as well as soil quality. Adnan *et al.*, (2010) reported that the untreated sugar mill effluent is toxic to plants when used for irrigation. The considerable amount of harmful substances including soluble salts and heavy metals like Fe, Cu , Zn , Mn , Pb were presented in sugar mill effluent which continuously used in agriculture to contaminates soil and toxic to plants and consumers (Fakayode, 2005). The effluent contained high amount of plant nutrient which alter use of fertilizer to promote development of plant (Kumar and Chopra 2012). The sugar mill effluent used in developing countries for agriculture as fertilizer has gained more significance as it is considered as a source of organic matter and plant nutrients and serves as good fertilizer. The present research work has been made to assess the physic-chemical characteristics of sugar mill effluent and their effects on germination behaviour and seedling growth of green gram (*Vigna radiata* L.)

Materials and Methods

Effluent samples

The effluent samples were collected in plastic containers from the out let of the N.P.K.R. Co-operative sugar mill in Thalainayar, Mayiladuthurai Taluk, Tamil Nadu, India. They were brought to the

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Ecology Laboratory, Department of Botany and stored in refrigerator at 4ºC for analysis purpose.

Seed material

The seeds of *Vigna radiata* L. were obtained from Pulses seed Research Station, Vamban, Pudukkotai district. Healthy and uniform seeds were selected for the study.

Analysis of sugar mill effluent sample

The collected sugar mill effluent sample was analysed for their various physico-chemical roperties in Ecology Laboratory, Department of Botany, Annamalai University as per the routine standard methods mentioned in American Public Health Association (APHA, 2005).

Preparation of different concentrations of effluent

The collected effluent sample from the outlet of sugar mill industry was treated as 100 per cent raw effluent. Different concentrations (10, 25, 50, 75 and 100%) of sugar mill effluent were prepared freshly by using distilled water whenever necessary. They were used for germination studies.

Control	:	Distilled water
10%	:	10 ml effluent + 90 ml water
25%	:	25 ml effluent + 75 ml water
50%	:	50 ml effluent + 50 ml water
75%	:	75 ml effluent + 25 ml water
100%	:	Raw effluent

Germination studies

The healthy and uniform sized *Vigna radiata* L. seeds were selected and surface sterilized with 0.1% $HgCl_2$ for two minutes. They are thoroughly washed with tap water to avoid surface contamination. Twenty seeds were placed equidistantly in petridishes filled with sterilized soil. The seeds were irrigated with equal quantity of different concentrations of effluent and the seeds irrigated with distilled water treated as control. Five replicates were maintained for each treatment including control. The germination percentage, seedling length, seedling fresh weight and seedling dry weight were taken and recorded on the 7th day's seedlings. The values of vigour index, Tolerance index and percentage of phytotoxicity were also calculated.

Germination percentage

The number of seeds germinated in each concentration was counted on the 7th day and the germination percentage was calculated by using the following formula

Germination percentage =

$$\frac{\text{Number of seeds germinated}}{\text{Total number of seeds sown}} \times 100$$

Shoot and root length (cm/seedling)

Five seedlings were taken from each treatment and their shoot length and root length were measured by using a cm scale and these values were recorded.

Fresh weight (g/seedling)

Five seedlings were collected from each treatment and their fresh weights were measured with the help of an electrical single pan balance.

Dry weight (mg/seedling)

The same seedlings used for fresh weight were kept in hot air oven at 80°C for 24 hours. Then, the seedlings were taken from the oven and kept in desiccators for some time. Their dry weights were taken by using an electrical single pan balance.

Vigour index

Vigour index of the seedlings was calculated by using the (Abdul–Baki and Anderson, 1973).

Vigour index = Germination percentage × Length of seedling

Percentage of phytotoxicity

The percentage of phytotoxicity of effluent was calculated by using the formula (Chou *et al.*,1978).

Percentage of phytotoxicity =

$$\frac{\text{Radicle length of control - Radicle lenght of test}}{\text{Radicle length of control}} \times 100$$

Results and Discussion

Physico-chemical properties of sugar mill effluent are given in Table – 1. The analyses of sugar mill effluent showed that it is acidic in nature with dull white in colour. It contained high amounts of suspended solids and dissolved solids. It showed a high value of Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). The presence of considerable amounts of calcium, chloride, sulphate, nitrate, fluoride, and silica were also noticed in the effluent. This is in conformity with the earlier findings (Kaushik *et al.*, 2004; Rajesh *et al.*, 2013). The pollution load of the effluent depends upon the nature of raw materials, chemicals used, the processes involved in the factory and also the methods of treatments given to the effluent before they discharged from the factory.

The effect of different concentrations of sugar mill effluent on germination studies of *Vigna radiata* L. is presented in the bellow the figure -1. In the present investigation, the higher concentration (25, 50, 75 and 100%) of sugar mill effluent inhibited the germination of green gram because the presence of high salt content in the effluent at these concentrations.

Table–1. Physico – Chemical analysis of sugar mill effluent with it's to tolerance limits for agricultural irrigation

S. No.	Properties	Raw effluent	Tolerants limits for Agricultural irrigation suggested by TNPCB(2009)
1	Colour	Dull white	Colourless
2	Odour	Decaying molasses smell	-
3	pH	4.04	5.5-9.0
4	Electrical Conductivity (EC)	4745 Mm- homs	-
5	Temperature (^{0}C)	36.0	40.0
6	Acidity	1350.0	-
7	Suspended solids	180.0	200
8	Total dissolved solids	3725.0	200
9	Total solids	3905.0	2100
10	BOD	3480.0	30
11	COD	7880.0	250
12	Chloride	314.0	600
13	Sulphate	290.88	12
14	Magnesium	286.0	100
15	Phosphorous	7.2	10
16	Nitrogen	1250	600
17	Fluoride	1.88	1.0
18	Silica	99.0	-
19	Calcium	124.8	200
20	Zinc	0.89	0.01
21	Iron	16.00	1.00
22	Copper	0.420	0.01
23	Lead	0.52	0.05
24	Manganese	0.068	0.01
25	Oil & grease	19	10

All parameters except colour, odour, pH, EC and temperature are expressed in mg/l.; TNPCB - Tamil Nadu Pollution Control Board.

Seed absorption water during germination and hydrolyse stored food material and to activate enzymatic systems. During germination salts can inhibit germination. The high salt concentration can slow germination by several days or completely inhibit it (Sahai *et al.*, 1979). The lower concentration of sugar mill effluent (10%) promoted the germination of green gram. It may be due to presence of optimum level of nutrients in this effluent concentration. Similar observation was recorded in many researchers (Rathore *et al.*, 2000; Rajesh *et al.*, 2013; Shalu Malik *et al.*, 2014; vaithiyanathan *et al.*, 2014). The seedling stage is the most sensitive stage in the life of a plant and more susceptible to physical and chemical adversities. Seedling growth and their fresh and dry weight of green gram seedlings increased at lower concentration of sugar mill effluent. It may be due to maximum uptake of nitrogen, phosphorus and potassium by plants from this effluent concentration. The improvement of vegetative growth may be ascribed to the role of potassium in nutrient and sugar translocation in plants and turgor pressure in plant cells (Vijayaragavan *et al.*, 2011). However, the higher concentrations of sugar mill effluent decreased in above the vegetative parameters of the green gram plants. In higher concentrations of sugar mill effluent contains high amount of organic and inorganic compounds, it becomes toxic to plants. Similar observations were obtained by several workers (Sundaramoothy *et al.*, 2007; Pandey *et al.*, 2008; Rajendra *et al.*, 2010; Doke *et al.*, 2011).

Conclusion

From this study concluded that sugar mill effluent contained high amount of organic and inorganic compounds as well as BOD and COD which harmful affects the plant. The germination of green gram under sugar mill effluent as results the lower concentrations (10%) of sugar mill effluent was observed highest germination and growth of green gram plant and on other hands, germination and plant development was gradually decreased with increase of sugar mill effluent concentrations then highest inhibition was observed 100 per cent effluent treatment. Higher concentration of effluent have may be toxic elements presented but the lower concentration of effluent have may be required amount of plant nutrients. However, the lower concentration of effluent can be utilized for agricultural irrigation after suitable treatment with appropriate dilution.

Figure 1.1 Germination percentage

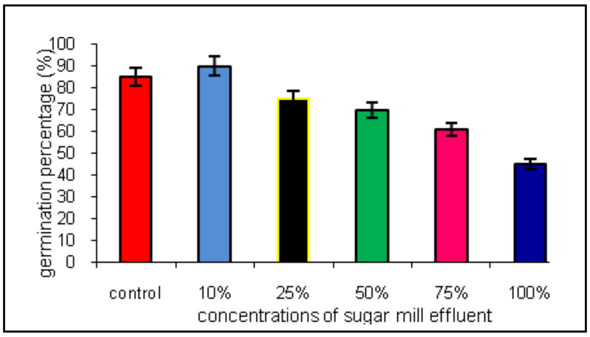

Figure 1.2 Seedling length

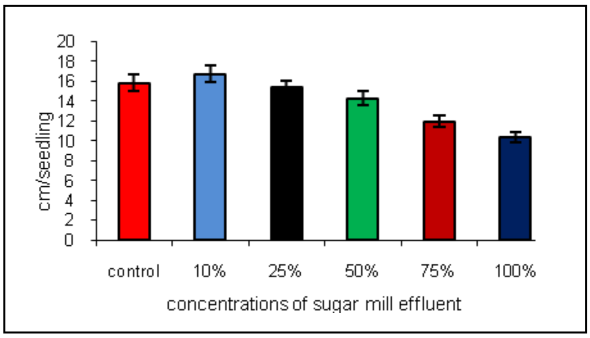

Figure 1.3 Fresh weight

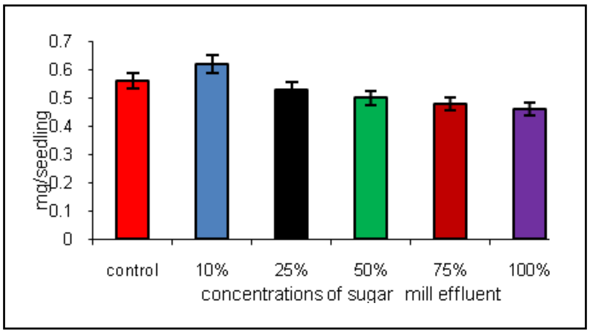

Figure 1.4 Dry weight

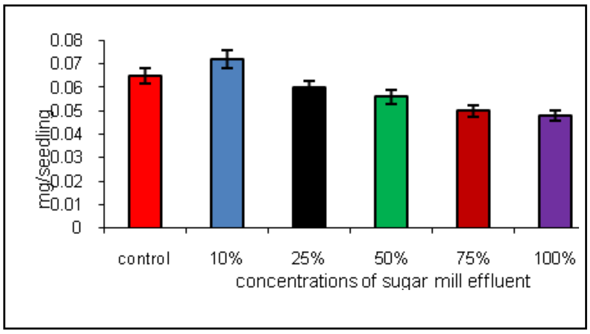

Figure 1.5 Seed vigour index

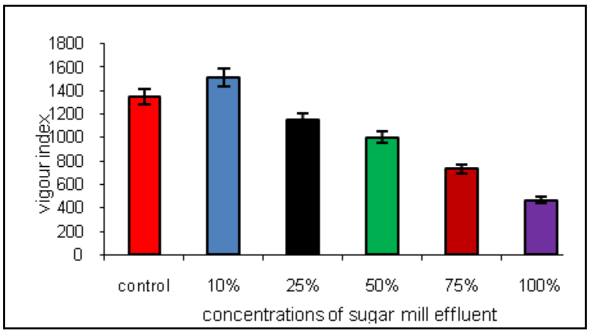

Figure 1.6 Percentagy of phytotoxicity

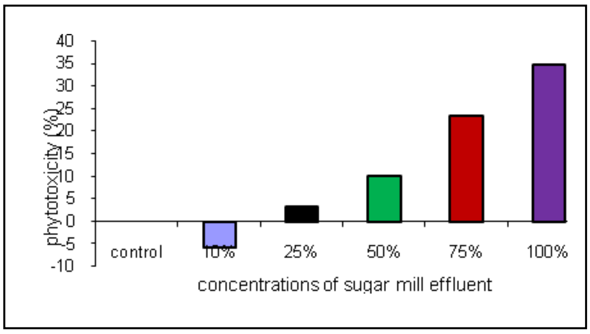

Figure 1: Germination studies of green gram grown under different concentrations of the Sugar mill effluent.

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