ISSN 0976 – 3333

Available Online at www.ijpba.info

International Journal of Pharmaceutical & Biological Archives 2011; 2(5):1469-1472

ORIGINAL RESEARCH ARTICLE

Physico-Chemical Analysis of Sugar Mill Effluent, Contaminated Soil and its Effect on Seed Germination of Paddy (*Oryza sativa* L.)

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Received 17 Jul 2011; Revised 14 Oct 2011; Accepted 19 Oct 2011

ABSTRACT

Sugar mills play a major role in polluting the water bodies and land by discharging a large amount of wastewater as effluent. The sugar mill effluents are having high amount of suspended solids, dissolved solids, BOD, COD, chloride, sulphate, nitrates, calcium and magnesium. The continuous use of these effluents harmfully affects the crops when used for irrigation. In the present study, physico-chemical parameters of sugar mill effluent and contaminated soil was determined and the effect of various concentrations (0%, 10%, 25%, 50%, 75 % and 100%) of the effluent on seed germination, germination speed of Paddy (*Oryza sativa* L.) was also studied. The low effluent pH (4.20), total dissolved solids, (TDS, 1480mg/L) and chemical oxygen demand, (COD, 3140mg/L) indicate the high inorganic and organic content with an acidic load. Germination percentages and germination values decrease with increasing concentration of effluent in the seeds tested.

Key words: Sugar mill effluent, Physico-chemical analysis, Seed germination, Germination percentages and Paddy.

INTRODUCTION

Industrialization is an important tool for the development of any nation. Consequently, the industrial activity has expanded so much all over the world. Today, it has become a matter of major concern in the deterioration of the environment. With the rapid growth of industries (sugar, paper, tannery, textile, sago, dye industries) in the country, pollution of natural water by industrial waste water has increased tremendously.

Advances in science and technology and the industrial revolution have enabled humans for plot resources. Though industrialization contributes economical development, most important natural resources like water and soil are commonly polluted with by- products, waste materials and non- utilized parent chemical compounds. These in- turns ultimately affect the agriculture production and food security. Polluted soil and water also acts as secondary source of pollution [1]. India is an agriculture based country and a major user of water resource for irrigation [2]. But there is a great demand for water for irrigation while gallons and gallons of effluents are let out into water sources untreated. The most important effluent discharging industries are thermal power plants, paper mills, textiles, distilleries, fertilizer unit, electroplating plants, tannery industries, sugar mills, sago factories, oil refineries, pesticide and herbicide industries. Industrial effluents containing heavy metals pose a threat to the ecosystem [3]. Use of these 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 get accumulated into plant tissues from soil. These metals have damaging effects on plants themselves and may become a health problem to man and animals

India is the largest producer of sugar in the world. Among the effluent discharging industries, sugar mills plays a major role in polluting the water bodies. Diverse sugar industry effluents disposed of in soil and water cause major pollution problems. The sugar industry plays an important role in the economic development of India, but the effluents released produce a high degree of organic pollution in both aquatic and terrestrial ecosystems [4]. The effluents also alter the physico-chemical characteristics, and flora and fauna of receiving aquatic bodies. In addition, sugar factory effluent discharged in the environment poses a serious health hazard to the rural and semi-urban populations that use stream

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and river water for agriculture and domestic purposes. Fish mortality and damage to paddy crops due to sugar industry waste-waters entering agricultural land have been reported [5].

Sugar factory effluent that has not been treated properly has an unpleasant odour when released into the environment. Farmers using these effluents for irrigation to reduce water demand have found that plant growth and crop yield were reduced and soil health was compromised. Because sugar industry effluents are commonly used for irrigation, it is essential to determine how crops respond when exposed to industrial effluents. In this regard, efforts have been made to determine the effect of industrial effluents on seed germination of various crops such as maize, rice, wheat, pine, green gram and catechu. Seed germination is a critical stage that ensures reproduction and controls the dynamics of plant populations, so it is a critical test of probable crop productivity [6]. The present laboratory experiment was designed to determine the effect of different concentrations (0-100%) of sugar industry effluent on seed germination in Paddy (*Oryza sativa* L.).

MATERIALS AND METHODS

The effluent and contaminated soil from a sugar mill located at Cuddalore district, India was collected in pre-cleaned, acid washed, plastic bottles and containers which was later stored in a refrigerator below 5°C until used. Temperature, pH, electrical conductivity (EC) and dissolved oxygen (DO) were measured. Physico-chemical properties such as total dissolved solids (TDS), chemical oxygen demand (COD), chloride, calcium, magnesium, sulfate, sodium, potassium and heavy metals were measured using standard methods [7].

For bioassays, the effluent was diluted to 0%, 10%, 25%, 50%, 75% and 100% with distilled water. Seeds of Paddy (*Oryza sativa* L.) were sterilized with 0.1% w/v mercuric chloride solution for 5 minutes to remove microbes and then washed three times with sterile distilled water. Plant seeds were spread on each sterilized petri dish lined with blotting paper, spread in a plastic packets containing contaminated soil and then irrigated with 5 ml of the different concentrations of sugar industry effluent. Each treatment consisted of three replicate plates with ten seeds per plate. Observations were recorded at 24 hours intervals, the germinated seeds were counted and the number of germinated seeds was expressed as a percentage.

RESULTS AND DISCUSSION

The physico-chemical analysis data of the sugar industry effluent and contaminated soil are given (**Table 1 & 2**). Some of physico-chemical parameters of the effluent were found to exceed those permissible. The pH was relatively low due to the use of phosphoric acid and sulfur dioxide during clarification of sugar cane juice [8]. The pH is an essential factor in the formation of algal blooms that makes the water unfit for irrigation; if the same water is used for irrigation over a large area, the soil becomes acidic resulting in poor crop growth and yield. Similarly, the effluent had a very high TDS, which was in agreement with the previous report of sugar factory effluent [9]. The COD value of the effluent was 3140mg/L, while the recommended level set by BIS is 250 mg/L; the measured COD indicates the high organic load similarly other factors exceeded the permissible limits.

The percentage germination of crop plant seeds varied with respect to different concentrations of effluent (Table 3). The percentage of seeds germinating decreases as the effluent concentration increases. The percentage germination and germination value was maximum at the lower effluent concentrations of 10% and 25%. At lower concentrations (10% – 25%) of sugar factory effluent; 80-90% of the seeds of Paddy had germinated whereas in undiluted effluent the percentage germinations were 25% to 50% (**Fig 1**). Lower concentration of effluent (25%) was shown to support 80% seed germination in Paddy on contaminated soil, but osmotic pressure associated with higher concentration of sugar factory effluent were found to reduce the germination in undiluted (100%) effluent (**Fig 2**).

Table 1: Physico- chemical properties of sugar mill effluent

S.No	Parameters	Effluent
1	Colour	Black
2	pH	4.20
3	BOD	970mg/L
4	COD	3140mg/L
5	Oil and Grease	12
6	Temperature	33.0
7	Electrical conductivity	2.23
8	Total dissolved solids	1480
9	Calcium	361mg/L
10	Magnesium	268mg/L
11	Sulphate	419mg/L
12	Iron	12.8mg/L
13	Lead	0.065mg/L
14	Zinc	0.26mg/L
15	Copper	0.135mg/L
16	Potassium	113mg/L

Table 2: Physico-chemical properties of sugar mill contaminated soil:

S. No	Parameters	Contaminated soil
1	pH	6.0
2	EC (mMhos)	0.43
3	N(Nitrogen) (kg/ha)	92
4	K(potassium)(kg/ha)	150
5	Iron(ppm)	21.28
6	Lead(ppm)	0.53
7	Zinc(ppm)	7.28
8	Copper(ppm)	0.75
9	Phosphorus(kg/ha)	50

Table 3: Percentage seed germination on sugar mill effluent

Effluent concentration	Paddy (*Oryza sativa* L.)
Control (0%)	90%
10%	85%
25%	80%
50%	75%
75%	50%
100%	25%

Table 4: Percentage seed germination on sugar mill effluent contaminated soil

Properties	Paddy (*Oryza sativa* L.)
Control	90%
Contaminated soil	30%

Fig 1: Germination percentage of paddy on different concentration of effluent

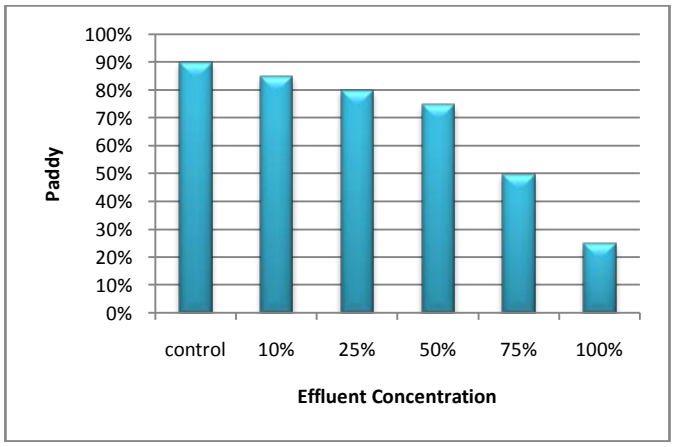
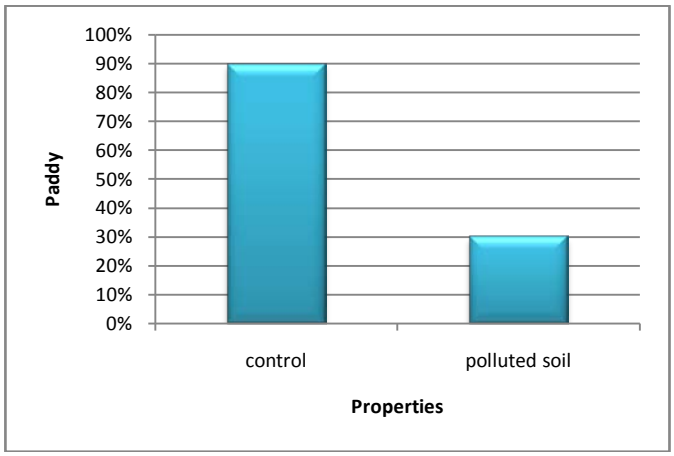


Fig 2: Germination percentage of paddy on contaminated soil



CONCLUSION

From this study, it was concluded that physico-chemical parameters such as pH, electrical conductivity, COD, chloride, hardness, calcium, magnesium, sulphate and TDS were relatively high in the sugar factory effluent and severely affected seed germination. There was a gradual decrease in the percentage seed germination and germination value with sugar industry effluent concentration. The untreated sugar industry effluent could possibly lead to soil deterioration and low productivity. Terrestrial and aquatic environmental pollution could be averted by proper treatment of the effluents using suitable conventional methods. In conclusion, sugar industry effluent concentration governs seed germination. The effects vary from crop to crop because each plant species has its own tolerance of the different effluent concentrations.

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