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# A Review on Soil Irrigation Effect of Sugar Mill Effluent on Seed Germination

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***Abstract—*** *With the onset of rapid industrialization various environment related issues are there due to the degradation in quality of the various components of environment. Water pollution is one of them as most of the Indian rivers and fresh water streams are seriously polluted by industrial effluents which come along waste waters of different industries such as fertilizer, pulp and paper, textile, sugar mills, tanneries, distilleries, etc. The sugar industry, apart from being an important contributor to the economy of India, is also a major source of organic and inorganic wastes in water bodies. The sugar mill effluents are having high amount of suspended solids, dissolved solids, biochemical oxygen demand, chemical oxygen demand, calcium, magnesium, chloride, nitrate and sulphate. Use of sugar mill effluents for agricultural purposes is a highly warranted utility of water pollutants proposition. The continuous use of such type of effluents harmfully affects the crops when used for irrigation. In the present study, the soil irrigation effect of effluents from sugar mills on seed germination are reviewed hereunder.*

***Keywords—Industrial effluents, irrigation, seed germination, water pollution.***

## I. INTRODUCTION

The problem of water pollution due to problem of disposal of industrial waste is increasing day by day. Various industries have been continuously adding lot of waste water containing hazardous substances and heavy metals to the cultivable land (Srivastava *et al*., 2000; Chandra *et al*., 2004; Malaviya and Rathore, 2007). The sugar industry, apart from being an important contributor to the economy of numerous countries including India, is also a major source of organic and inorganic wastes in water bodies. India is the second largest producer of sugarcane after Brazil in the world with 550 sugar mills and 220 million tons cane per year and total sugar production 13.5 million tons per year (Kaur *et al*., 2010). A considerable amount of water is used in sugar industry and subsequently a large amount of effluent of medium pollution range is discharged. Sugar industry effluent contains several organic and inorganic contents in differ**e**nt concentrations. In our country a huge amount of waste water generated from sugar industries is discharged on land or into the water bodies. They are hazardous to aquatic plants, animals and human beings. However, some effluents at certain dilution are found to be beneficial for irrigation purposes (Taghavi and Vora, 1994; Nath *et al*., 2007; Doke *et al*., 2011). Plant responses to sugar mill effluent has been studied and reviewed extensively by (Rath *et al*., 2013; Vaithinathan *et al*., 2014; Elayaraj, 2014).

**Physico-chemical characteristics of sugar mill effluent**

The sugar mill effluent contains a high amount of production load particularly, dissolved solids, suspended solids, organic matters, press mud (Bevan, 1971). Sugar mills discharge large amount of wastewater having low pH with high concentration of suspended solids, dissolved solids, biochemical oxygen demand (BOD) and chemical oxygen demand (COD) (Sajani & Muthukkarupan, 2011). There are more than 20 types of industries including sugar industry falls under red category because of their potentiality in polluting the environment (Central Pollution Control Board, 2016). The sugar industry generates about 7.5 million ton of molasses, 45 million ton of bagasse, 5 million ton of press mud and 40 million $m^3$ of spent wash (Kumar, 2003; Uppal, 2004).

The physico-chemical parameters of sugar mill effluent are, colour (dark brownish), odour (decaying smell), pH (4.5), temperature ($36^0$C), electrical conductivity (3.1µS), total solids (2200 mg/l), total dissolved solids (1990 mg/l), total suspended solids (190 mg/l), chemical oxygen demand (3725 mg/l), biochemical oxygen demand (970 mg/l), total hardness (210 mg/l) and total alkalinity (360 mg/l) and according to the permissible level suggested by Bureau of Indian standards (BIS) almost all the water quality parameters in the sugar mill effluent have been found to be very high and well above the permissible limits (Kamlesh and Kidwai, 2016).

**Effect of sugar mill effluent**

Mycin, 2014 studied physico-chemical parameters of sugar mill effluent and effect of different concentrations (control,

5, 10, 15, 20, 25, 75 and 100) of effluent on seed germination, seedling growth of cowpea *vigna unguiculata* (L.) Walp and reported that growth parameters were found to increase at 5% concentration and decrease from 10% effluent concentration onwards.

Vaithiyanathan *et al.* (2014) studied on response of black gram (*vigna mungo* L.) to sugar mill effluent treatment. Germination studies parameters such as germination percentage, germination index, shoot length, root length, fresh and dry weight of seedlings were found to be increased up to 10% concentration of effluent. Percentage of vigour index, tolerance index and phytotoxicity were also calculated and found germination parameters of black gram decreased at higher concentration (25, 50, 75 and 100%) of sugar mill effluent.

Elayaraj (2014) studied physico-chemical analysis of sugar factory effluent stress on seedling growth of black gram (*Vigna mungo* (L.) *Hepper*) varieties. Germination studies was conducted with black gram seed varieties (ADT-3, ADT-5, Vamban-3, Vamban-5 and Co-6) treated with different concentrations (control, 5, 10, 25, 50, 75 and 100 % ) of sugar mill effluent. Germination studied parameters such as germination percentage, germination index, shoot length, root length, fresh and dry weight of seedlings were found to be increased up to 10 % concentration of effluent. Vigour index, tolerance index, percentage of phytotoxicity and germination index were decreased with increasing concentration (25-100%).

Rath *et al.* (2013) studied the impact of different concentrations of sugar factory distillery spent wash (DSW) on germination, seedling growth, pigment content and different biochemical parameters of rice and found the germination percentage was highest (99.6%) at 15% DSW concentration. The highest germination index and seed vigour index were 16.66 and 2030, respectively at 15% DSW concentration. The maximum root length was 12.62 cm and shoot length was 7.68 cm at 15% and 20% DSW concentration, respectively. The chlorophyll content was highest (0.712 mg g-1) at 15% DSW concentration while the carotenoid (0.008 mg g-1) and pheophytin (0.962 mg g-1) contents were highest at 20% DSW concentration. The highest DNA and RNA contents were 0.049 mg ml-1 and 0.254 mg ml-1 respectively at 15% DSW concentration but the protein content was highest (1.859 mg ml-1) at 20% DSW concentration.

Sajani *et al.,* (2011) studied physico-chemical parameters of sugar mill effluent and contaminated soil 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.) and found germination percentages and germination values decrease with increasing concentration of effluent in the seeds tested.

Doke *et al.* (2011) assessed physico- chemical parameters of treated waste water effluents from a sugar industry and determined the effect of various concentrations (0%, 20%, 40%, 60%, 100%) of effluent on seed germination, germination speed, peak value and the germination value of mung (*vigna angularis*), Chavali (*vigna cylindrical*) and jowar (*sorghum cernum*) seeds and found germination percentages and germination values decrease with increasing concentration of effluent in all the seeds tested. The low effluent pH (4.35), total dissolved solids (720 mg/l) and chemical oxygen demand (1330 mg/l) indicated the high inorganic and organic content with an acidic load.

Nath *et al.* (2007) studied effect of treated distillery and sugar factory mixed effluent on seed germination and seedling growth in wheat, garden pea, black gram and mustard and found seed germination and seedling growth significantly reduced with increase in concentration of the effluent. Wheat, garden pea, black gram, mustard invariably showed inhibition in fresh weight and dry weight was found consistently reduced in different treatments.

Hussain *et al*., 2013 conducted experiments on two maize cultivars and reported that when these crops were treated with different concentrations of sugar mill effluent, there was slight decrease in the growth at higher concentration but lower concentration (25%) of effluent was very effective in increasing the growth of both maize cultivars when compared with control.

Rani and Kumar, 2010 conducted work on *Triticum aestimum* and found promotory effect of different concentration of sugarcane industrial effluent on chlorophyll level, growth and yield of plant.

Beg *et al.,* 2010 studied effect of sugar industry effluent on vegetative and yield characteristics of *Brassica campestris* L. var.Varuna type 59 and recorded maximum increase in almost all the parameters in T treatment. Crop showed vigorous enhancement in almost all the vegetative and yield characteristics studied may be due to the suitable pH and chemical composition of the sugar industry effluent. The presence of nitrogen, phosphorus, magnesium and sulphur etc. in effluent played important role in growth and development of the plants.

Jayakumar *et al*., 2014 studied impact of sugar mill effluent on photosynthetic pigment content and biochemical constituents variance of Cluster Bean (*Cyamopsis tetragonaloba* (L) Taub) and found all the photosynthetic pigment content; such as chlorophyll-a, chlorophyll-b, total

chlorophyll, carotenoid content and biochemical constituents, such as, starch, amino acid, protein, reducing and non-reducing sugar content were increased at 10% sugar mill effluent concentration while decreased at higher (25, 50, 75 and 100 %.) concentrations of sugar mill effluent.

Saini and Pant, 2014 studied physico-chemical parameters of sugar mill effluent and its impact on germination and growth patterns of wheat and maize. The physico-chemical parameters studied were color, odour, temperature, pH, electrical conductivity, total hardness, biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), total dissolved solids (TDS), potassium, phosphate, sodium, ammonia and chloride. The seeds of Wheat and Maize were incubated with concentration of effluent dilution ranging from control, 0%, 25%, 50%, 75% and 100% and 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.)**.**

Sivaraman *et al*., 2013 studied impact of different concentration (control, 5, 10, 25, 50, 75 & 100 %) of sugarmill effluent on seed germination, growth and pigment contents changes of blackgram (*Vigna mungo*, var.co-5) and found that effluent was brown in colour with acidic in nature and has high biochemical oxygen demand, chemical oxygen demand, suspended and dissolved solids. The results showed that at lower concentration (5 & 10%) germination, seedlings length, fresh and dry weight and pigment content like chlorophyll 'a', chlorophyll 'b' and carotenoid were increased while decreased at higher (25-100%) concentration.

Bharathi and Sivaraman, 2013 studied utilization of different concentration (control, 5, 10, 25, 50, 75 & 100 %) of sugar mill effluent on growth and biochemical contents of blackgram (*Vigna mungo*, var.KM-2) and found that effluent was brown in colour with acidic in nature and had high biochemical oxygen demand, chemical oxygen demand, suspended and dissolved solids. The results showed that at lower concentration (10%) growth and biochemical contents were increased while decreased at higher concentration.

Madan and Saxena, 2012 studied effect of sugar mill effluent on seed germination, root length, shoot length, fresh biomass, dry biomass, chlorophyll a and b, total chlorophyll and ascorbic acid on *Solanum melongena* by using different adsorbent viz; activated charcoal, wood ash and bagasse pith and assessed morphological parameters of test crop grown in adsorbent mixed soil by using different concentrations of sugar mill effluent i.e, 25%, 50%, 75% and 100%. The results showed that at 75% concentrations of sugar mill effluent along with application of activated charcoal the germination percentage, root length, shoot length, chlorophyll and biomass of the crop were increased and suggested that effluent can be used safely for *S. melongena* cultivation, only after proper treatment and dilution.

Vijayaragavan *et al*., 2011 studied effect of sugar mill effluent on plant growth and biochemical constituents of *Raphanus sativus* L. var. Pusha Chetki in a pot culture experiment during the period of January to March 2008 up to 60 days by using different concentrations of sugar mill effluent (viz, 0, 20%, 40%, 60%, 80% & 100%v/v). Plants were thinned to a maximum of three per pots, after a week of germination. The results showed that the higher sugar mill effluent concentrations (above 40%) were found to affect plant growth and decreased chlorophyll-a, chlorophyll-b and total chlorophyll, caroteinoids, total sugar, amino acids and protein contents, but diluted effluent (up to 40% ) favoured the plant growth and biochemical contents.

Kumar, 2014 studied effect of sugar mill effluent fertigation on soil properties and agronomical characteristics of Maize (*Zea mays* L. cv. NMH 589) in two seasons by using six treatments of effluent, namely, 0% (control), 20%, 40%, 60%, 80%, and 100% and resulted in significant ($P < 0.01$) changes in electrical conductivity (EC), pH, sodium ($Na^+$), potassium ($K^+$), calcium ($Ca^{2+}$), magnesium ($Mg^{2+}$), total kjeldahl nitrogen, phosphate, sulphate, iron, zinc, cadmium, copper, manganese, and chromium of the soil in both seasons. The results showed that maximum agronomic performance of *Z. mays* was noted with 40% concentration of effluent and biochemical components like crude proteins, crude fiber, and total carbohydrates were recorded highest with 40% concentration of sugar mill effluent in both seasons. The contamination factor (Cf) of various heavy metals was observed in order of $Mn^{2+} > Zn^{2+} > Cu^{2+} > Cd^{2+} > Cr^{3+}$ for soil and $Mn^{2+} > Zn^{2+} > Cu^{2+} > Cr^{3+} > Cd^{2+}$ for *Z. mays* in both seasons.

Baskaran *et al*., 2009 studied effect of different concentrations of sugar mill effluent on growth, yield, biochemical contents and enzymatic activities of green gram (*Vigna radiata* (L.) Wilczek) by pot culture experiment. The physico-chemical analysis showed that it was acidic in nature and yellowish in colour and was rich in total suspended and dissolved solids with large amount of

Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). The higher amount of chloride, calcium, magnesium, sodium, potassium and iron were also present in the effluent. The growth parameters such as germination percentage, shoot length, root length, fresh weight, dry weight and leaf area were measured at 15, 30, 45 and 60 Days After Sowing (DAS) and pigment analyses viz. chlorophyll 'a', chlorophyll 'b', total chlorophyll, protein, amino acid, sugar contents and enzymes activities were analysed at 15 and 60 DAS. The results showed that all morphological growth parameters, biochemical contents, enzyme activities and yield parameters were found to increase at 10% effluent concentration and it decreased from 25% effluent concentration onwards.

Gaikwad *et al*., 2010 analysed physico-chemical and biological parameters of effluents of sugar mill and distillery. The result showed that effluent of sugar factory was black in colour with decaying odour while effluent of distillery was wine red in colour with decaying odour. Dissolved oxygen and dissolved carbon dioxide ($CO_2$) in sugar effluent was 18mg/l and 47 mg/l respectively while dissolved oxygen and $CO_2$ in distillery effluent was 40 mg/l and 9 mg/l. total solids of sugar effluent and distillery effluent was 94000 mg/l and 2000 mg/l respectively. Both effluents showed phytotoxic effect on seeds of Turkish Bean and was found not suitable for crop irrigation.

Poddar and Sahu, 2015 determined the physico-chemical characteristics of sugar industry waste water by the standard method and minimized the fresh water consumption in sugar industry by water pinch methodology. Many different types of techniques were introduced and modified for the purpose, but depended upon the water quality parameters.

## II. CONCLUSION

Among the effluent discharging industries, sugar mill plays a major role in producing a higher amount of water pollution because it contains large quantities of chemical elements. The untreated sugar mill effluent could possibly lead to soil deterioration and low productivity. Reuse of treated sugar mill effluent for safe disposal is receiving attention as a reliable water resource for irrigation.

From the reviewed work, it may be concluded that diluted concentrations may be an adequate strategy for waste management by utilization of such type of Industrial effluent.

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