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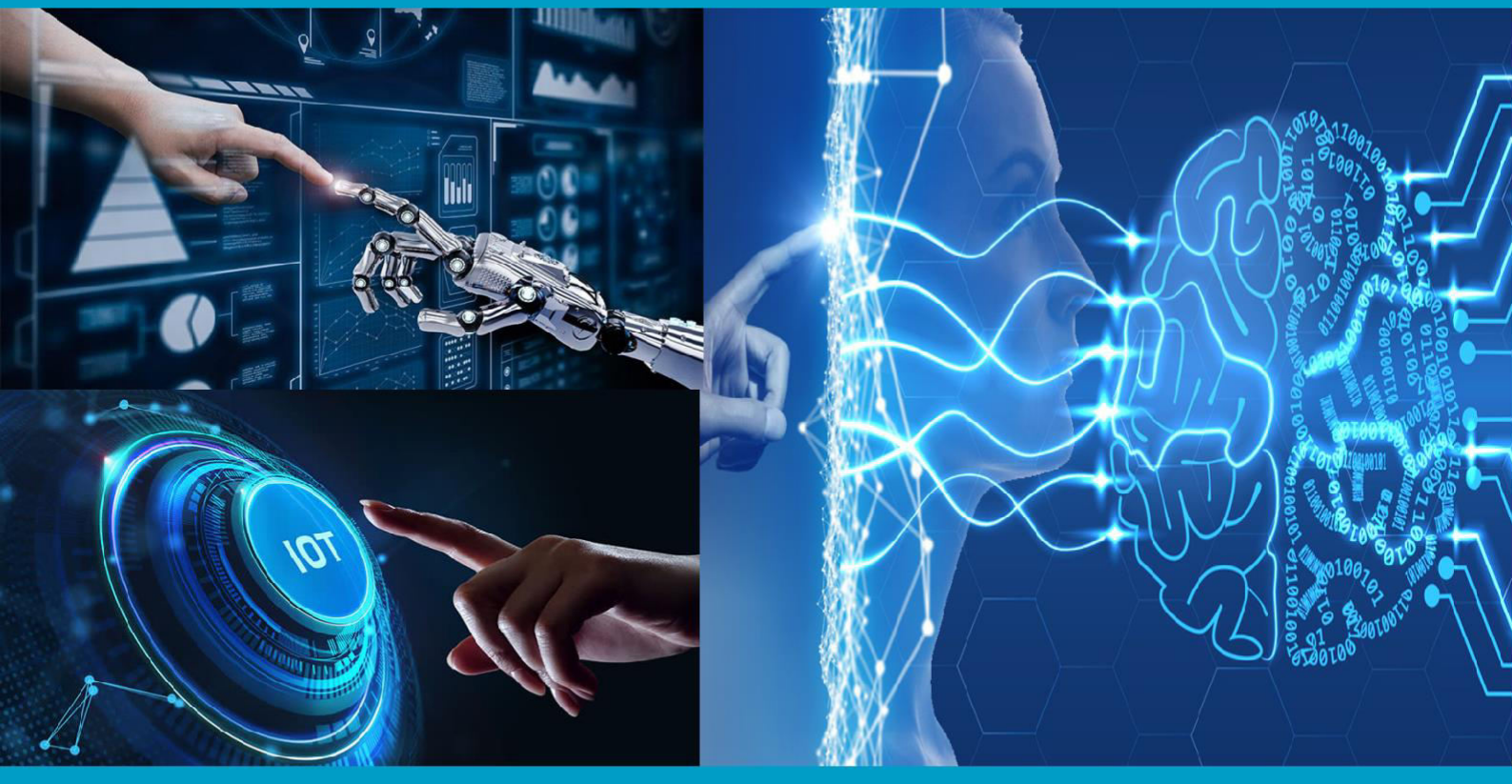

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Effect of Sugar Mill Effluent on Soil

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ABSTRACT: This article evaluates the effects of sugar mill effluent on soil and crop plants. The effluents were high in various solids, COD, BOD, chlorides, sulphates, and had low dissolved oxygen and moderately alkaline pH. The effluents disturbed the pH, N, P, $CaCO_3$ and organic matter, the greatest perturbance being observed in the potassium of the soil when effluent was used for irrigation. The effluent was applied to different plant seeds in four concentrations .
Germination in the water-irrigated soil was 100% whereas it ranged between 99% and 91% in other concentrations of the effluent. The water-irrigated soil and the soil irrigated with 25% effluent were found most suitable for germination. It is suggested that the sugar factory effluents be used for irrigation after dilution.

KEYWORDS: sugar mill, effluents, seeds, plants, water, soil, irrigation, factory, germination

I.INTRODUCTION

In many agroindustrial processes, some by-products may be utilized as useful products [1, 2]. In India, the sugar industry is one of the greatest industries, based on sugar cane. Presently India has nearly 650 sugar mills that produce about 15 million tons of sugar and 13 million tons of molasses annually [3, 4]. The high production of sugar generates high quantities of the sugar industry wastes such as effluent, filter mud cake, vinasse, molasses, bagasse, and bagasse ash [5]. A few years ago, these by-products were considered as a waste and were often disposed of causing environmental problems such as aquatic and terrestrial pollution [6]. Recently, it has been recognized that such by-products should be considered as useful materials [7]. These by-products are of great agricultural interest because of their high organic matter, N and K contents, and probably other elements [3, 8, 9]. Therefore, some of these sugar industry by-products may represent an important source of nutrients and thereby could be used as a substitute for chemical and organic fertilizers [2, 8, 10, 11].

Use of wastewater in agricultural fields may be a viable method of disposal and would sustain agriculture in non-irrigated areas where the availability of fresh water is scarce [12, 13]. It reduces fertilizer and irrigation water cost as it is available without paying any cost and rich in various plant nutrients [12]. Although, metals like Cu, Fe, Ni, and Zn and other trace elements are important for proper functioning of biological systems, and their deficiency, or excess could lead to a number of disorders [14–16]. But long term irrigation with effluents increases accumulation of metals in soil and plants and increases chances of their entrance in food chain [17]. Contamination of agricultural soils with metals can pose long term environmental problems and is not without health implications [17–19].

Many crops are cultivated for food and fodder throughout the world under diverse environments [20, 21]. Their biomass is variously used for the production of energy, fiber, or paper, as well as for syrup and animal feed [22]. In India, examples are maize, rice, wheat, and sorghum. These are cultivated for food and fodder in the northwestern states of the country in all the seasons, namely, rainy, winter, and summer, with a production of 14.71 million tonnes from an area of 7.23 million hectares with productivity of 19.04 quintals per hectare [4]. It also has the ability to tolerate and survive under adverse conditions of intermittent and continuing drought [24, 25]. Therefore, crops have has received considerable attention during the last years as an alternative source for food, fodder, and energy production [4, 11].

Some crops have higher potential yields with wastewater irrigation, reduce the need for chemical fertilizers,[22] and result in net cost savings to farmers [13, 22]. It is important to understand the specificity of crop-effluent interaction for appropriate applications in irrigation [13]. In some studies characteristics of the effluent of industries and agronomic properties of various crop plants have been determined [10, 22]. Most studies were conducted on few agronomic stages with limited parameters in various crops, but there are few reports on comprehensive agronomic studies at various

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agronomic stages of these plants [22]. Use of industrial effluents on cultivation of many crops is receiving attention [4] but additional information is needed on how this crop responds to various concentrations of different types of effluents.
The effluent samples were collected from the R.B.N.S. Sugar Mill, Laksar, Haridwar, Uttarakhand, India (29°44′46″N 78°1′46″E), which produces sugar from sugar cane at the rate of 150 ton sugar per day. The effluent was collected in the plastic container from the outlet of the settling tank situated in the campus of the sugar mill to reduce the biological oxygen demand (BOD) and solids from the effluent. The effluent was brought to the laboratory and then analyzed for total dissolved solids (TDS), pH, electrical conductivity (EC), dissolved oxygen (DO), BOD, chemical oxygen demand (COD), chlorides , bicarbonates , carbonates , sodium , potassium , calcium , magnesium , total Kjeldahl nitrogen (TKN), nitrate , phosphate , sulphate , iron , zinc , cadmium , copper , manganese , chromium , standard plate count (SPC), and most probable number (MPN) following [11] and used as fertigant.

Values of physicochemical and microbiological parameters were different over sugar mill effluent concentration . The sugar mill effluent was highly alkaline with a pH 8.98. The alkaline nature of the sugar mill effluent might be due to the presence of high concentrations of alkalis used in the sugar manufacturing process.[21] The BOD, COD, TKN, , MPN, and SPC were beyond the prescribed limit of the Indian irrigation standards [13]. Higher BOD and COD might be due to the presence of more oxidizable organic matter and rapid consumption of dissolved inorganic materials. The higher bacterial load (SPC and MPN) in sugar mill effluent might be due to the presence of more dissolved solids and organic matter in sugar mill effluent . The presence of MPN in sugar mill effluent may be due to sewage received from the toilet of staff quarters and offices. The TKN and in effluent were higher than the prescribed standards. In the present study, the values of BOD, COD, TKN, and were more in sugar mill effluent than the values of BOD (2769.00 mgL^{-1}), COD (4830.00 mgL^{-1}), chlorides (789.00 mgL^{-1}), sulphate (374.95 mgL^{-1}), and phosphate (23.00 mgL^{-1}) in sugar mill effluent. In case of metals, the contents were higher than the permissible limit for industrial effluent. The content of these metals in sugar mill effluent was also higher than the content of Zn (16.34 mgL^{-1}), Cd (3.47 mgL^{-1}), and Cu (8.62 mgL^{-1}) in sugar mill effluent .[1,2]

II.DISCUSSION

Vegetative growth of crops at 45 days was affected in both seasons summer and winter . The minimum root length (12.15 and 13.21 cm), number of leaves (10.00 and 12.00), and dry weight/plant (55.87 and 57.98 g) of many crops were recorded with control while moderate root length (12.44 and 13.63 cm), number of leaves (12.00 and 13.00), and dry weight/plant (44.78 and 45.96 g) of crops were observed with 100% sugar mill effluent in both seasons. The maximum root length (14.24 and 16.12 cm),[20] number of leaves (14.00 and 16.00), and dry weight/plant (65.47 and 68.68 g) of crops were noted with 40% concentration of sugar mill effluent in both seasons. Sugar mill effluent concentrations, the seasons, and their interaction had no effect on root length, number of leaves, and dry weight of the crops..[3,4]

Maximum plant height, fresh weight, chlorophyll content, and LAI/plant of crops were due to the treatment with the 40% concentration of sugar mill effluent in both seasons . The ANOVA indicated that sugar mill effluent concentrations affected plant height, fresh weight, chlorophyll content, and LAI/plant of crops. The seasons had no effect on plant height, fresh weight, chlorophyll content, and LAI/plants of crops. The interaction of seasons and sugar mill effluent concentrations affected plant height, fresh weight, chlorophyll content, and LAI/plant of crops. The effluent irrigation significantly changed the soil quality and affected the natural composition of the soil. Such alterations improved the fertility and enhanced the nutrient status of soil at lower concentrations of effluent irrigation. These were recorded maximum with 100% concentration of sugar mill effluent.[19] The agronomic performance of crops was gradually increased from 20% to 40% and decreased from 60% to 100% concentration of sugar mill effluent in both seasons. The maximum growth performance of crops was noted with 40% concentration of sugar mill effluent in both seasons. It may be due to the fact that, at lower concentrations, the nutrients and heavy metals may provide better and much effective stimulation to the agronomic performance of the crops, while more irrigation increased the accumulation of nutrients/heavy metals at higher effluent concentrations (i.e., 60% and 100%), thus inhibiting the overall performance of the crop plants. Biochemical components like crude proteins, crude fiber, and total carbohydrates were also highest with 40% sugar mill effluent in both seasons.[5,6]

III.RESULTS

Sugar mill effluent plays a vital role in polluting the environment which contained high pollutants. In the present study the physico-chemical properties of soil due to the effluent irrigation (before and after harvesting of crops with different

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concentration of sugar mill effluent irrigation). Control of soil used as a tap water. The following parameters were analyzed such as pH, EC, moisture content, N, P, K, Ca, Mg, Zn, Cu, Fe and Mn.[17,18] The results showed that sugar mill effluent reduced the pH and moisture content of the soil. The highest level of EC value recorded in higher concentrations of effluent irrigated soil. The sugar mill effluent significantly increased the nutrients and heavy metals in the soil with increasing of effluent concentrations.[7,8] The highest agronomic performance of crops was found at 10% concentrations of sugar mill effluent irrigated soil. Based on the work lower concentrations of sugar mill effluent (10%) contained required amount of plant nutrient which increased soil fertility. The suggestion of the work the lower concentration (10%) of sugar mill effluent can be utilized for irrigation, which used for alternative scarcity of water and fertilizer.[9,10]

IV.CONCLUSIONS

Results shows promotory effect of different concentration of sugarcane industrial effluent on chlorophyll level, growth and yield of plant. Similar observations were also studied by many workers. *Triticum aestivum* and *Phaseolus aureus* showed that when these crops were treated with different concentrations of industrial effluent,[16] there was slight increase in the shoot length, root length and dry matter accumulation and chlorophyll content at lower concentration (10% and 25%).[11,12] It was argued that mill by-products contribute towards better yield, productivity, and profitability by affecting the physical condition of the soil, such as reducing bulk density in the surface soil and by raising pH of the surface soil. The elongation of growth was diretly proportional to the concentration of effluent. Crops of wheat, barley, kidney bean and pearl millet show promotory effects in response to industrial effluent. An increase in chlorophyll content takes place under treatment of sugarcane industrial effluent. Increase in chlorophyll content is due to activation of chlorophyllase enzyme. It was suggested increase in chlorophyllase activity by chemical agents[13].Another reason is due to the presence of Mg++ ions in the effluents , which are required for the synthesis of different chlorophyll molecules. Promotion in growth and yield is due to increase in chlorophyll level , leaf area, increase in no. of leaves. Promotion in these parameters will lead to ultimate promotion in photosynthetic activity and hence promotion in growth and yield occurs. Maximum response was recorded in the plant suggests that the diluted effluent can be used for better growth of the crops. [14,15]

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