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# Growth Response of *Solanum Melongena* in Three Different Adsorbents Irrigated With Sugar Mill Effluent

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**ABSTRACT**

*The present investigation has been carried out on Solanum melongena to search out the 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. In-vivo conditions were set up for the experiment purpose. Pots were filled with soil and mixed with different adsorbent viz; activated charcoal, wood ash and bagasse pith. The seeds of uniform size of test crop were selected and surface sterilized with 0.1% $HgCl_2$. Exposure of different concentrations of sugar mill effluent i.e, 25%, 50%, 75% and 100% on morphological parameters of test crop grown in adsorbent mixed soil was assessed. Results of germination studies showed that at 75% concentrations of sugar mill effluent along with application of activated charcoal increased the germination percentage, root length, shoot length, chlorophyll and biomass of the crop. The study suggests that the effluent can be used safely for S. melongena cultivation, only after proper treatment and dilution.*

**Key words**: Chlorophyll a and b, Sugar mill effluent, Seed germination, adsorbent

## INTRODUCTION

The problem of environmental pollution on account of essential industrial growth is, due to the problem of disposal of industrial waste whether solid, liquid or gaseous. Polluted water, in addition to other effects, directly affect soil not only in industrial areas but also in agricultural fields and river beds, thereby creating secondary source of pollution [1,2]. Various industries have been continuously adding lot of waste water containing high level of nutrients, heavy metals and hazardous substances to the cultivable land [3,4,5,6]. These effluents not only increase the nutrient level, but also excess tolerance limits and cause toxicity [7]. Adsorption is a promising alternative method to treat industrial effluents, mainly because of its low cost and high metal binding capacity [8]. Various adsorbents are used for decontamination of soil and water [9]. However, a large number of low-cost adsorbents have been utilized for the removal of organic pollutants and metal ions, search for more cheaper and effective adsorbent still continues unabated**.**

A large number of industrial effluents are used for the irrigation of crops in fields. Although, it is essential that the impact of these effluents on seed germination and seedling growth should be well assessed before recommending for irrigation purposes. Any disturbance in the environment in which the seed germinates, affects the germination and ultimately growth and dry matter yield of crop. Several workers studied the effect of various effluent on germination, growth and yield of crop plant [10,11,12,13]. But, the present study focused on the application of cheap and natural available adsorbents for the morphological assessment of *S. melongena* irrigated with different concentrations of the sugar mill effluent.

## MATERIALS AND METHODS

The effluent was collected from the sugar mill situated at Laksar in Haridwar (U.K.) and analysed for its physico-chemical properties *viz;* pH, Turbidity, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Dissolved Solids (TDS), Total Solids (TS), Chloride, Sulphate, Sodium, Potassium by standard procedures [14].

Three different adsorbents namely, activated charcoal, wood ash and bagasse pith procured from laboratory, paper mill and sugar mill, respectively. Plastic pots of 20 cm (diameter) × 30 cm (height) size were filled with sandy loam soil and adsorbents in ratio of 200:1 gm. The healthy and uniform size seeds of *S. melongena* were selected for present study. For germination tests, 10 seeds of the test crop were surface sterilized with 0.1% $HgCl_2$ solution for two minutes, rinsed twice with distilled water and evenly placed in each pot. Equal volume (200 ml) of different dilutions of the effluent (25%, 50%, 75%, 100%) was used for irrigation at alternate days. Control set involving no application of adsorbents was also run in parallel. Pots containing adsorbent mixed soil were considered as treated while the pots involving no addition of adsorbents were considered as control. Triplicates were maintained in each case of adsorbent and various growth characters such as, seed germination, root length, shoot length, fresh biomass, dry biomass after 21 days of sowing and chlorophyll a, chlorophyll b, total chlorophyll and ascorbic acid after 45 days of sowing as per [15]. Analysis of variance is the major statistical tool used in the study for testing the statistical significance of the variance of mean at $\alpha$=0.05. Overall statistical analysis (F-test) of the present study was done using the SPSS (12.0).

## RESULTS AND DISCUSSION

The physico-chemical characterisation of sugar mill effluent is shown in Table 1. Changes in the morphological and biochemical parameters of *S. melongena* after 21 days and 45 days of sowing are presented in Table 2 and 3 respectively. From the Table 1, it is clear that, the sugar mill effluent was brownish in colour and acidic in nature. It contain considerable amount of solids, biological oxygen demand and chemical oxygen demand. It appears that high concentration of potassium, chloride, sodium, sulphate ions and high amount of BOD and COD contribute to the toxicity of the effluent [16].

**Table 1. Characterisation of sugar mill effluent**

| S.No. | Properties | Untreated Effluent |
|---|---|---|
| 1. | Colour | Brownish |
| 2. | Odour | Decaying molasses smell |
| 3. | pH | 4.26 |
| 4. | E.C.(dS/m) | 4.2 |
| 5. | Temperature (°C) | 31 |
| 6. | Suspended Solids (mg/l) | 379.1 |
| 7. | Total Dissolved Solids (mg/l) | 2998.32 |
| 8. | Total Solids (mg/l) | 3377.42 |
| 9. | BOD (mg/l) | 1711.00 |
| 10. | COD (mg/l) | 2890.32 |
| 11. | Sulphate (mg/l) | 1410.6 |
| 12. | Chloride (mg/l) | 696.3 |
| 13. | Calcium (mg/l) | 3486.96 |
| 14. | Magnesium (mg/l) | 1930.78 |
| 15. | Potassium (mg/l) | 96.0 |
| 16. | Sodium(mg/l) | 69.0 |

**Table 2. Morphological parameters of *S. melongena* after 21 days of sowing under different concentrations of sugar mill effluent (Values are Mean±S.D. of 3 observations each)**

| Treatments | Effluent Conc.(%) | % Seed Germination | Root length (cm) | Shoot length (cm) | Fresh Biomass ($gm/m^2$) | Dry Biomass ($gm/m^2$) |
|---|---|---|---|---|---|---|
| Control | 25 | 53.33±5.78 | 3.96±0.67 | 8.78±0.58 | 0.52±0.03 | 0.06±0.02 |
| | 50 | 66.67±5.78 | 4.36±0.64 | 10.92±0.92 | 0.58±0.06 | 0.07±0.03 |
| | 75 | 60.00±10.0 | 4.1±0.19 | 11.64±0.48 | 1.01±0.03 | 0.10±0.01 |
| | 100 | 53.33±5.78 | 2.07±0.12 | 6.19±0.21 | 0.47±0.06 | 0.04±0.02 |
| F-value | | 2.444* | 14.527 | 49.953 | 90.303 | 4.744 |
| AC | 25 | 83.33±5.78 | 7.77±0.39 | 15.62±0.43 | 1.84±0.05 | 0.16±0.03 |
| | 50 | 88.67±5.78 | 5.29±0.54 | 13.33±0.57 | 1.18±0.03 | 0.17±0.04 |
| | 75 | 93.33±5.78 | 8.42±0.38 | 16.69±0.44 | 2.24±0.16 | 0.31±0.03 |
| | 100 | 66.67±5.78 | 3.25±0.15 | 10.03±0.23 | 1.17±0.13 | 0.06±0.02 |
| F-value | | 11.583 | 111.875 | 138.802 | 72.204 | 32.747 |
| BP | 25 | 60.00±10.0 | 4.49±0.34 | 11.75±0.53 | 0.59±0.03 | 0.09±0.02 |
| | 50 | 66.67±15.3 | 3.59±0.80 | 11.17±0.86 | 0.86±0.06 | 0.09±0.03 |
| | 75 | 76.67±15.3 | 7.21±0.67 | 12.21±0.39 | 0.73±0.05 | 0.17±0.04 |
| | 100 | 60.00±10.0 | 2.56±0.49 | 7.67±0.34 | 0.64±0.05 | 0.03±0.01 |
| F-value | | 1.117* | 33.320 | 39.982 | 17.997 | 17.510 |
| WA | 25 | 53.33±5.78 | 4.1±0.12 | 9.70±0.57 | 0.96±0.04 | 0.08±0.01 |
| | 50 | 50.00±10.0 | 3.77±0.51 | 9.96±1.00 | 0.64±0.09 | 0.07±0.02 |
| | 75 | 70.00±10.0 | 6.78±0.41 | 12.10±0.19 | 0.73±0.05 | 0.28±0.30 |
| | 100 | 46.67±5.78 | 1.78±0.09 | 5.47±0.39 | 0.59±0.03 | 0.03±0.02 |
| F-value | | 4.833 | 114.611 | 60.975 | 58.600 | 91.111 |

** NS at ($\alpha$= 0.05) ; AC- activated charcoal, WA- wood ash, BP- bagasse pith*

**Table 3. Biochemical parameters of *S. melongena* after 45 days of sowing under different concentrations of sugar mill effluent (Values are Mean±S.D. of 3 observations each)**

| Treatments | Effluent Conc.(%) | Chl. a (mg/gm) | Chl.b(mg/gm) | Total chl. (mg/gm) | Ascorbic acid(mg/gm) |
|---|---|---|---|---|---|
| Control | 25 | 0.76±0.013 | 0.77±0.006 | 1.53±0.016 | 0.36±0.045 |
| | 50 | 0.77±0.005 | 0.80±0.006 | 1.57±0.010 | 0.32±0.04 |
| | 75 | 0.81±0.005 | 0.95±0.012 | 1.76±0.014 | 0.58±0.045 |
| | 100 | 0.73±0.004 | 0.76±0.04 | 1.49±0.032 | 0.14±0.030 |
| F-value | | 52.868 | 59.763 | 105.659 | 58.653 |
| AC | 25 | 0.82±0.007 | 0.96±0.004 | 1.78±0.012 | 0.43±0.045 |
| | 50 | 0.76±0.001 | 0.86±0.001 | 1.62±0.002 | 0.40±0.030 |
| | 75 | 0.86±0.006 | 1.04±0.002 | 1.90±0.005 | 0.89±0.025 |
| | 100 | 0.75±0.006 | 0.84±0.015 | 1.59±0.022 | 0.24±0.036 |
| F-value | | 207.348 | 381.086 | 371.317 | 191.266 |
| BP | 25 | 0.79±0.019 | 0.86±0.005 | 1.64±0.024 | 0.44±0.051 |
| | 50 | 0.77±0.007 | 0.76±0.005 | 1.53±0.012 | 0.55±0.061 |
| | 75 | 0.81±0.007 | 1.00±0.009 | 1.81±0.011 | 0.69±0.031 |
| | 100 | 0.77±0.003 | 0.71±0.011 | 1.48±0.011 | 0.21±0.031 |
| F-value | | 8.280 | 761.011 | 264.305 | 60.409 |
| WA | 25 | 0.76±0.010 | 0.78±0.003 | 1.54±0.006 | 0.51±0.020 |
| | 50 | 0.76±0.003 | 0.72±0.005 | 1.47±0.008 | 0.39±0.026 |
| | 75 | 0.79±0.006 | 0.82±0.010 | 1.62±0.014 | 0.64±0.046 |
| | 100 | 0.77±0.003 | 0.76±0.007 | 1.52±0.007 | 0.44±0.036 |
| F-value | | 21.831 | 124.755 | 112.944 | 31.378 |

*Analysis of Variance at ($\alpha$= 0.05) ; AC- activated charcoal, WA- wood ash, BP- bagasse pith*

The germination percentage, root length, shoot length, fresh biomass and dry biomass, for different concentrations of effluent in adsorbents treated and control sets are shown in Table 2. Germination of seeds was recorded with emergence of plumule above the soil surface. Percentage of seed germination do not differ significantly ($\alpha$= 0.05) in the control set and BP treated set at different concentrations of the effluent. Highest percentage of seed germination (93.33±5.78) was recorded at75% concentration of the sugar mill effluent treated with activated charcoal as compared to control. Percentage of seed germination showed increasing trend from 25% to 75% concentration of the effluent treated with AC followed by BP and WA, but germination percentage was decreased if concentration was increased further. This may be due to fact that AC gradually release certain adsorbed products such as nutrients and growth regulators which become available to plants. The highest root length (8.42±0.38 cm) and shoot length (16.69±0.44 cm) were found maximum at 75% concentration in case of AC- treated set as compared to the control. Minimum root length (1.78±0.09 cm) and shoot length (5.47±0.39 cm) were recorded at 100% concentration in case of WA- treated pots followed by BP and AC as compared to control. [17] observed highest root and shoot length at 25% concentration of raw and fly ash neutralized sago factory effluent. Fresh and dry biomass was calculated using fresh weight and dry weight respectively, in 21 day old seedlings of *S. melongena*. Fresh and dry biomass of seedling was found to be highest at 75% concentration of effluent using AC followed by WA. However, further increasing the effluent concentration resulted in sharp reduction in fresh and dry biomass of the test crop. The growth promoting effect at lower concentrations of raw and neutralized effluent can be attributed to the presence of essential nutrients at lower concentrations [18].The results in Table 2, clearly showed that treatment using different adsorbents in all the four concentrations, facilitated the germination process, increased the root and shoot length and fresh and dry biomass of *S. melongena* in comparison to the seedlings grown as control. [8] observed that seedlings which were grown in spreaded tea wastage and soil mixed with the tea wastage showed remarkable effect on the growth as well as physiological parameters. There were significant improvements in growth of the plants, indicating the adsorption of toxic metal on surface applied. Biochemical parameters i.e., Chlorophyll a, b and ascorbic acid of *S. melongena* under various concentration of effluent is presented in Table 3. Effect of various treatments given to different concentrations of effluent on various biochemical parameters was found statistically significant at $\alpha = 0.05$. Maximum chlorophyll content (1.90±0.012 mg/gm) in case of AC followed by BP (1.81±0.02 mg/gm) and WA (1.61±0.02 mg/gm) at 75% conc. of effluent was recorded as compared to control. Maximum (0.89±0.03 mg/gm) and minimum (0.21±0.03 mg/gm) ascorbic acid was recorded at 75% using AC and at 100% using BP repectively. The reduction in growth parameters of *S. melongena* at higher concentrations may be due to the presence of excess quantity of micronutrients in both control and treated effluent. [19] reported that the chlorophyll and carotenoid contents had been significantly increased after the application of seaweed treated metal solution in *Vigna radiate* seedlings. However, the anthocyanin content was decreased by the application of seaweed treated metal solution seedlings.

## CONCLUSION

Sugar industry plays a major role in producing a higher amount of water pollution because it contains large quantities of chemical elements. They contain higher amounts of total hardness, total dissolved solids, biological oxygen demand, chemical oxygen demand, calcium, magnesium, sodium, iron and sulphate. Effluents which are released from sugar industry should be treated and then may be utilized for industrial processing again. Recycle rise of waste water is possible in sugar industry and it is economically profitable for sugar industry [20]. The effluent not only affects the plant growth but also deteriorate the soil properties when used for irrigation [21]. The present investigation was focused on the application of low cost abundant adsorbents in the soil to minimize the toxic effects of effluent. The result of the present study clearly indicates that effluent irrigation in test crop grown under adsorbents treated set, showed improved shoot and root length, biomass and other biochemical parameters over the control set of pots. Out of the three adsorbents, AC give better results followed by BP and WA at 75% concentration of the effluent. Hence, it has been suggested that 75% concentration of the effluent treated with AC can efficiently remediate the toxicity of pollutants and thus can be safely used for the purpose of irrigation.

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