A Study on Effects of Heavy Metal Industrial Solid Waste Toxicity on Relative Growth of Solanum melongena L. on Different Harvesting Days

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Abstract: The Industrial solid waste samples were collected at the outlet of release channel of the “Oil and Gas Industry” at Kakinada, air-dried and was brought to the laboratory. The soil amendments were prepared for as Control, Amendment 1,2,3 and 4. The RGR values of Control plants recorded on 21-51, 51-81 and 81-95 day growth periods were 0.0921, 0.0460 and 0.0095 mg/g/d respectively. Both control and A1, A2, A3 and A4 soils showed an insignificant decreasing trend in RGR over the harvesting periods. The relative growth rate in A1, A2, A3 and A4 soils did not exhibit any definite pattern of variation. The high toxicity levels of the Copper, Zinc, Iron and Manganese heavy metals were accumulated in the industrial solid waste. The results of this study stress the need for environmental awareness, adequate regulations and proper management of waste sites by the local municipal authorities and Pollution control board take the necessary actions to control Industrial solid waste disposal site on the Kakinada, Andhra Pradesh and India.

Keywords: Andhra Pradesh, East Godavari, Heavy Metals, Industrial Solid waste, Relative growth rate.

I. Introduction

The Brinjal (Solanum melongena L.) is one of the most commonly grown vegetable crops of Solanaceae family and this plant is native to India [1]. Waste is a by-product of life. High standards of living and ever increasing population has resulted in an increase in the quantity of wastes generated. Improper disposal of Industrial solid wastes is a potential source of contamination and results in enrichment of various types of substances. Industrial Solid Waste (ISW) is generally a combination of industrial activities refuse which is generated from the industrial community. Among the multitude of the environmental problem existing in the urbanizing cities of developing countries, ISW management and its impact on groundwater quality have become the most prominent in the recent years.

Management of industrial solid waste is distinctly different from the approach used for municipal waste [2]. There is a lot of similarity between the characteristics of the waste from one municipality or one region and another, but for industrial waste, however, only a few industrial sectors or plants have a high degree of similarity between products and waste generated [3]. Nowadays industrial solid waste management is an important part of industry. The number of contaminated sites, which are polluted by industrial and hazardous waste, are increasing in developing countries [4]. Heavy metals can accumulate in living organisms in living organisms and cause various diseases [5]. Heavy metal toxicity is potentially dangerous because of bioaccumulation though the food chain and this can cause hazards effects on livestock and human health [6] and[7]. The contamination of Industrial solid wastes including mine wastes has become a worldwide concern. Several authors have shown a relationship between atmospheric elemental deposition and elevated elemental concentrations in plants and top soils, especially in cities and in the vicinity of emitting factories [8], [9], [10], [11] and [12].

During the last two decades groundwater quality has emerged as one of the most important environmental issues confronting much of the world’s populace. Due to lack of efficient Industrial solid waste management system and improper dumping of ISW as open landfills, the groundwater and surface water in the Kakinada city is found to be contaminated in various places.

II. Study Area

The Kakinada city is the capital of East Godavari District of Andhra Pradesh on the central east coast of India. The area under study Kakinada is located at 16°56′N 82°13′E. It has an average elevation of 2 metres (6 ft) and many areas of the city are below sea level. The present study deals with the “Effects of Industrial solid waste on Relative growth of Solanum melongena L., on different harvesting days in Kakinada, Andhra Pradesh, India.
III. Material and Methods

Industrial Sludge Waste ion Collection
The Industrial solid waste samples were collected at the outlet of release channel of the “Oil and Gas Industry” at Kakinada; air-dried and was brought to the laboratory. Site longitude, latitude and altitude values are 82°16’42.42”E; 17° 1’24.60”N and 5 m. The dried material was powdered in a mortar. ISW Disposal area longitude and latitude values are 17°01’27.52”N and 82°16’28.48”E.

Seed Material Collection
The seeds of (Brinjal) *Solanum melongena* L. variety: were procured from an Agricultural Cooperative Centre at Kakinada, East Godavari district, Andhra Pradesh.

Collection of the Soil Sampling
Soil from the conventional crop fields near the (ISW) Oil and Gas factory (East Godavari District, Andhra Pradesh, Kakinada) was selected and used in the experimental studies on *Solanum melongena* L. Soil samples were collected randomly from the field in five replicates and air dried for 72 hours, powdered, sieved through 2 mm sieve and subjected to physico- chemical analysis. The Soil from the Conventional Crop Field longitude and latitude values are 17°01’24.55”N and 82°16’29.05”E.

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Amendment Composition</th>
<th>Amendment Code</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>100% Control Soil</td>
<td>Control (C)</td>
</tr>
<tr>
<td>2</td>
<td>95% Control Soil + 5% ISW</td>
<td>Amendment 1 (A&lt;sub&gt;1&lt;/sub&gt;soil)</td>
</tr>
<tr>
<td>3</td>
<td>90% Control Soil + 10% ISW</td>
<td>Amendment 2 (A&lt;sub&gt;2&lt;/sub&gt;soil)</td>
</tr>
<tr>
<td>4</td>
<td>70% Control Soil + 30% ISW</td>
<td>Amendment 3 (A&lt;sub&gt;3&lt;/sub&gt;soil)</td>
</tr>
<tr>
<td>5</td>
<td>50% Control Soil + 50% ISW</td>
<td>Amendment 4 (A&lt;sub&gt;4&lt;/sub&gt;soil)</td>
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</tbody>
</table>

IV. POT Experiments

The POT Experiment was conducted with the Amendments like Control, A<sub>1</sub>, A<sub>2</sub>, A<sub>3</sub> and A<sub>4</sub> Soils. Although pot experiments on the growth and yield of Brinjal (*Solanum melongena* L.) were conducted with the amended soils, the germination performance of the seeds of *Solanum melongena* L. was tested following the method described by Carley and Watson (1968) [13] with the water extract of the Solid waste. This is mainly because of the fact that the germination process is relatively rapid process in Petri-dishes culture when compared to soil. The water extract of the solid waste extract was thoroughly hand shaken before experimental use. Graded concentrations of the water extract of the solid waste were prepared using the distilled water as diluent. For each experiment, 25 seeds of *Solanum* were taken in sterilized Petri-dishes (15×20 cms) at equal distance. These were treated with equal doses of different concentrations (V/V) of water extract of the solid waste (5%, 10%, 30%, 50%) as and when necessary. Seeds treated with distilled water were maintained as control. Four replicates were maintained for each treatment including the control. The petridishes were kept under diffuse light at room temperature (28 ± 1°C). Emergence of radical having atleast 5mm length was taken as indicative of germination. Percentage germination was recorded as per the method specified by Carley and Watson (1968) [13]. One-week-old seedlings in experimental pots were used for measurement of seedling growth (root and shoot). The dry mass of shoot and root was recorded from 7 day-old seedlings after keeping them in an oven at 80°C for 72 hr. Each Experiment was repeated thrice with six replicates per treatment of 20 seeds on each Occasion. The data were statistically analysed for LSD at 95% confidence limits (Pause and Sukhatma, 1967) [14].

**Figure 1: Location Map of Kakinada**
V. Growth Performance

Shoot and Root length:
These were measured in cm from the base of the plant to the tip of shoot, in the case of shoot length and from the base of the plant to the tip of the longest root for root length.

Shoot and Root biomass:
The above and belowground parts were separated and dried in hot air oven at 80° C for 24 hr. The plants from each concentration were dried “enmasse” and the average dry weights of shoot and root were calculated. These were presented in grams.

Growth Rate:
Estimation of growth rate of crop plants involves addition of positive increment in biomass during a period of time. The increment of biomass in the present investigation was divided into two categories (a) Mean increment and (b) Relative growth rate (RGR).

R.G.R. (Relative Growth Rate) (g/g·d⁻¹): Increment of biomass per unit biomass per unit time was represented as RGR.

\[
RGR = \log \frac{W_2 - W_1}{T_2 - T_1}
\]

Where \( W_1 \) = Initial dry weight
\( W_2 \) = Final dry weight
\( T_1 \) = Initial Time
\( T_2 \) = Final Time

VI. Results and Discussion

Relative growth rate (RGR):
The results relating to Relative growth rate (RGR) of both C plants and A₁, A₂, A₃ and A₄ soils are presented in Table 2 and Fig 2. The RGR values of C plants recorded on 21-51, 51-81 and 81-95 day growth periods were 0.0921, 0.0460 and 0.0095 mg/g/d respectively. Both C and A₁, A₂, A₃ and A₄ soils showed an insignificant decreasing trend in RGR over the harvesting periods. The relative growth rate in A₁, A₂, A₃ and A₄ soils did not exhibit any definite pattern of variation.

Table 2: Effects of Industrial Solid Waste on Relative Growth Rate (mg/g/d) of Solanum melongena L.

<table>
<thead>
<tr>
<th>Concentration (%)</th>
<th>Harvesting Days</th>
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<tbody>
<tr>
<td></td>
<td>21-51 days</td>
</tr>
<tr>
<td>Control</td>
<td>0.0921</td>
</tr>
<tr>
<td>A₁</td>
<td>0.0765</td>
</tr>
<tr>
<td>A₂</td>
<td>0.0293</td>
</tr>
<tr>
<td>A₃</td>
<td>0.0493</td>
</tr>
<tr>
<td>A₄</td>
<td>0.0854</td>
</tr>
</tbody>
</table>

Figure 2: Relative growth Rate of Solanum melongena L. Plants in Soils Amended with ISW
VII. Conclusion

The results of the present study urge further research on all agricultural crops grown in the surroundings of the solid waste dumpsites of all industries in different regions and soils. Proper methods of Industrial solid waste disposal have to be undertaken to ensure that it does not affect the environment ground water contamination around the area or cause health hazards to the people, Flora and Fauna living there. The study highlights the dire need to control heavy metals contamination of groundwater and if this issue is left unattended to, this will pose problems to provide safe drinking water for human beings. The results of this study stress the need for environmental awareness, adequate regulations and proper management of waste sites by the local municipal authorities. There is a need to check industrial water pollution by implementing strictly the pollution control laws and strict control on the disposing of untreated effluents around the industries needs to be enforced. High concentration of heavy metals and other hazardous substances in the groundwater quality in the Kakinada city in particular need to be evaluated.

VIII. Recommendations

- Urban local bodies may undertake collection, transportation and disposal of solid waste on cost recovery basis as per existing rules and may identify suitable sites for final treatment and disposal of industrial solid waste as per existing rules and regulations.
- Urban local bodies should identify the areas from where industrial solid waste is generated.
- Screening of all agricultural crops to understand their response to the ISW contamination and also make necessary strategies to advise the farmers.
- Pollution control boards needs to take necessary to control the Industrial solid waste on the disposal areas.

Acknowledgements

Authors are thankful to Dr. A.V. Purushotham, Principal, MSN Degree College, Kakinada and Dr. K.V.S.G. Murali Krishna, Professor, Department of Civil Engineering, JNTUK KAKINADA for encouragement of the research work.

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