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Effects of Industrial Solid Waste Toxicityon Different Harvesting Days of *Solanum melongena* L.

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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 A_1, A_2, A_3 and A_4 soils showed an insignificant decreasing trend in RGR over the harvesting periods. The relative growth rate in A_1, A_2, A_3 and A_4 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

1. Introduction

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.

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 have 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 generatedfrom the industrial community. Among the multitude of the environmental problem existing inthe urbanizing cities of developing countries, ISW management and its impact ongroundwater 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].

2. 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 toxicity on *Solanum melongena L.,* on different harvesting days in Kakinada, Andhra Pradesh, India.

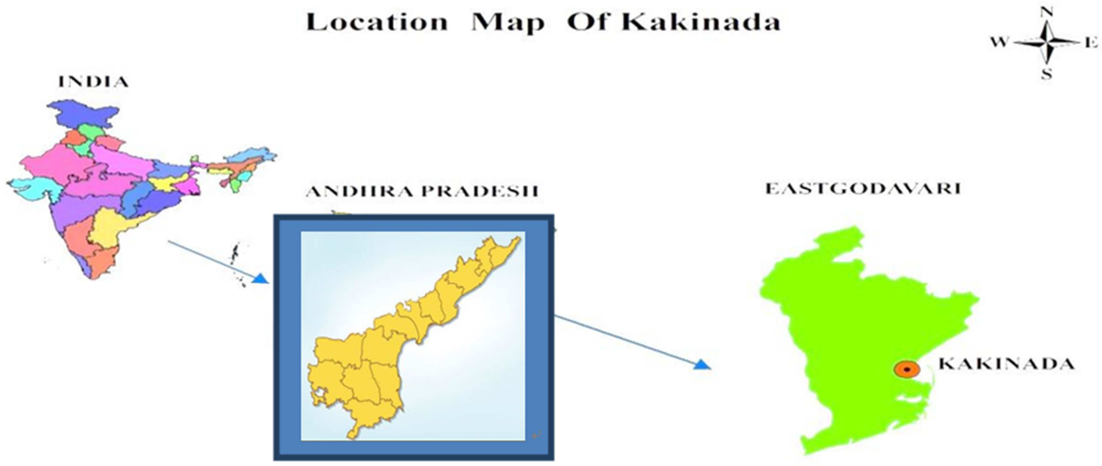

Figure 1. *Location Map of Kakinada.*

3. Material and Methods

3.1. Industrial Sludge Wasteion 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°16'24.42"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.

3.2. 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.

3.3. 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 1. *Preparation of the soil amendments.*

Sl. No	Amendement Composition	Amendment Code
1	100% Control Soil	*Control (C)*
2	95 % Control Soil + 5 % ISW	*Amendment 1 (A_1 soil)*
3	90 % Control Soil + 10 % ISW	*Amendment 2 (A_2 soil)*
4	70 % Control Soil + 30 % ISW	*Amendment 3 (A_3 soil)*
5	50 % Control Soil + 50 % ISW	*Amendment 4 (A_4 soil)*

3.4. POT Experiments

The POT Experiment was conducted with the Amendments like Control, A_1, A_2, A_3 and A_4 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 petridishes 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 petridishes (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 diffused light at room temperature (28 ± 1°C). Emergence of radical having atleast 5*mm* 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].

3.5. Growth Performance

3.5.1. 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.

3.5.2. 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*.

3.5.3. 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).

3.5.4. Growth Rate

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3.5.5. R. G. R. (Relative Growth Rate) ($G/G^{-1}/D^{-1}$)

Increment of biomass per unit biomass per unit time was represented as RGR.

$$\text{RGR} = \log \frac{W_2 - W_1}{T_2 - T_1}$$

Where W_1 = Initial dry weight
W_2 = Final dry weight
T_1 = Initial Time
T_2 = Final Time

4. Results and Discussion

4.1. Relative Growth Rate (RGR)

The results relating to Relative growth rate (RGR) of both *C* plants and A_1, A_2, A_3 and A_4 soils are presented in *Table 2* and *Figure 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 A_1, A_2, A_3 and A_4 soils showed an insignificant decreasing trend in RGR over the harvesting periods. The relative growth rate in A_1, A_2, A_3 and A_4 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..*

Concentration (%)	Harvesting Days		
	21-51 days	51-81 days	81-95 days
Control	0.0921	0.0460	0.0095
A_1	0.0765	0.0640	0.0088
A_2	0.0293	0.0636	0.0043
A_3	0.0493	0.0719	0.0046
A_4	0.0854	0.0776	0.0024

4.2. General Discussion

The results and Discussions 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.

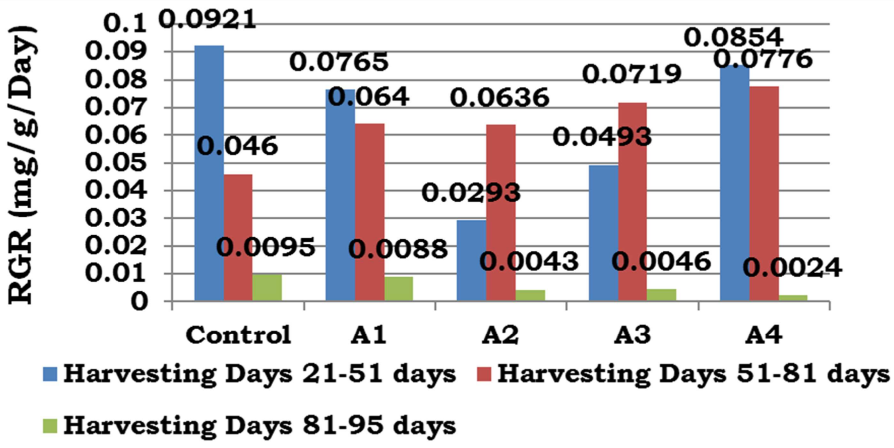

Figure 2. *Relative growth Rate of Plants in Soils Amended with ISW.*

5. Conclusion

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 disposable 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.

Recommendations

1. 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.
2. Urban local bodies should identify the areas from where industrial solid waste is generated.
3. Screening of all agricultural crops to understand their response to the ISW contamination and also make necessary strategies to advise the farmers.
4. Pollution control boards needs to take necessary to control the Industrial solid waste on the disposal areas.

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