



EFFECTS OF INDUSTRIAL SOLID WASTE ON ROOT LENGTH AND BIOMASS OF *Solanum melongena* L. (BRINJAL PLANT)

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Abstract: The present study deals with the “A Study of Effects of Industrial Solid Waste on Root of *Solanum melongena* L”. The seeds of *Solanum melongena* L. variety were procured from an Agricultural Cooperative Centre at Kakinada, East Godavari district, Andhra Pradesh. The POT experiments were conducted the different concentrations of 5%, 10%, 30% and 50% of the Industrial solid waste. In each pot seeds were dibbled in equal distance and depth. Growth parameters such as root length, dry weight of root were scored on each harvest day i.e., 21, 36, 51, 66, 81 and 95 days. Comparative between the controls to A₄ Soils Root length and Root biomass declined.

Keywords: Andhra Pradesh, East Godavari, Heavy Metals, Industrial Solid waste, Root length.

I. INTRODUCTION

Worldwide environmental pollution is continuously increasing. Industrial and agricultural activities have contributed to the increasing occurrence of heavy metals in the ecosystem (Vinit-Dunand et al., 2002). Heavy metals such as manganese (Mn), copper (Cu), iron (Fe), zinc (Zn) and nickel (Ni) are essential mineral nutrients for higher plants. Cu also induces toxicity in tissue concentrations slightly above its optimal levels (Fernandes & Henriques., 1991). Awadhesh Kumar Pathak et al., (2012) has reported the effect on root length (cm) of *Solanum melongena* L. after amendment with municipal solid waste (Viz. Kitchen waste) compost at two seasons in red soil are depicted. The exposure of plants to toxic levels of heavy metals triggers a wide range of physiological and metabolic alterations (Dubey., 2011; Villiers et al., 2011). The most widespread visual evidence of heavy metal toxicity is a reduction in plant growth (Sharma and Dubey., 2007) including leaf chlorosis, necrosis, turgor loss, a decrease in the rate of seed germination, and a crippled photosynthetic apparatus, often correlated with progressing senescence processes or with plant death (Dalcorsio et al., 2010; Carrier et al., 2003). Cu toxicity has a significant effect on the root growth and form, often before any effect on the above-ground growth (Minnich et al., 1987).

Copper and Cd in combination have affected adversely the germination, seedling length and number of lateral roots in *Solanum melongena* L. (Neelima and Reddy., 2002). Zinc is slowly oxidised in moist air. Zinc is an essential element for the plant growth. Zinc toxicity in plants limited the growth of both root and shoot (Malik et al., 2011). Zinc toxicity also causes chlorosis in the younger leaves, which can extend to older leaves after prolonged exposure to high soil Zn levels (Ebbs and Kochian., 1997). Excess Zn can also give rise to manganese (Mn) and copper (Cu) deficiencies in plant shoots. Such deficiencies have been ascribed to a hindered transfer of these micronutrients from root to shoot. Iron toxicity in tobacco, canola, soybean and *Hydrilla verticillata* are accompanied with reduction of plant photosynthesis yield and the increase in oxidative stress and ascorbate peroxidase activity (Sinha et al., 1997). Mn is readily transported from root to shoot through the transpiration stream, but not readily remobilized through phloem to other organs after reaching the leaves (Loneragan., 1988). Manganese toxicity in some species starts with chlorosis of older leaves moving toward the younger leaves with time (Bachman and Miller., 1995).

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 Root length and biomass of *Solanum melongena* L. (Brinjal Plant)” in Kakinada, Andhra Pradesh, India.

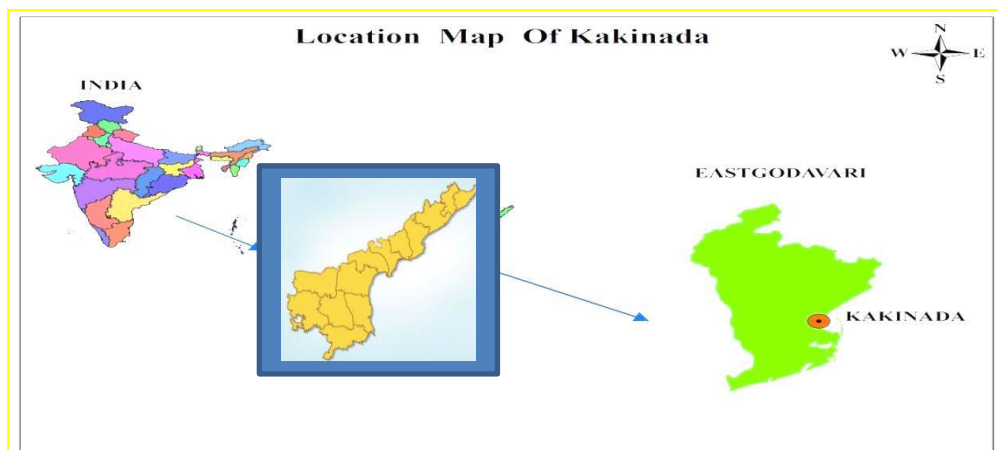


Figure 1: Location Map of Kakinada

III. Material and Methods

A. Brinjal Plant Sampling:

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

B. POT EXPERIMENT:

All the experiments pertaining to the pot culture were conducted in the experimental farm and the ground water sample was used for this experiment.

C. Preparation of the Soil Amends for Pot Experiments:

The solid waste was powdered and mixed with black soil and farm yard manure in the ratio 2:1, placed in 15kg pots in different concentrations (5%, 10%, 30% and 50%). The pots were watered with tap water at the rate of 2 l /pot/d. In each pot seeds were dibbled in equal distance and depth. A fortnight after only 3 seedlings were retained in each pot at equal distance and the rest were removed. For each concentration seven replicates were maintained making a total of 21 plants, including control. Observations were made on 20 plants for each concentration. Plants harvests were made on 21, 51 and 95 days. As three harvests were studied a total of 105 pots were maintained and for each harvest a total of 35 pots were taken at random for analysis. For each harvest and for each concentration monoliths of plants were dug out from seven pots including that of control. Care was taken to keep intact the entire root system during washing. Growth parameters such as root length, shoot length, dry weight of root and shoot were scored on each harvest day i.e., 21, 36, 51, 66, 81 and 95 days.

D. Root length:

These were measured in cm from the base of the plant to the tip of the longest root for root length.

E. Root biomass:

The above and below ground 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 root were calculated. These were presented in grams.

IV. RESULTS AND DISCUSSION

Solanum melongena L. (Brinjal) plants raised in both control and A₁, A₂, A₃ and A₄ soils were analysed on 4 occasions i.e. on 21, 51, 81 and 95-day crop growth. The growth parameters such as root lengths and root dry weight. The data relating to root length (cm), dry weights (g/plant) for root and the whole plant (root) are presented in Tables 1, 2 & Figure 2, 3.

Table 1: Effects of Industrial Solid Waste on the growth of root (cm) of *Solanum melongena* L. on different harvesting days

S. No	Concentration (%)	Harvesting Days			
		21 st day (cm)	51 st day (cm)	81 st day (cm)	95 th day (cm)
1	C R.L	4.468± 0.78	6.74± 1.41	6.057± 0.95	5.879± 1.86
2	A1 R.L	4.120± 0.74	6.612± 0.95	6.732± 1.90	5.745± 1.60
3	A2 R.L	3.986 ± 0.40	5.93± 1.50	6.71± 2.14	5.532± 1.40
4	A3 R.L	3.438 ± 0.49	4.021 ± 1.08	5.432 ± 0.96	3.099 ± 0.77
5	A4 R.L	3.053± 0.48	3.877± 0.99	3.987 ± 0.79	4.876 ± 1.40

R.L = Root Length

Table 2: Effects of Industrial Solid Waste on the biomass of root of *Solanum melongena* L. on different harvesting days

S. No	Concentration (%)	Biomass (g/plant)	Harvesting Days			
			21 day	51 day	81 day	95 day
1	Control (C)	Root	0.022	0.318	0.655	0.826
2	Amendment (A ₁)	Root	0.019	0.177	0.725	0.824
3	Amendment (A ₂)	Root	0.018	0.159	0.680	0.650
4	Amendment (A ₃)	Root	0.014	0.122	0.481	0.572
5	Amendment (A ₄)	Root	0.011	0.117	0.312	0.321

A. Root length:

The mean root lengths of control plants recorded on 21, 51, 81 and 95 days were 4.468, 6.74, 6.057 and 5.879cm respectively. The increase in root length was sharp from 21day to 51 day and there after it decreased. The root lengths of the plants raised in A₁, A₂, A₃ and A₄ soils decreased over C soils and with harvest period showed some variations (Table 4.18 & Fig. 4.24), the trend seems to be more or less agreeing with that of the C plants.

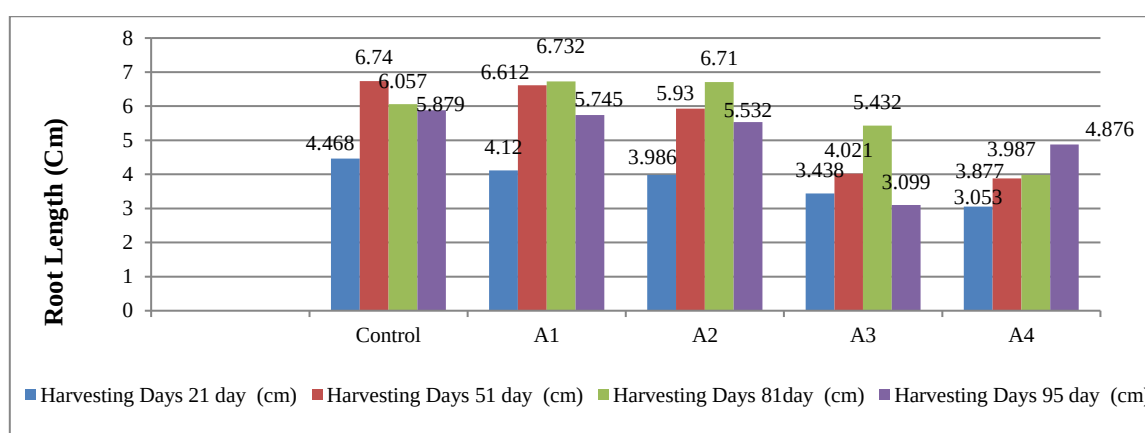


Figure 2: Root length grown in soils amended with ISW

B. Root dry weight:

The mean root dry weights of control plants recorded were 0.022, 0.318, 0.655 and 0.826 g/plant on 21, 51, 81 and 95 days respectively. 51 Days Plant grown of *Solanum melongena* L. The data shows that the root dry weight recorded an increase from 21day to 95 day. The root dry weights of the plants raised in A₁, A₂, A₃ and A₄ soils showed similar trend with time but the rate of increase has decreased in A₃ and A₄ soils especially on 81 and 95 days. The root dry weights of plants recorded in A₁ and A₂ soils decreased over C plants while that of A₃ and A₄ has increased.

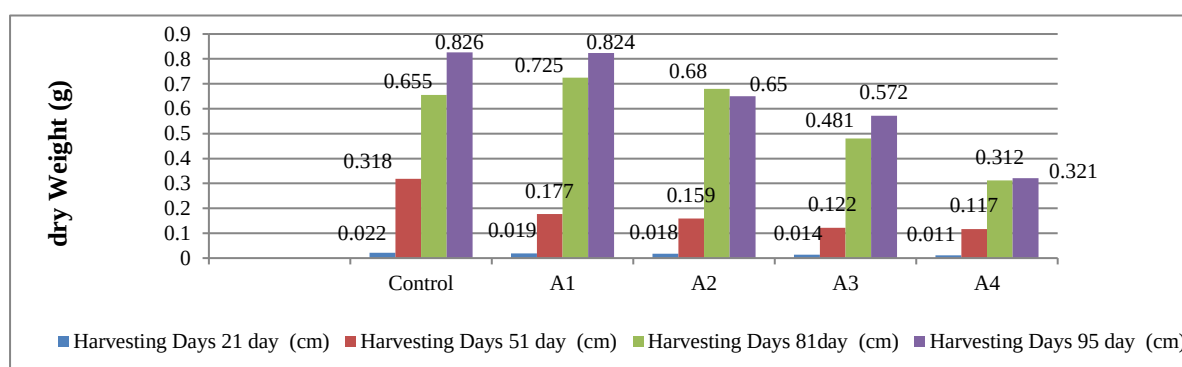


Figure 3: Root Biomass grown in soils Amended with ISW

The total dry weight of the plants raised in A₁, A₂, A₃ and A₄ soils followed similar trend with harvesting time. The total dry weights recorded in A₁, A₂, A₃ and A₄ soils showed a decrease over C plants. In the present investigation plants grown on Industrial sludge exhibited a decrease in root length and root dry weight. Further the roots of the plants grown in soils treated with Industrial sludge exhibited an increase in Cu, Zn, Fe and Mn decrease in phosphorous and potassium concentration.

C. Effects on Root length:

The maximum root length of *Solanum melongena* L. in red soil recorded as 11.20 in 2010 after 90 days of harvesting. The root length has decreased in the soil amends from 8.9% in A_1 to 31.24% in A_4 on day 21. Even within the same amendment, the rate of inhibition of root growth has increased with the age of the crop plant. The degree of the root length decline in different amends with the age of crop and a comparison with control soils is presented in below table 3. The presence of higher concentrations of Cu, Zn, Iron and Manganese in root system and significant reduction in the root lengths of plants grown A_1 , A_2 , A_3 and A_4 over C soils indicate. Inhibitory effect on the root growth has increased with harvest time and decreased from A_1 to A_4 suggesting the possible direct relation between root growth and the amount of Cu, Zn Iron and Mn in roots.

Table 3: Root length

S. No	Amendment	Mean Decline in Root length (cm)			
		C to A_x on day 21	C to A_x on day 51	C to A_x on day 81	C to A_x on day 95
1	A_1	0.348	0.128	0.675	0.134
2	A_2	0.482	0.810	0.653	0.347
3	A_3	1.030	2.719	0.625	2.780
4	A_4	1.415	2.863	2.070	1.003

D. Effects on Root biomass:

The accumulation of Copper, Zinc Iron and Manganese in the roots of Brinjal has also reduced the root biomass. The decrease in root biomass is significant and followed the trend shown by root length. The observed reduction in the root length and dry weight in plants grown in soils treated with Industrial sludge waste may be due to the prevailing low pH values and high Cu, Zn, Iron and Manganese concentrations in A_1 , A_2 , A_3 and A_4 , and also may be due to the reduction in the uptake of P, K, and Ca contents in the roots. The degree of the root biomass decline in different amends with the age of crop and a comparison with control soils is presented below:

Table 4: Root Biomass

S. No	Amendment	Decline in Root Biomass			
		C to A_x on day 21	C to A_x on day 51	C to A_x on day 81	C to A_x on day 95
1.	A_1	0.003	0.141	0.070	0.002
2.	A_2	0.004	0.159	0.025	0.176
3.	A_3	0.008	0.196	0.174	0.254
4.	A_4	0.011	0.201	0.343	0.505

V. CONCLUSION

The presence of higher concentrations of Cu, Zn, Fe and Mn in root system and significant reduction over C in root lengths of plants grown in A_1 , A_2 , A_3 and A_4 soils indicate that the crop plant seems to be Cu, Zn, Fe and Mn sensitive. The rate of decrease in root length has increased with harvest time and decreased from A_1 to A_4 suggesting possible relation between root growth and the amount of Cu, Zn, Fe and Mn in roots. The accumulation of Cu, Zn, Iron and Manganese in the roots of *Solanum melongena* L. has also reduced the root biomass and the decrease in root biomass is significant and followed root length. *Solanum melongena* L. Proper methods of Industrial solid waste disposal have to be undertaken to ensure that it does not affect the environment soil contamination around the area or cause health hazards to the people, Flora and Fauna living there.

VI. RECOMMENDATIONS

- 1) Urban local bodies should identify the areas from where industrial solid waste is generated.
- 2) 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.
- 3) Screening of all agricultural crops to understand their response to the ISW contamination and also make necessary strategies to advise the farmers.
- 4) Encourage research on remediation of Soil and Industrial solid waste contaminated sites in industrial area of Kakinada.

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