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Effects of Industrial Solid Waste on Crop and Yield of *Solanum melongena* L. (Brinjal)

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ABSTRACT

The present study deals with the 'Effects of Industrial Solid Waste on Crop and Yield Characters of Solanum melongena L. *(Brinjal)' plant Species were investigated in the pot experiment. Due to the Industrial solid waste contamination of soils 5%, 10%, 30% and 50% concentrations of all the Brinjal crop and yield characters are effected and declined. The fruit yield of Solanum melongena* L. *reduced by 3.77% over the control soils in A1 soils. Thereafter the rate of reduction steeply rose to 40.31% in A2, 49.70% in A3 and finally reached 70.54% in A4 soils. Thus, the ISW even at 10% concentration has potential to reduce the fruit yield and result in considerable economic loss to the farmers. The economic loss affected by the amendment of soils with ISW ranged in A1 soils is Rs.1, 45,600 /- per hectare per year in A4 soils. Even 10% contamination of soil with ISW, which is most likely to exist in the study area, may result in a loss of Rs.83, 200/- per hectare per year through the Brinjal production.*

Key words: Industrial solid waste, Kakinada, oil and gas industry, *Solanum melongena* L. and yield

INTRODUCTION

The contamination of Industrial solid 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 [1-5]. The Brinjal (*Solanum melongena* L.) is one of the most commonly grown vegetable crops of Solanaceae family and this plant is native to India [6]. The Brinjal is of much importance in the warm areas of Far East, being grown extensively in India, Bangladesh, Pakistan, China and the Philippines. The flowers are large, violet-coloured and either solitary or in clusters of two or more [7]. Improper disposal of Industrial solid wastes is a potential source of contamination and results in enrichment of various types of substances. Knowledge of the Physico-chemical characteristics of the wastes is a pre requisite for evaluating their impacts on plants and animals. The higher concentrations of Cu, Zn, Fe and Mn might interfere with the physiological and biochemical activities affecting the essential metabolic activities and result in low growth and yield [8]. In India, most of the vegetable crops are grown in the areas situated between the urban and rural centres [8]. Soils in most of these areas have been subjected to industrial pollution, the influence of which on different crop plants are not properly known. Rarely, the impacts of soil pollution were considered, despite the fact that in many areas, the crop yields have been affected by the soil pollution [9-10]. The phyto-remediation has also emerged as an alternative to the engineering based methods. In this approach, plants are used to absorb contaminants from the sludge and transfer them to the all parts of the plant [11]. The plant growth was better in 60 t/ha 120 t/ha 180 t/ha and 240 t/ha combinations irrespective of control, maximum being at 120 -180 t/ha level of Municipal solid waste (viz. Kitchen Waste) compost. The photosynthetic pigments (chlorophyll a chlorophyll b and total chlorophyll) were significantly increased in the treatments with 120 to 180 t/ha Municipal solid waste (viz. Kitchen Waste) compost as compared with soil [12]. The addition of sewage sludge has a positive effect on plant productivity, as no negative impact was recorded in the crop yield [8]. The contamination of heavy metals is one of the major threats to water and soil as well as human health [13]. Phyto-remediation has been used to remediate metal-contaminated sites. The effect of different degrees of zinc to Brinjal cultivars, an experiment was carried out at Horticulture Nursery [15].

STUDY AREA

The Kakinada city is the capital of East Godavari District of Andhra Pradesh on the central east coast of India. The present study deals with the 'Effects of Industrial Solid Waste on Crop and Yield Characters of *Solanum melongena* L.' Kakinada is situated between the latitude 16˚57' North and longitude 82˚15' East. The study was carried out at the *Solanum melongena* L. Seed species were taken from an Agricultural Cooperative Centre at Kakinada, Andhra Pradesh area of East Godavari District. The present study deals with the Effects of Industrial Solid Waste on Crop and Yield of *Solanum melongena* L. (Brinjal).

Fig. 1 Location Map of Kakinada

Table -1 Preparation of the Soil Amendments

Amendement Composition	Amendement Code
100% Control Soil	***Control (C)***
95 % Control Soil + 5 % ISW	***Amendment 1 (A_1 soil)***
90 % Control Soil + 10 % ISW	***Amendment 2 (A_2 soil)***
70 % Control Soil + 30 % ISW	***Amendment 3 (A_3 soil)***
50 % Control Soil + 50 % ISW	***Amendment 4 (A_4 soil)***

MATERIAL AND METHODS

Industrial Sludge Waste on 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.

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.

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) [15] 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 Petri-dishes 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) [15]. 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) [16].

Yield Characters

Fruit length, breadth, weight and number of fruits were measured and yield was calculated in terms of dry weight of fruits per plant.

RESULTS AND DISCUSSION

Solid wastes contain both organic and inorganic matter in a variety of forms and a part of this tend to spread to the neighboring systems from where they are deposited. The solid wastes are sufficiently long-lived and very often pollute soil.

Yield Characteristics

The data relating to fruit length, fruit breadth, fruit weight, number of fruits/plant and yield/plant (*g*) are presented in *Table*.

Fruit Length: The average fruit length of the ***C*** plants was 90.00*mm* and the fruit length declined from ***A1*** to ***A4*** ranging from 90% to 30%.

Fruit Breadth: ***C*** plants had recorded an average fruit breadth of 50.00*mm* while it reduced from ***A1*** to ***A4*** registering a range of 50% to 20%.

Fruit Weight: Average fruit weight of the ***C*** plants was 1.487*g*, while in the plants raised in A_1, A_2, A_3, and A_4 soils it decreased from A_1 to A_4 ranging from 1.5% - 0.8%.

Number of Fruits/Plant: The average number of fruits / plant recorded in ***C*** soil was 16 and the number of fruits/plant recorded a slight decrease in A_1, A_2, A_3, and A_4 soils from A_1 to A_4.

Yield/Plant: The data in *Table* shows that the yield/plant obtained in ***C*** soils was 23.79 *g/plant* where as in A_1, A_2, A_3, and A_4 soils it showed a slight decreasing trend from A_1 to A_4.

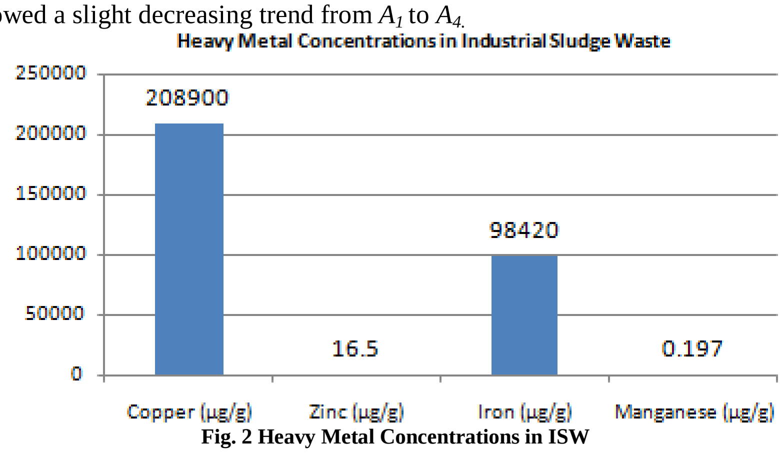

Fig. 2 Heavy Metal Concentrations in ISW

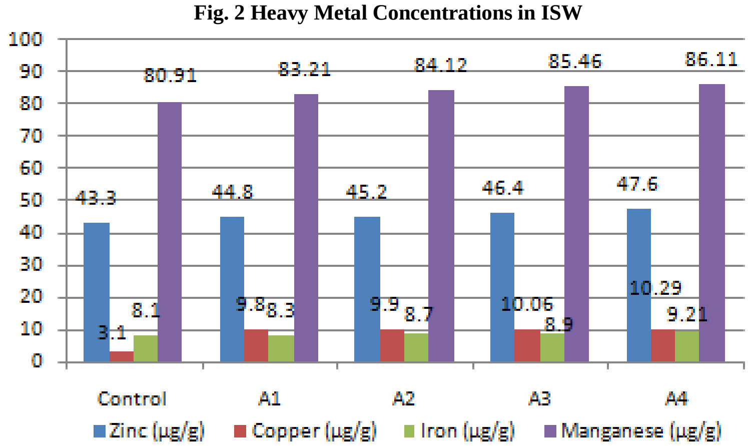

Fig. 3 Heavy Metal Concentrations in Soils Amended With ISW

Table -1 Physico- Chemical Characteristics of Control &Amended Soils

Sl. No	Parameter					
		C	A_1	A_2	A_3	A_4
1.	pH	7.32	6.82	6.76	6.11	5.57
2.	Conductivity *(millimohs)*	0.263	0.268	0.268	0.576	0.698
3.	Organic Carbon *(%)*	5.36	5.12	4.95	3.59	3.42
4.	Organic Matter *(%)*	7.89	8.60	8.36	6.04	5.88
5.	Available Nitrogen *(%)*	0.182	0.160	0.284	0.411	0.532
6.	Available Phosphorus *(%)*	2.83	2.670	2.729	2.908	3.057
7.	Available Potassium *(%)*	3.82	3.62	3.60	2.68	1.80
8.	Chlorides *(μg/g)*	240.38	252.1	276.8	291.2	316.0
9.	Aluminium, *(%)*	2.4	3.5	3.8	3.8	3.9
10.	Nickel *(μg/g)*	8.10	6.8	6.2	5.1	4.2
11.	Copper *(μg/g)*	3.1	9.8	9.9	10.6	10.29
12.	Zinc *(μg/g)*	43.3	44.8	45.2	46.4	47.6
13.	Iron *(μg/g)*	8.1	8.3	8.7	8.9	9.21
14.	Manganese *(μg/g)*	80.91	83.91	84.12	85.46	86.11

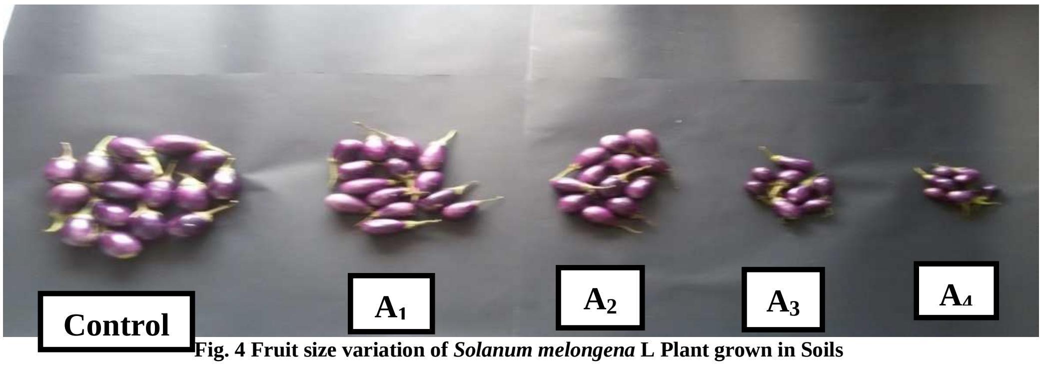

Fig. 4 Fruit size variation of *Solanum melongena* L Plant grown in Soils

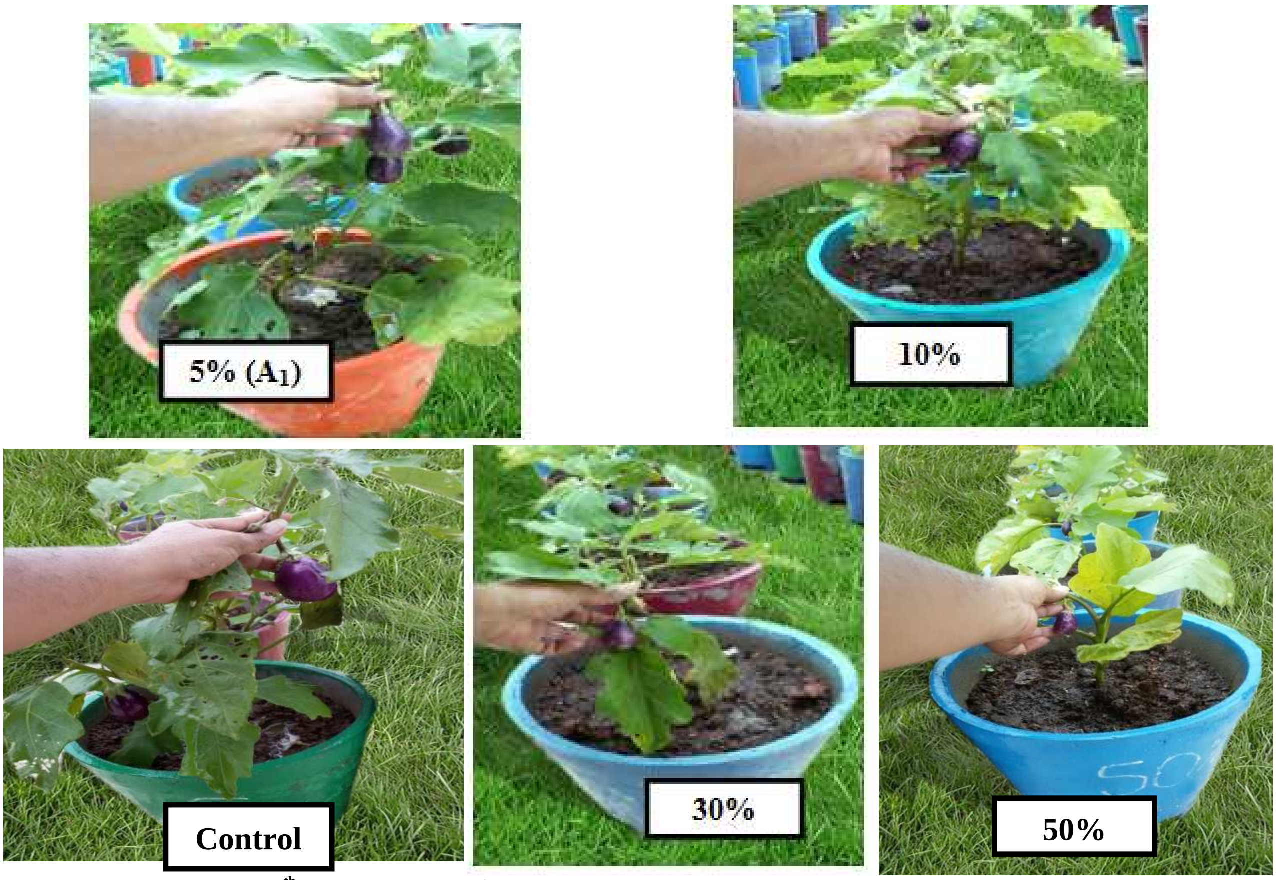

Fig. 5 90th Days – Variations of Fruit sizes in *Solanum melongena* L. C, A_1, A_2, A_3, & A_4 Soils

The fruit yield of *Solanum melongena* L. reduced by 3.77% over the control soils in A_1 soils. Thereafter the rate of reduction steeply rose to 40.31% in A_2, 49.70% in A3 and finally reached 70.54% in A_4 soils. Thus, the ISW even at 10% concentration has potential to reduce the fruit yield and result in considerable economic loss to the farmers. Since most of the farmers are having smallholdings, many of them have less than a hectare, the reduction in productivity magnifies the impact on their economics. The economic loss affected by the amendment of soils with ISW ranged in A_1 soils is *Rs.1,45,600 /-* per hectare per year in A_4 soils. Even 10% contamination of soil with ISW, which is most likely to exist in the study area, may result in a loss of *Rs.83,200/-* per hectare per year through the Brinjal production. The results of the present study unequivocally suggests that the ISW from the *Oil and Gas Industry, Kakinada, Andhra Pradesh, India* has enormous potential to change the soil characteristics and there by may seriously affect the growth and yield of Brinjal which is a widely grown commercial crop in the study area. Besides, the wide variation in the yield of Brinjal in the study area may be attributed to the possible ISW contamination of soils.

The Industrial Sludge Waste amended soils, considerable reduction in the growth and yield of Brinjal crop (*Solanum melongena* L.) is evident as shown below Tables -2 and 3.

Table -2 Nature of the Industrial solid waste contaminated Soil, Yield, Income and Reduction over Control (%)

Nature of Soils	Yield/ha (Quintals)	Income/ ha (Rs)	Reduction Over Control (%)
Control	10.32	2,06,400/-	
A1 (5%)	9.93	1,98,600/-	3.77
A2 (10%)	6.16	1,23,200/-	40.31
A3 (30%)	5.19	1,03,800/-	49.70
A4 (50%)	3.04	60,800/-	70.54

Table -3 Percentage of the Industrial Solid waste - Reduction of Income

Percentage of the ISW Contamination	Reduction of the
5%	Rs: 7800/-
10%	Rs: 83,200/-
30%	Rs: 1,02,600/-
50%	Rs: 1,45,600/-

CONCLUSION

With the increase in ISW concentration in soils amended with ISW, the yield of *Solanum melongena* L. plants declined, both in terms of average number of fruits/plant and average fruit weight. This may be attributed to the reduced uptake of some of the essential nutrients. The present study emphasizes the need for further research on different crops grown in the surroundings of the solid waste dumpsites of industries of different regions and soils. In some cases, the effects may not limit only to the growth and yield of the crop, but also may cause health problems to consumers if the crop is Cu, Zinc, Iron and Manganese tolerant and can accumulate in Cu, Zinc, Iron and Mn higher concentrations. 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 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. The results of this study stress the need for environmental awareness, adequate regulations and proper management of waste sites by the local municipal authorities.

- Urban local bodies should identify the areas from where industrial solid waste is generated.
- 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.

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