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Field Level Study on The Impact of Zinc Electroplating Industry Effluent Residue on Growth, Biochemical Characteristics and Yield of Brinjal *Solanum Melongena*

KEYWORDS: Field level study,impact,Zinc Electroplating industry effluent residue, growth, biochemical, yield, brinjal.

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ABSTRACT *The present study deals with the field level study on the impact of different quantities of electroplating industry effluent residue(250, 500, 750, 1000 and 1250mg) on growth, biochemical characteristics and yield of Brinjal Solanum melongena. The growth characteristics of Brinjal such as seed germination percentage, shoot and root length, total fresh and dry weight, leaf area index and vigour index were higher in T3 with 750 mg and lower in T5 with 1250 mg of zinc electroplating industry effluent residue on 90th day. The chlorophyll a, b, total chlorophyll, carotenoid and total soluble protein content of Brinjal was higher in T3 and lower in T5. The total sugar of Brinjal was higher in T2 and lower in T5. The anthocyanin, free amino acids, L- proline and leaf nitrate of Brinjal was higher in T5 and lower in T1. The length, weight and number of fruits of Brinjal were higher in T3 and lower in T5.*

INTRODUCTION

Environmental pollution is one of the major problems of world and increasing day by day due to urbanization and industrialization. Large amount of industrial effluents discharged due to rapid industrialization is a serious threat to India. Industrial effluents are rich in organic and inorganic matter including heavy metals (Kumawat et al., 2001). Major industries in India are electroplating, textile dye, paper mill, tannery, fertilizer industries etc. Among these industries, Zinc electroplating industry effluent plays an important role in water pollution. Zinc electroplating industry effluent is rich in total dissolved solids, total solids, hardness, BOD, COD and contains large quantities of inorganic pollutants like chloride, sulphate, nitrate and organic compounds. The large amount of electroplating industry effluents are discharged in to the river and soil (Deval et al., 2012). The Zinc electroplating industrial effluent contaminates soil and water and has deleterious effect on human health and planktons. The utilization of industrial effluent residue as fertilizer of crop plants is highly beneficial. This may prove beneficial for plant growth. Plants are capable of accumulating heavy metals and so play a significant role in cleaning up the environment. Metals such as Zinc, Sodium, Potassium and Calcium are the best candidates for removal by phytoextraction because it has been shown that it is preferred by the majority of plants that uptake and absorb unusually large amounts of metals and acts as micronutrients for the growth of plants. Zinc is one of the micronutrients essential for normal growth and development of plants as it is known to be required in several metabolic processes (Nazar Khan 2013). The work related to the field level study on the impact of Zinc electroplating industry effluent residue on growth, biochemical characteristics and yield of Brinjal (Solanum melongena) is totally wanting. Hence the present study was carried out.

MATERIALS AND METHODS

For the present study, zinc electroplating industry effluent was collected from Sundararajpuram, Madurai, Tamil Nadu, India, in plastic containers (20L),transported to the laboratory and evaporated in the plastic tray (10 L) in order to collect residue . After evaporation the residue was scratched and collected for the field studies. 1gm of residue was taken in a boiling tube and digested using 10ml triple acid solution (HNO_3,H_2SO_4 and $HClO_4$ in 9:2:1 proportion respectively) till the sample became colorless. The digested sample was filtered using Whatman No.1 filter paper two times and was made up to 50ml and it was subjected to analysis of zinc using Atomic Absorption Spectrophotometer (AAS). The residue was standardized for the present study by a pilot study with various weight ranges from 250 to 5000 mg. From the pilot study it was observed that the electroplating industry effluent residue beyond 1250mg is not suitable for germination. Hence, in the present study, the weight ranged between 250 and 1250mg of zinc electroplating industry effluent residue was chosen. Both control and experimental plants were grown for a period of 90 days for Brinjal Solanum melongena Linn. Growth, biochemical characteristics and yield were estimated finally.

The experimental field is located at KVK (Krishi Vigyan Kendra), Gandhigram, Dindigul district and is situated in the central region of Tamilnadu at 10º 3' N latitude and 77 º 15' E longitudes. The field experiment was laid out in Randomized block design. The field was ploughed three times and brought to a fine tilth at the last ploughing. The experimental plants in field trial had six treatments supplied with different quantities of zinc electroplating industry effluent residue such as 0, 250, 500, 750, 1000 and 1250mg for treatment 0 (control), 1, 2, 3, 4 and 5 respectively and had three replications in the field layout. The experimental field was irrigated by well water. Ten plants were raised in each microplot with appropriate spacing between rows and plants.

The experimental results are presented in the form of tables and graphs using Microsoft Excel (Version 2007). Mean and Standard deviation were also calculated with the help of the same tool. One-way ANOVA method was used for the analysis using MATLAB (Version R2008a). The data was input manually and computed. The output results obtained from the software indicate differences between the treatments and days. Sum of square variations (SS), Degree of freedom (df), Variability of sample means (MS), critical probability (prob) were also obtained.

RESULTS AND DISCUSSION

Impact of different quantities of zinc electroplating industry effluent residue on growth characteristics of Brinjal Solanum melongena is presented in Table 1. In the present study the

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germination percentage of Brinjal Solanum melongena was higher in T_3 (100%) followed by T_4 (88%) and lower in T_5 (76%) and these result showed that higher concentration of zinc electroplating industry effluent residue (1250mg) inhibited the seed germination. Yadav and Meenakshi (2007) reported that the percentage germination was higher in 25% surgical effluent than control in wheat but higher concentration of effluent affected germination percentage. Suresh Kumar and Mariappan (2013) reported that the seed germination was inhibited with higher concentration of sugarcane mill effluent (50%). In the present study the shoot and root length, total fresh and dry weight was higher in T_3, followed by T_2 (500mg of residue) in Brinjal. The higher concentration of effluent residue had negative effect on growth characteristics. Mariappan and Rajan (2002) reported similar results in Parkinosonia aculeate and Caesalpinia coriaria treated with 10% of tannery effluent. Sreya Basu and Prasada Rao (2013) reported that the shoot and root length decreased with increasing concentration of treated chrome plating industry effluent on Cow pea. Azra et al., (2011) reported that textile mill effluent enhanced both total fresh and dry weight in higher concentration (80%). Rajan et al., (2013) also reported that the both weight parameters increased in zinc electroplating industry effluent residue (500 and 750mg) on Brinjal. In the present study the leaf area index and vigour index increases with increase in concentration. Vijayaragavan et al., (2011) showed that the leaf area index gradually decreased with higher concentration of sugar mill effluent. Sandeep et al., (2009) reported that the leaf area index and vigour index is higher in 50% treated distillery effluent but higher concentration of effluent inhibited the leaf area index and vigour index. Rani and Shrivastava (1990) reported that the lower concentration (25%) of distillery effluent showed higher vigour index in two cultivars of Oryza sativa L. Cv.Saka-4 and Pusa 44. One way ANOVA of Brinjal for growth characteristics on 90th day is presented in Table 2.

Table 1 Effect of different quantities of Electroplating industry effluent residue on growth characteristics of Bhendi Abelmoschus esculentus on 60th day.

Parameters							
Treatment	Germination(%)	Shoot Length (cm)	Root Length (cm)	Total Fresh Weight (g)	Total Dry Weight (g)	Leaf Area Index (cm^2)	Vigour index(%)
T_0	96	25.6 ± 0.56	16.3 ± 0.02	40±0.5	10±0.1	16±0.44	4031±0.07
T_1	90	29.6 ± 0.23	18 ± 0.06	38.66±0.1	9.66±0.6	20±0.43	4289±0.02
T_2	95	31 ± 1.081	20 ± 0.01	41±0.6	10±0.1	23±0.57	4845±0.06
T_3	100	36 ± 0.850	22.66 ± 0.1	56.66±0.01	13.33±0.07	29±0.88	5866±0.05
T_4	88	22.6 ± 0.31	16 ± 0.6	30±0.7	8.33±0.02	22±0.60	3866±0.80
T_5	76	18.3 ± 0.87	13.3 ± 0.1	23.33±0.7	5.33±0.5	18±0.53	2406±0.06

The Values are averages of five observations. Mean±SE

Table 2. One way ANOVA of Brinjal for growth characteristics on 90th day.

Growth characteristics	Sources of variation	SS	df	MS	F	Prob>F
Shoot length (cm)	Days	454.855	1			
	Treatments	233.584	5	454.855	10.45	0.0111
	Error	710.749	5	4.469	101.77	0.0002
	Total	22.347	11	159.068		
Root length(cm)	Days	156.068	1			
	Treatments	74.422	5	14.888	237.67	0
	Error	3.346	5	0.669	22.25	0.002
	Total	236.856	11	1021.21		
Total fresh weight (g)	Days	1021.21	1			
	Treatments	626.26	5	125.25	40.58	0.0014
	Error	125.82	5	25.16	4.98	0.0514
	Total	1773.28	11	44.4675		
Total dry weight (g)	Days	44.4675	1			
	Treatments	49.1584	5	9.8317	116.5	0.0014
	Error	1.9084	5	0.3817	25.76	0.0001
	Total	95.5343	11	75		
Leaf area index (cm^2)	Days	75	1			
	Treatments	143.667	5	28.7333	53.57	0.0007
	Error	7	5	1.4	20.52	0.0024
	Total	225.667	11			

SS-Sum of square Variation, df- Degree of Freedom
MS- Variability of Sample Mean, F- Critical Probability Value Prob- Probability

Impact of different quantities of zinc electroplating industry effluent residue on biochemical characteristics of Brinjal Solanum melongena is presented in Table 3. In the present study the effect of different quantities of zinc electroplating industry effluent on chlorophyll a, chlorophyll b, total chlorophyll, carotenoids and total protein were higher in T_3 (750mg). Shadma Naaz and Pandey (2010) reported that the value of chlorophyll a, b, total chlorophyll and carotenoids increased in 50% of industrial waste water in Lactuca sativa. Priya and Chellaram (2012) reported that the textile effluent stress reduced the protein in some vegetable crops. Kaushik et al., (2005) reported that the chlorophyll and carotenoid contents of three different cultivars of wheat did not show any inhibitory effect at low concentration (6.25%) of textile effluent. The total sugar was higher in T_2 (500mg). Baskaran et al., (2009) reported that the total sugar was higher in low concentration (10%) of sugar mill effluent and at the same time higher concentration of effluent was decreased the total sugar in Green gram. In the present study the anthocyanin, free amino acids and L- proline was higher in T_5 (1250mg). Similar study was reported in Cyamopsis tetragonoloba treated with 80% match industry effluent (Selvaraj et al., 2013). The leaf

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nitrate of Brinjal was higher in T_4 (1000mg). Dilshada tabassum et al., (2013) reported that higher concentration (100%) of industry effluent increased leaf nitrogen in Mustard. One way ANOVA of Brinjal for biochemical characteristics on 90th day is presented in Table 4.

Table 3 Impact of different quantities of Electroplating industry effluent residue on Biochemical characteristics of Brinjal Solanum melongena on 90th day.

Parameters	Treatments					
	T_0(Control)	T_1	T_2	T_3	T_4	T_5
Chlorophyll a	13.8±0.26	18.1±0.46	16.1±0.99	19±02.6	11±02.4	9±0.81
Chlorophyll b	5.9±0.04	6.2±0.26	8.9±0.64	10.9±0.4	15.2±0.64	4.3±0.42
Total Chlorophyll	18.9±0.46	24.3±0.10	25±0.12	29.9±0.21	17±0.21	13.3±0.64
Carotenoid	2.03±0.42	3.55±0.04	5.93±0.16	14.78±0.2	13.99±0.1	23.04±0.26
Anthocyanin	4.51±0.69	2.66±0.04	5.31±0.66	6.04±0.06	7.33±0.62	9.54±0.24
Total soluble Sugar	9.47±0.07	10.14±0.124	11.89±0.05	11.01±012	18.98±26.04	8.02±26.14
Total protein	0.929±0.26	0.989±0.249	1.012±0.46	1.208±0.248	0.899±0.267	0.708±0.06
Free amino acids	2.302±0.124	2.526±0.263	2.886±0.467	2.992±0.869	3.126±0.426	3.404±0.241
L-Proline	0.958±0.46	1.158±0.60	1.301±0.24	1.562±0.64	1.629±0.82	1.794±0.42
Leaf Nitrate	8.29±0.69	10.48±0.04	11.23±0.66	11.58±0.06	12.92±0.62	12.02±0.24

All the values are mg/gfw except carotenoid, anthocynin, Total soluble sugar, Total protein and L-Proline (µmole/gfw)
All the values are averages of 5 individual observations (Mean±SE)

Table 4. One way ANOVA of Brinjal for biochemical characteristics on 90th day.

Biochemical characteristics	Sources of variation	SS	df	MS	F	Prob>F
Chlorophyll a (mg/g fw)	Days	29.359	1	29.3394		
	Treatments	116.434	5	23.2869	21.05	0.0059
	Error	6.975	5	1.395	16.69	0.0039
	Total	152.769	11			
Chlorophyll b (mg/g fw)	Days	9.9008	1	9.90083		
	Treatments	37.5942	5	7.51883	15.03	0.0117
	Error	3.2942	5	0.65883	11.41	0.0092
	Total	50.7892	11			
Total chlorophyll (mg/g fw)	Days	76.255	1	76.2552		
	Treatments	265.836	5	53.1672	35.12	0.002
	Error	10.856	5	2.1712	24.49	0.0016
	Total	352.947	11			
Carotenoids (µmole/g fw)	Days	11.1169	1	11.1169		
	Treatments	14.0799	5	2.816	66.51	0.0005
	Error	0.8357	5	0.1671	16.85	0.0038
	Total	26.0325	11			
Anthocyanin (µmole/g fw)	Days	3.9331	1	3.9331		
	Treatments	51.8293	5	10.3659	18.84	0.0074
	Error	1.0437	5	0.2087	49.66	0.0003
	Total	56.8061	11			
Total sugar (µmole/g fw)	Days	10.3045	1	10.3045		
	Treatments	14.8388	5	2.9678	63.65	0.0006
	Error	0.8096	5	0.1619	18.33	0.0031
	Total	25.9528	11			
Total protein (mg/g fw)	Days	0.10342	1	0.10342		
	Treatments	0.1496	5	0.02992	21.73	0.0055
	Error	0.0238	5	0.00479	6.29	0.0325
	Total	0.2768	11			
Free amino acids (mg/g fw)	Days	5.25363	1	5.25363		
	Treatments	0.77756	5	0.15551	66.49	0.0006
	Error	0.39505	5	0.07901	1.97	0.2376
	Total	6.42624	11			
L-Proline (mg/g fw)	Days	0.10102	1	0.10102		
	Treatments	1.0678	5	0.21356	56.86	0.0006
	Error	0.00888	5	0.00178	120.21	0
	Total	1.1777	11			
Leaf nitrate (mg/g fw)	Days	3.9687	1	3.96865		
	Treatments	22.018	5	4.40359	60.53	0.0006
	Error	0.3278	5	0.06557	67.16	0.0001
	Total	26.3144	11			

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In the present study the effect of different quantities of zinc electroplating industry effluent residue on yield performance such as number of fruits, length of fruits and weight of fruits were higher in T_3 (750mg) and lower in T_5 (1250mg)(Table 5). Mahimairaja and Bolan (2004) reported that low doses of distillery spentwash remarkably improve the yield of dry land crops (ragi, ground nut, sorghum and green gram). Soundravalli (2011) reported that the medium concentration of dye industry effluent residue improved yield of Lady's finger.

Table 5 Impact of various quantities (250, 500, 700, 1000 and 1250mg) of zinc electroplating industry effluent residue on length, weight and number of Brinjal Solanum melongena on 90th day.

Treatment	Length of the fruit/plant(cm)	Wt. of the fruit/plant(g)	No. of fruit/ plant
T_0(Control)	5.5	30.48	5
T1	5.2	26.56	3
T2	5.8	29.52	4
T3	6.5	38.33	7
T4	4.2	19.05	2
T5	3.6	15.42	1

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