RESEARCH PAPER | Environment | Volume : 3 | Issue : 12 | Dec 2013 | ISSN - 2249-555X

Impact of Zinc electroplating industry effluent residue on growth, biochemical characteristics and yield of Tomato *Lycopersicom esculentum*

KEYWORDS: Impact, electroplating industry effluent residue, growth, biochemical, characteristics, yield, tomato, Lycopersicon esculentum

M.R.Rajan
Department of Biology, Gandhigram Rural Institute-Deemed University, Gandhigram -624 302, Tamilnadu, India

M.Periyasamy
Department of Botany, Vivekanandha College of Arts and Sciences for Women, Elayapalayam, Thiruchencode- 637 205,Tamil Nadu, India

ABSTRACT *The present study evaluates the impact of different quantities (500, 1000, 1500, 2000 and 2500 mg) of electroplating industry effluent residue on growth, biochemical characteristics, yield performance Tomato Lycopersicon esculentum. Growth characteristics such as shoot length, root length, total fresh weight, total dry weight, and vigour index and biochemical characteristics such as chlorophyll a, b, total chlorophyll, carotenoides, total soluble sugar and protein content were decreased with increasing quantities of electroplating industry effluent residue. However, anthocyanin, free amino acids, L-proline and leaf nitrate content were increased with increasing quantities of electroplating industry effluent residue. Yield performance such as number of fruits/plant, length of fruit and weight of fruits/plant was reduced with increasing quantities of electroplating industry effluent residue.*

INTRODUCTION

Rapid industrialization and urbanization have created enormous problems of environmental pollution by generating variable quantity and quality of effluents.Compared to the organic waste, inorganic wastes like heavy metals pose a great threat and cannot be completely removed or degraded from the ecosystem. The production and utilization of heavy metals increased rapidly since industrial revolution (Sharma and Srivastava 2006).Heavy metal pollution not only affects the production and quality of crops but also influences the quality of the atmosphere and water bodies and threatens the health and life of animals and human beings. Among the metal producing industries Electroplating industries produces liquid wastes containing metallic ions such as zinc, nickel, chromium, lead, silver, cadmium, mercury as well as salts of cyanides, hydrogen sulphide, ammonia and chloroamines. In zinc electroplating industry effluent, the zinc content is high. 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 (Cakemake and Marshner 1973). Methodology of using zinc electroplating industry effluent residue for growing vegetable crop is not yet standardized. Although a few works are available on the physico- chemical characteristics of electroplating industry effluent and its impact on drinking and irrigation water, specific studies on the impact of electroplating industry residue on growth, biochemical characteristics and yield of Tomato *Lycopersicom esculentum* is totally wanting. It is in this context that the present study has been undertaken.

MATERIALS AND METHODS

For the present study zinc electroplating industry effluent was collected from an electroplating industry located at Sundarajapuram, Tamil Nadu, India, in plastic containers (20 L). After collection, Electroplating industry effluent was evaporated in glass tray (3 litre capacity) in order to collect the residue. After evaporation the residue was scratched and collected for the pot culture studies. Red soil was collected from the nursery, Department of Biology, Gandhigram Rural Institute – Deemed University, Gandhigram. For the collection of the red soil, a trench of 25 cm depth was dug out and the red soil was taken from the trench. The red soil was dried in the shade and powdered using wooden mallet and sieved through a 2 mm sieve before being used for analysis.Vegetable crop Tomato *Lycopersicon esculentum* was selected for pot culture studies based on the relative importance in daily diet of a common man, surviving capacity, growth capabilities and economic value. Healthy, uniform, quality, dried and pre-treated seeds were used in the present study.

Pot Culture studies:

The zinc electroplating industry effluent residue was standardised for the present study by a pilot study with various weight ranges from 100 to 5000 mg. From the pilot study it was found that the zinc electroplating industry effluent residue below 500 mg did not enhance the chosen vegetable crop growth and was not suitable for germination above 2500 mg. Hence, in the present study, different quantities (weight) of electroplating industry effluent residue were kept between 500 and 2500 mg.Both control and experimental seeds were allowed to grow in plastic pots having capacity of 6 kg (12 X 20 cm). The experimental plants were supplied with various quantities (500, 1000, 1500, 2000 and 2500 mg) of electroplating industry effluent residue. In each treatment 5 replicates were maintained and regularly watered with ground water. The seedlings were allowed to grow in respective pots. The growth and biochemical characteristics of vegetable crop were analyzed on 90th day. After harvesting, the yield performance was calculated.

RESULTS AND DISCUSSION:

Effect of different quantities (500,1000,1500,2000 and 2500 mg) of electroplating industry effluent residue on growth characteristics of Tomato *Lycopersicon esculentum* on 90th day is presented in Table 1. The shoot length was higher in T_1 (113.9cm) and lower in T5(101.5cm) on 90th day. With reference to the range of suppression in shoot length, the worst affected treatment was T_5(2500 mg of electroplating industry effluent residue). It was observed that the root length was higher in T_1(29 cm) and lower in T5(26.5 cm) on 90th day. Shoot and root length decreased with increasing the quantity of the residue. This confirms the earlier results reported in *Brassica juncea* (Begonia et al 1998). Kumar et al (1990) studied the effect of chemical factory on growth of Guar and observed that the shoot and root length increased in lower concentration 5, 10 and 15% of the effluent treated plants. The total fresh weight and dry weight was higher in T1 and lower in T5.Total fresh and dry weight decreased with increasing quantities of electroplating industry effluent residue. These results coincide with the studies conducted on the impact of tannery effluent on pulses (Saxena et al 1986) and on cereals (Geetha and Vembu 1998).Mariappan and Rajan(2002)

Volume : 3 | Issue : 12 | Dec 2013 | ISSN - 2249-555X

reported that the decrease in total fresh and dry weight at higher concentration of treated tannery effluent in *Parkinsonia aculeata* and *Caesalpinia coriaria*. The vigour index was higher in T1 and lower in T5 on 90th day. Mariappan (2002) reported that the vigour index decreased with increasing concentration of treated tannery effluent in *Acacia auriculiformis, A.holosericea*, *Ailanthus excelsa* and *Dalbergia sissoo*.

Table1 Effect of various quantities (500, 1000, 1500, 2000 and 2500 mg) of electroplating industry effluent residue on growth characteristics of Tomato ***L.esculentum* on 90th day (pot culture)**

Parameters	Treatments					
	T_0(Control)	T_1	T_2	T_3	T_4	T_5
Shoot Length(cm)	113.9	113.1	112	107	104.3	101.5
Root Length(cm)	29	28	27.8	27.2	26.9	26.5
Fresh Weight(g)	59.65	58.91	57.85	56.55	54.06	53.811
Dry Weight(g)	14.95	14.87	14.83	13.15	12.63	10.83
Vigour Index (%)	14290	13980	13545	12614	11808	11520

All the values are averages of five individual observations.

Effect of various quantities (500, 1000, 1500, 2000 and 2500 mg) of electroplating industry effluent residue on biochemical characteristics of Tomato *L. esculentum* on 30th, 60th and 90th day are presented in Table 2.The chlorophyll *a*, *b* and total chlorophyll content were higher in T_1 and lower in T5 on 90th day. The total chlorophyll content was reduced with increase in the quantity of electroplating industry effluent residue. Singh et al (1996) studied the effect of fertilizer factory effluent on chlorophyll content of gram at different concentration of the effluent and time intervals and reported that the chlorophyll content showed a gradual declaim with increase in effluent concentration. The carotenoides was higher in T_1 (1.86 μmole g fw) and lower in T5 (1.55 μmole g fw) on 90th day. The carotenoides content was found to have declined with increasing quantity of the electroplating industry effluent residue. Carotenoides are known to protect the chlorophyll from photo bleaching and damage (Ramasubramanian et al 1993).The anthocyanin content was higher in T5 (5.65 μmole g fw) and lower in T_1 (3.29 μmole g fw) on 90th day. The anthocyanin content increased with increasing quantity of the electroplating industry effluent residue. At higher quantities of electroplating industry effluent residue anthocyanin accumulates as a stress response. It is also reported that, with the decreased mobilization of other nutrients into the primary root under conditions of salinity in mustard seedlings by chloramphenicol, there is an increase in the level of phenylalanine a precursor of anthocyanin (Wagner et al., 1967). Further accumulation of metal ion is found to be responsible for the accumulation of flainoids. This may be the reason behind the accumulation of anthocyanin under indirect influence of accumulated sodium salt during salt stress (Grgisebach et al 1966). The total soluble sugar content was higher in T_1 (115.23 μmole g fw) and lower in T5 (108.62 μmole g fw) on 90th day. The total soluble sugar content decreased with increasing quantities of electroplating industry effluent residue on 30th, 60th and 90th day. The total soluble protein was higher in T_1 (133.45 μmole g fw) and lower in T5 (126.56 μmole g fw) on 90th day. The total soluble protein content decreased with increasing quantities of electroplating industry effluent residue. The free amino acids content was higher in T5 (18.39 mg/g fw) and lower in T_1 (12.27 mg/g fw) on 90th day. The increased amino acids content observed in the experimental plants may be due to the destruction of protein or the increase in the biosynthesis of amino acids from the nitrate source, which were not utilized in the protein synthesis (Sharma et al., 1997). It is an adaptive mechanism employed by the plant cell to overcome post stress metabolism (Singh and Vijayakumar, 1974). A similar observation was reported in sugar cane mill effluent (Jeyarathi and Ramasubramanian, 2000).The L-proline content was higher in T5 (6.30μmole g fw) and lower in T_1 (3.37 μmole g fw) on 90th day. L-proline content was found to increase with increasing quantities of electroplating industry effluent residue. Palag and Aspinall (1983) reported that L- proline accumulated in the leaves of many plants subjected to stress. Salt stress caused plants to accumulate more proline and perhaps it played some role in their survival(Bellinger and Larher,1987). The leaf nitrate content was higher in T5 (28.48 mg/g fw) and lower in T_1 (22.44 mg/g fw) on 90th day. The leaf nitrate content showed an increase in accumulation with increased quantities of electroplating industry effluent residue. Leaf nitrate content was increased with increasing concentration of colour match industry effluents on *Phaseolus mungo*(Ahalya and Ramasubramanian, 2001) and increase in concentration of sugarcane effluent on *Abelmoschus esculentus*(Jeyarathi and Ramasubramanian,2000).Mariappan(2002) reported that the leaf nitrate content increased with increasing concentration of treated tannery effluent in *Acacia auriculiformis, A.holosericea*, *Ailanthus excelsa* and *Dalbergia sissoo.*

Table 2 Effect of **different quantities (500, 1000, 1500, 2000 and 2500 mg) of electroplating industry effluent residue on biochemical characteristics of Tomato *L.esculentum* on 30th, 60th and 90th day (pot culture)**

Parameters	Treatments					
	T_0(Control)	T_1	T_2	T_3	T_4	T_5
Chlorophyll *a*	3.06 ± 0.11	3.03 ± 0.11	2.86 ± 0.11	2.75 ± 0.10	2.65 ± 0.09	2.44 ± 0.09
Chlorophyll *b*	1.95 ± 0.09	1.76 ± 0.10	1.65 ± 0.10	1.63 ± 0.09	1.55 ± 0.12	1.35 ± 0.10
Total chlorophyll	5.01 ± 0.20	4.80 ± 0.20	4.52 ± 0.21	4.38 ± 0.19	4.19 ± 0.21	3.79 ± 0.18
Carotenoides	1.88 ± 0.10	1.86 ± 0.10	1.82 ± 0.09	1.77 ± 0.10	1.66 ± 0.11	1.55 ± 0.12
Anthocyanin	3.21 ± 1.04	3.29 ± 0.85	4.38 ± 1.08	4.85 ± 1.01	5.32 ± 1.08	5.65 ± 0.98
Total soluble sugar	116.59 ± 1.27	115.23 ± 1.04	113.44 ± 1.20	112.40 ± 1.08	110.67 ± 1.18	108.62 ± 1.29
Total soluble protein	133.61 ± 1.27	133.45 ± 1.25	132.57 ± 1.18	131.56 ± 1.05	129.62 ± 0.87	126.56 ± 1.03
Free amino acids	11.68 ± 1.02	12.27 ± 1.40	13.55 ± 0.99	15.31± 1.04	16.41 ± 1.04	18.39 ± 1.02
L- proline	2.88 ± 1.13	3.37 ± 0.84	3.79 ± 0.93	4.58 ± 0.83	5.38 ± 0.97	6.30 ± 0.95
Leaf nitrate	20.91 ± 0.60	22.44 ± 1.26	23.32 ± 1.15	24.59 ± 1.16	25.39 ± 1.17	28.48 ± 1.09

All the values are averages of five individual observations.

Volume : 3 | Issue : 12 | Dec 2013 | ISSN - 2249-555X

Effect of various quantities (500, 1000, 1500, 2000 and 2500 mg) of electroplating industry effluent residue on yield performance of Tomato *L. esculentum* is presented in Table 3. The yield performance such as number of fruits/plant, length of the fruit and weight of the fruits/plant of Tomato *L. esculentum* were higher in T_1 lower in T5. The yield performance showed a declining trend with increase in the quantities of the electroplating industry effluent residue. Rashmi Varma(2008) studied the effect of zinc stress on growth parameters of *Triticum aestivum* variety and reported that lower concentration of zinc is beneficial for the yield of wheat plant, but higher concentration has inhibitory effect. Chandra Shekar et al (2011) reported that the fruit weight decreased with increasing concentration of mercury.

Table 3 Effect of various quantities (500, 1000, 1500, 2000 **and 2500 mg) of** electroplating industry effluent residue on fruits/plant, length **of the fruit (cm) and weight of the fruits/plant (g) of Tomato *L. esculentum*** (pot culture)

Treatment	Total no. of fruits/plant	Length of the fruit	Weight of the fruits/plant
T0	13.67 ± 1.53	2.60 ± 0.10	704.55 ± 0.93
T1	12.33 ± 1.15	2.20 ± 0.17	631.78 ± 1.26
T2	11.33 ± 1.15	2.03 ± 0.15	559.13 ± 1.09
T3	9.67 ± 1.53	1.80 ± 0.10	469.86 ± 1.30
T4	8.33 ± 1.15	1.40 ± 0.10	386.51 ± 0.83
T5	7.67 ± 0.58	1.27 ± 0.15	341.23 ± 1.14

All the values are averages of five individual observations.

Acknowledgment**:** Authors are thankful to UGC, New Delhi for offering financial assistance to carry out this work.

REFERENCE

Ahalya, M and Ramasubramanian, V.2001.Analysis of colour match industrial effluent and its impact on some biochemical characteristics of Phaseolus mungo. Proc. of State Level Seminar on Biodiversity – the present and the future scenario. Ayya Nadar Janaki Ammal College, Sivakasi, Tamil Nadu,pp.82-85. | Begonia, G.B., Davis,C.D., Begonia, M.F.T. & Gary, C.N.1988. Growth responses of Indian mustard (Brassica juncea) and its phytoextraction of lead from contaminated soil. Bull. Environ. Contam. Toxicol. 61:38. | Bellinger, Y. 7 Larher, F.1987. Proline accumulation in higher plants. A redox buffer. Plant Physiol.,(Life Sci. Adv.) 6; 23-27. | Buris, J.S., Edje, T &Wahab, A.H.1969. Evaluation of various indices of seed and seedling vigour in soybeans. Proc. Ass- off seed analysis, 59: 73-81. | Cakemake, L. &Marshner, H.1973.Effect of zinc nutritional status on superoxide radical and hydrogen peroxide scavenging enzyme in bean leaves. Barrow, N.J.(Ed.) Plant nutrition. Academic Publisher, Dordrecht. pp.133-137. | Chandra Shekar, C.H., Sammaiah, D., Shasthree, T. & Jaganmohan Reddy,K. 2011. Effect of mercury on tomato growth and yield attributes. Internat. Journal of Pharma and Biosciences, 2(2): 358-364. | Geetha, S. &Vembu, B.1998. Effect of tannery effluent on the morphological and biochemical characteristics of Eleusine coracana Gaertn. J. Ecotoxicol. & Environ. Monit., 8(30: 183-186. | Grgisebach,H., Barz, W., Hahlbrock, K., Kether,S. & Patschke, L.1966. Recent investigation on the biosynthesis of flavinoides. Biosynthesis of aromatic compounds, Ed.G.Billek. J.Exp. Bio., 25-36. | Jeyarathi, K.P. & Ramasubramanian, V.2000. Analysis of sugar cane mill effluent and its impact on the growth and biochemical characteristics of Abelmoschus esculentus. Proc. of Natl. Conf. On Recent Trends in Biotechnology. Allapuzha, Kerala, pp. 97-99. | Kumar, K.T., Kumar, P., Patel, B & Pushapalatha, K.1990. Effects of chemical factory effluent on germination and growth of Gaur(Cyamopsis tetragonoloba Taub. Var. PNB). J. Adv.Plant Sci., 3: 34-42. | Mariappan, V.2002. Evaluation of treated tannery effluent and soil amendment studies for growing certain tree species. Ph.D thesis submitted to Gandhigram Rural Institute- Deemed University, Gandhigram, Tamil Nadu, India. | Mariappan, V. & Rajan, M.R.2002. Effect of tannery effluent on seed germination and seedling growth of Parkinsonia aculeate and Caesalpinia coriaria. J.Ecobiol.,14(4): 241-246. | Palag, L.G. & Aspinall, D.1983. Proline accumulation: Physiological and biochemistry of drought resistance in plants. Academic press. Sydney, Australia. | Ramasubramanian,V., Ravichandran, V. & Kannan,S.1993. Analysis of industrial effluents and their impact on the growth and metabolism of Phaseolus mungo L. Commun. Soil Sci. Plant Analysis, 24(17&18); 2241- 2249. | Rashmi Varma.2008.Studies on the effect of zinc stress on growth parameters of Triticum aestivum variety9LOK-1), Asian Jr. of Microbiol. Biotech. Env. Sci.,10(4): 811-812. | Sharma, S.K., Srivastava, A. &Singh, V.P.1997. Effect of rubber factory effluent on growth in Vigna mungo. Journal of Environ.Poll., 4(30: 175-177. | Sharma, Y.C. & Srivastava,V.2006. Adsorption of cadmium (II) from aqueous solutions by an indigenous clay mineral. Ind. J.of Chemical Toxicology, 13; 218-221. | Singh, D.S. & Vijayakumar, K.P.1974. Carryout effects of salinity on yield and quality of wheat seed. Seed Res., 21: 13-18. | Singh, R.S., Matwaha, S.S.& Khanna, P.K.1996.Characteristics of pulp and paper mill effluents. J. of Indust. Pollut. Control, 12(7): 163-172. | Wagner, E.I., Bienger, H.& Mohr, J.1967. The increase of photochrome mediated anthocyanin synthesis in the mustard seedlings by chloramphenicol. Planta, 75: 1-9.