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Impact of Zinc Electroplating Industry Effluent Residue on Growth, Biochemical Characteristics and Yield of Cow Pea Vigna Unguiculata

KEYWORDS: Impact, electroplating industry effluent residue, growth, biochemical, characteristics, yield, cow pea, vigna unguiculata

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ABSTRACT *The present study evaluates the impact of different quantities (0,250,500, 750 1000 and 1250 mg) of zinc electroplating industry effluent residue on growth, biochemical characteristics, yield of Cow pea Vigna unguiculata. 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, carotenoide content and yield were estimated after 60 days. Germination percentage of cow pea is 100 in all treatments. Growth, biochemical characteristics and yield of Cow pea Vigna unguiculata was higher in treatment 3 with 750 mg of zinc electroplating industry effluent residue*

INTRODUCTION:

Growth of population, massive urbanization, rapid rate of industrialization and introduction of modern technology in agriculture and animal husbandry lead to water pollution which subsequently results in gradual deterioration of quality of water. Water pollution due to hazardous heavy has been a major global concern for environmentalists. The problem of heavy metal pollution is increasing throughout the world, their presence in the atmosphere, soil and water can cause serious problems to all organisms . Industrial effluents have been regarded as a source of pollution because of the lack of efficient treatment and disposal(Srivastava and Pandey, 1999). Among the major industries, electroplating industry effluent contains large amount of heavy metals. Some of the heavy metals such as zinc, lead, copper and chromium acts as micronutrients for the growth of plants. Among the heavy metals zinc plays an important role in many biochemical reactions within the plants. Plants response to zinc deficiency occurs in terms of decrease in membrane integrity, decreased synthesis of carbohydrates, cytochromes and chlorophyll. The work related to the impact of Zinc electroplating industry effluent residue on growth, biochemical characteristics and yield of cow pea Vigna unguiculata is totally wanting. Hence the present study was carried out.

MATERIALS AND METHODS:

For the present study zinc electroplating industry effluent was collected from Madurai, Tamil Nadu, India, in plastic containers (20 L). After collection, the effluent was immediately transported to the laboratory for analysis. The physic- chemical characteristics such as pH,electrical conductivity, total solids, total dissolved solids, total suspended solids, hardness, sodium, potassium, calcium, sulphate, chloride, dissolved oxygen, COD and zinc were estimated (APHA 2012).Vegetable crop Cow pea Vigna unguiculata was selected for pot culture studies The electroplating industry effluent was evaporated in the glass tray(3 liter) in order to collect residue. Residue was standardized for the present study by the pilot study with various weight ranges from 100 to 5000 mg. From the pilot study, it was found that electroplating industry effluent residue beyond 2000 mg was not suitable for germination and hence weight range from 250 to 1250 mg was used in the present study. Garden soil and sand were collected from the nursery, Department of Biology, Gandhigram Rural Institute- Deemed University, Gandhigram. For the collection of red soil a trench of 25 cm depth was dug out and the red soil were taken from the trench. The seeds of cow pea were soaked in ground water and kept as control. Both control and experimental seeds were allowed to grow in plastic pots(25 cm dia and 20 cm height) containing a mixture of red soil, sand and cow dung manure in the ratio of 1:1:1. All the pots are kept in Green House.The experimental plants were supplied with different quantities of electroplating industry effluent residue such as 0, 250, 500, 750, 1000 and 1250 mg for treatment 0(Control),1, 2,3,4 and 5 respectively. For each treatmet triplicates were maintained. The groth, biochemical characteristics and yield of cow pea were analyzed on 60th day.

RESULTS AND DISCUSSION:

The physico-chemical characteristics of zinc electroplating industry effluent are presented in Table 1. The pH of zinc electroplating industry effluent was 6.55. Ugoji and Aboaba(2004) reported that the industrial effluent samples with less than 7.0 have hydrogen in exchangeable form whereas those with pH greater than 7.0 have exchange complexes that are dominated by bases. Periyasamy and Rajan(2009) studied the physic-chemical characteristics and water quality of electroplating industry effluent. The electrical conductivity was 8700 mS/cm, is well above the value recommended by BIS(400Ms/cm), indicating high concentration of ionic substances. Ugoji and Aboaba(2004) reported that the effluents from textile industries have high electrical conductivity, COD, total dissolved solids and heavy metals. The total dissolved solids of the effluent was 4940 mg/l. Rajan et al(2010) reported higher value of total dissolved solids(9700 mg/l) in electroplating industry effluent. The BIS permits 2100 mg/l of total dissolved solids for disposal into the environment. The Chemical Oxygen Demand was 408 mg/l. Mariappan and Rajan(2002) reported the COD value of 272 mg/l. The BIS permits only 100 mg/l of COD for disposal of effluent into the environment. The chloride content was56 mg/l. Khobragade et al (2001) reported higher chloride(197.38 mg/l) content in sugar industry effluent.

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Table 1. Physico- chemical characteristics of zinc electroplating industry effluent

S.No.	Parameters	Value
1.	pH	6.55
2.	Electrical Conductivity ms/cm	8700
3.	Total Solids mg/l	5640
4.	Total Dissolved Solids "	4940
5.	Total Suspended Solids "	700
6.	Chloride "	56
7.	Dissolved Oxygen "	13.72
8.	COD* "	408
9.	Calcium ppm	174.8
10.	Sodium "	123.51
11.	Potassium "	219.96
12.	Zinc "	628.83

***Chemical Oxygen Demand.**

All the values are averages of five individual observation Impact of different quantities of zinc electroplating industry effluent residue on growth characteristics of Cow pea Vigna unguiculata is presented in Table 2. In the present study germination percentage was same (100) in all the treatments. The shoot and root length of cow pea increased in treatment 3(750 mg of residue). The Impact of different quantities of zinc electroplating industry effluent residue on biochemical characteristics of Cow pea Vigna unguiculata is presented in Table 3.In the present study chlorophyll content was higher in T3(34.9) and lower in T6(14.1). The chlorophyll content reduced with increased quantity of effluent residue. Gupta and Bishwas Ray(2005) also reported that the lower chlorophyll content in Withania somnifer when the plant exposed to high concentration of metal. Impact of different quantities of zinc electroplating industry effluent residue on yield of Cow pea Vigna unguiculata is presented in Table 4.

Table 2. Impact of different quantities of zinc electroplating industry effluent residue on Growth characteristics of Cow Pea Vigna unguiculata

S.No.	Parameters	Treatment					
		T0 (Control)	T1	T2	T3	T4	T5
1.	Germination (%)	100	100	100	100	100	100
2.	Shoot Length(cm)	109 ± 1	137 ± 0.57	140 ±1	151 ± 1	120 ± 1.52	115.3±1
3.	Root Length (cm)	5.4 ±0.36	8.59±0.17	10.03±0.15	10.8±0.26	8 ± 0.1	7.9±0.1
4.	Total fresh weight(g)	32.06±0.5	46.5±0.65	51.8 ±0.13	59.5±0.46	58.76±0.5	49.7±0.31
5.	Total dry weight (g)	7.41±0.17	12.36±0.2	13.25±0.15	17.25±1.1	15 ± 3.4	13.48±0.4
6.	Leaf area index(cm^2)	27.05	34.62	29.86	76.26	47.29	59.80
7.	Vigour index (%)	396	476	499	509	487	447

T0 – Red soil+sand+cowdung manure (1:1:1)
T1 - Red soil+sand+cowdung manure (1:1:1) + 250mg zinc electroplating industry effluent residue
T2 - Red soil+sand+cowdung manure (1:1:1) + 500mg zinc electroplating industry effluent residue
T3 - Red soil+sand+cowdung manure (1:1:1) + 750mg zinc electroplating industry effluent residue
T4 - Red soil+sand+cowdung manure (1:1:1) + 1000mg zinc electroplating industry effluent residue
T5 - Red soil+sand+cowdung manure (1:1:1) + 1250mg zinc electroplating industry effluent residue

Table 3. Impact of different quantities of zinc electroplating industry effluent residue on biochemical characteristics of Cow pea Vigna unguiculata

S. No.	Parameters	Treatment					
		T0 (Control)	T1	T2	T3	T4	T5
1.	Chlorophyll a (mg/gfw)	11.2±0.8	20.8±0.8	14.8±0.8	23.3±0.24	15.2±0.31	8.5±1.2
2.	Chlorophyll b "	8.8±2.51	12.38±1.8	12.2±0.8	11.66±9.9	11.2±2.8	5.5±2.8
3.	Total Chlorophyll "	19.7±3.8	33.9±2.2	27.6±1.2	34.9±7.5	26.4±2.8	14.1±0.8
4.	Carotinoid (µmole/gfw)	5.79±1.2	1.96±0.7	17.28±0.3	15.5±2.2	5.40±1.3	8.6±0.8

All the values are averages of five individual observation

Table 4. Impact of different quantities of zinc electroplating industry effluent residue on yield of Cow pea Vigna unguiculata

S. No.	Parameters	Treatment					
		T0 (control)	T1	T2	T3	T4	T5
1.	Pod length(cm)	14 ±0.28	15.7 ±0.79	17 ±0.14	19 ±0.2	16 ±0.14	15 ±0.3
2.	Pod weight(g)	19 ± 0.17	20 ± 0.2	23 ± 0.2	27 ± 0.2	24 ± 0.3	22 ±0.2

All the values are averages of five individual observation

In the present study the seed germination percentage, shoot and root length, total fresh and dry weight and photosynthetic pigments like chlorophyll and carotenoid content was higher in treatment 3. These results coincide with the studies conducted on the influence of chromium and cadmium on germination, growth and photosynthetic pigments of soybean(Sankar Ganesh et al 2006).

Volume : 4 | Issue : 5 | May 2014 | ISSN - 2249-555X

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