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Impact of Dyeing Industry Effluent Residue on Growth, Biochemical Characterstics and Yield of Brinjal *Solanum Melogena*

KEYWORDS: Impact, electroplating, effluent, residue, brinjal

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

U. Nisath Fathima
Department of Biology, Gandhigram Rural Institute- Deemed University, Gandhigram-624 302, Tamil Nadu, India

S. David Noel
Department of Biology, Gandhigram Rural Institute- Deemed University, Gandhigram-624 302, Tamil Nadu, India

ABSTRACT *Impact of different quantities of dyeing industry effluent residue on growth, biochemical characteristics and yield of Brinjal Solanum melongena were studied for a period of 90 days.. Germination of Brinjal Solanum melongena is higher (96%) in treatment 1(T1) with 200 mg of dyeing industry effluent residue and lower (85%) in treatment 5 with 1000 mg of residue. Shoot length and root length of Brinjal is higher in treatment 1 &4 respectively..Fresh weight of Brinjal is higher in treatment 3 and Dry weight of Brinjal is higher in treatment 1. Leaf index area of Brinjal is higher in treatment 5 (T5) and lower in treatment 6 (T6)Vigor index of Brinjal is higher in treatment 1 (T1) and lower in treatment 0 (T0).Chlorophyll a,b and total chlorophyll of Brinjal is higher in treatment 3 .Carotenoids is higher in treatment 3 (T3) and Anthocyanin of Brinjal is higher in treatment 5 .Total soluble sugar and protein of Brinjal is higher in treatment 2.Free amino acids and L-Proline of Brinjal is higher in treatment 6 .Leaf nitrate of Brinjal is higher in treatment 5 (T5) and lower in treatment 6 (T6).Nitrate reductase is higher in treatment 0 (T0) and lower in treatment 6(T6)Catalase is higher in treatment 6 (T6). Yield performance of Brinjal Solanum melongena is one (1) in Treatment T0, T1, T2 and in the remaing treatments brinjal was able to produce flowers but not able to produce fruits due to toxicity of the effluent residue.*

Introduction
Environmental pollution is one of the major problems of world and increasing day by day due to urbanization and industrialization. The utilization of industrial effluents for irrigation of crop plants is one of the highly beneficial propositions. Dyeing effluents contain considerable amounts of heavy metals and act as nutrients for plant growth. These heavy metals serve as an additional potential source of fertilizer for agricultural use. The use of dyeing effluents for irrigation may be an alternate for recycling if used rationally and in appropriate concentration (Kumawat *et al.*, 2001).Heavy metals when present within the permissible limit act as micronutrients for plant growth. A novel strategy is the use of effluent residue containing heavy metals for growth of plants. Hence dyeing industry effluent residue can be utilized to cultivate certain crop plants. The work related to the impact of dyeing industry effluent residue on growth, Biochemical characteristics and Yield of Brinjal (*Solanum melongena*) in totally wanting. Hence the present study was carried out with the following objectives.

Materials and Methods
For the present study, Dyeing industry effluent was collected from Chinnalappatti, Dindigul, Tamil Nadu, India, in plastic containers (20L). After collection, the effluent was immediately transported to the laboratory for analysis. The residue was standardized for the present study by a pilot study with various weight ranges from 200 to 2000mg. From the pilot study it was found that the dyeing industry effluent residue is not suitable for germination beyond 1200mg. Hence, in the present study, the weight range of dyeing industry effluent residue was kept between 200 and 1200mg.Both control and experimental plants were grown for a period of 90 days. Growth and biochemical characteristics were estimated on every 30 days.

The seeds of Brinjal were soaked in ground water and kept as control. Both the control and experimental seeds were allowed to grow in plastic pots, (25cm diameter,20 cm on height) containing a mixture of red soil, sand and cow dung in the ratio 1:1:1. The experimental plants were supplied with different quantities of dyeing industry residue such as 0, 200, 400, 600, 800, 1000, and 1200mg for treatment 1 (control) 2, 3, 4, 5, 6 and 7 respectively.

Results and Discussion
Effect of different quantities of dyeing industry effluent residue on growth characteristics of Brinjal s*olanum melongena* on 90th day (pot culture) is presented in Table 1.In the present study the germination percentage of Brinjal *Solanum melongena* was 100% in control. The increase in germination percentage might be due to the reduction in level of toxic metabolities by dilution and better utilization of nutrients present in the effluent. In present study higher quantity of residue inhibited the seed germination (96%) in 200 mg of dyeing industry effluent. (Mariappan and Rajan 2002) reported a seed germination and seedling growth of *Parkinsonia aculeate i*n tannery effluent. Enhanced seed germination of *Vigno mungo* is also documented at 25% concentration of textile effluent.(Wins and Murugan,2010).In the present study Shoot length was higher in T_1(51cm) and lower in T_6(16.4cm) and root length was higher in T_4(18.5cm) and lower in T_6(8.3). The reduction in shoot and root length at higher concentration of effluent may be due to the fact that germinating seeds under higher concentrations would get less amount of oxygen which might have restricted the energy supply and retarded growth and development. The retardation in plant growth is due to excess quantities of micronutrients, heavy metals and other toxic chemicals. (Rani and Alikhan 2007) also reported that the shoot and root length decreased with increasing concentration of treated distillery effluent on two cultivars of *Oryza sativa* .In the present study was vigour index was higher in T1(4476.48%) and lower in To(0.3633%) The leaf area index higher in T_2(55cm^2) and lower in T_6(22cm^2). The leaf area index was reduced in higher concentration of effluent. It may be due to the reduced cell size and decreased intracellular space was largely responsible for reduction in leaf area due to effluent toxicity. (Tiwari *et al* 2009) reported that the leaf area index of Pea plant decreased with increase in Cr (VI) supply.

Table 1 Effect of different quantities of dyeing industry ef-

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fluent residue on growth characteristics of Brinjal *Solanum melongena* on 90th day (pot culture)

Treatment	Parameters						
	Germination (%)	Shoot Length (cm)	Root Length (cm)	Total Fresh Weight (g)	Total Dry Weight (g)	Leaf Area Index (cm^2)	Vigour Index (%)
T_0	100	30.2±0.81	14.1±0.91	11.7±0.52	2.51±0.82	50±0.44	0.3633
T_1	96	51±0.50	10.1±0.05	14.1±0.85	4.60±0.11	34±0.43	4476.48
T_2	95	28.1±0.11	17.5±0.13	5.12±0.49	2.13±0.85	55±0.57	1242.41
T_3	96	36.7±0.31	11.3±.14	17.0±0.43	4.09±0.45	35±0.88	4037.76
T_4	94	38.4±0.25	18.5±0.26	16.3±0.70	2.69±0.54	46±0.60	3953.64
T_5	85	42.1±0.70	10.9±0.58	11.7±0.76	3.07±0.33	42±0.53	3676.56
T_6	94	16.4±0.03	8. 3±0.63	10.4±0.24	1.83±0.99	22±0.50	2899.9

All the values are averages of five observations. Mean±SE

T0-Red soil+ Sand+ Cow dung (1:1:1)

T1- Red soil + Sand +Cow dung (1:1:1) + 200mg of dye industry effluent residue

T2- Red soil + Sand +Cow dung (1:1:1) + 400mg of dye industry effluent residue

T3- Red soil + Sand +Cow dung (1:1:1) + 600mg of dye industry effluent residue

T4- Red soil + Sand +Cow dung (1:1:1) + 800mg of dye industry effluent residue

T5- Red soil + Sand +Cow dung (1:1:1) + 1000mg of dye industry effluent residue

T6- Red soil + Sand +Cow dung (1:1:1) + 1200mg of dye industry effluent residue

Effect different quantities (200, 400, 600, 800, 1000 and 1200mg)of dyeing industry effluent residue on biochemical characteristics of Brinjal S*olanum melongena* on 90th day is presented in Table 2.In the present study the effect of different quantities of dyeing industry effluent residue on chlorophyll a ,b, and total chlorophyll was higher in T_3 and lower in T_6.Chlorophyll is one of the important biochemical parameters, which is used as the index of production capacity. The total chlorophyll content which are indicator of the photosynthetic activities of the plants. (Ramasubramaian *et al* 1993) reported that the pigment content was in declining trend with increasing concentration paper mill effluent. Among different treatment the carotenoid and anthocyanin of the Brinjal was higher in T_3 and lower in T_6(control).The carotenoid decreased gradually with increase in quantity of effluent residue. The carotenoid synthesis increased due to decrease in nitrogen and other inorganic elements. The decline of these compounds may be due to the accumulation of heavy metals in the roots, which may prevent the uptake of these nutrients by the plants. The accumulation of anthocyanin is considered to be an adaptive mechanism for stressed plants. (Mariappan 2002) reported that the Carotenoids content decreased with increasing concentration of treated tannery effluent on four tree species. Among different treatments the total soluble sugar and total protein content, was higher in T_2 and lower in T_6. The soluble sugar increase the food material has been efficiently utilized for growth and development of seedling. A similar result was reported in rice seedlings with increasing effluent concentration. (Behra and Mishra 1983) The soluble protein level eventually leads to increasing in plant growth. In the present study L-proline and free amino acids was higher in T_3 and lower in T_6 L.proline accumulates in the leaves of many plants, when they are subjected to stress. Veerayaneyalu and Kumari (1989) observed a high level of proline accumulation in response to stress treatments applied in roots of mulberry seedlings.. Free amino acid also showed an increase in response to paper mill effluent treatment. (Paleg and Aspinall,1983) reported that the Free amino acids increased with the increase in the concentrations of paper mill effluent. In the present study leaf nitrate and nitrate reductase was higher in T_2 and T_6.This can be directly correlated with the accumulation of leaf nitrate. (Ahalya and Ramasubramanian 2001) reported that the leaf nitrate content was increased with increasing concentration of colour match industrial effluent on *Phaseolus mungo*. Increase in leaf nitrate may be coorelated with observed decrease in nitrate reductase activity. Nitrate Reductase enzyme depends on the photosyentic product and this enzyme is a cytoplasmic enzyme in higher plants and algae. In water stressed plants, lowering of nitrate reductase activity reflects a decreased rate of enzyme synthesis and enzyme degradation. In the present study catalases is higher in T_2 and lower in T_6.

Table 2 Effect different quantities (200, 400, 600, 800, 1000 and 1200mg) of dyeing industry effluent residue on biochemical characteristics of Brinjal Solanum melongena on 90th day (pot culture)

PARAMETERS	Treatments						
	T_0(Control)	T_1	T_2	T_3	T_4	T_5	T_6
Chlorophyll a	1.029±0.26	1.106±0.46	1.290±0.99	1.341±02.6	1.101±02.4	0.972±0.81	0.642±0.50
Chlorophyll a	1.107±0.04	1.119±0.26	1.181±0.64	1.216±0.41	1.171±0.64	1.100±0.42	0.197±0.64
Total Chlorophyll	2.13±0.46	2.22±0.10	2.47±0.12	2.55±0.21	2.27±0.21	2.07±0.64	0.839±0.26
Carotenoide	1.109±0.42	1.216±0.04	1.294±0.16	1.315±0.21	1.264±0.12	1.512±0.62	6.17±26.04
Anthocyanin	1.340±0.69	1.356±0.04	1.399±0.66	1.414±0.06	1.134±0.26	1.614±0.24	5.42±26.14
Total soluble sugar	10.47±06.07	11.14±0.124	11.46±0.05	9.42±012.1	1.152±0.62	1.821±0.29	5.06±0.92
Total protein	1.142±0.266	1.891±0.249	1.219±0.46	0.156±0.25	0.135±0.27	0.121±0.07	0.109±0.27
Free amino acids	2.461±0.124	2.510±0.263	2.618±0.47	2.910±0.88	3.012±0.43	3.198±0.24	3.398±0.46
L-proline	0.916±0.46	1.21±0.60	1.462±0.24	1.742±0.64	1.795±0.82	1.867±0.42	1.956±0.42
Leaf nitrate	2.416±0.102	12.014±0.49	12.11±0.27	12.95±0.24	13.02±0.29	13.21±0.42	0.81±0.502
Nitrate Reductase	16.21±0.64	16.09±0.00	15.56±0.14	15.04±0.64	14.24±0.64	13.12±0.12	13.01±.214
Catalase	1.684±0.026	1.689±0.001	1.692±0.12	1.701±0.90	1.789±0.14	1.842±0.64	1.894±0.21

Effect different quantities of (0,200, 400, 600, 800, 1000 and 1200mg) of dyeing industry effluent residue on yield characteristics of Brinjal Solanum is presented in Table 3. The yield of Brinjal is one (1) and in T0,T1,T2. In the remaining treatments Brinjal was able to produce flower but not able to produce fruits due toxicity of the effluent residue. (Chandra Shekar *et al* 2011) reported that no initiation of flowering in tomato at the concentration of 20 mg/kg of mercury. The weight of the fruit is higher in T_0 (84.007g) and lower in T_1(15.665g).The fruit length of Brinjal is higher in T_0(11.5cm) and lower in T_1(7cm). The high yield of plants at lower concentrations might depend on the enhanced low biosynthesis of pigments and proteins. In the present study weight of the Brinjal was reduced with increasing quantities of effluent residue. (Mahimairaja and Bolan 2004) reported that low doses of distillery effluent remarkably improve the yield of dry land

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crops ragi, groundnut, sorghum and green gram.

Table 3 Effect different quantities of (0,200, 400, 600, 800, 1000 and 1200mg) of dyeing industry effluent residue on yield characteristics of Brinjal Solanum melongena on 90th day.

Treatment	No of fruits	Wt.of the fruit/plant(g)	Length of the fruit/plant(cm)
To(Control)	1	84.007	11
T1	1	15.665	7
T2	1	33.213	8
T3	0	-	-
T4	0	-	-
T5	0	-	-

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