RESEARCH PAPER | Environment | Volume : 5 | Issue : 12 | December 2015 | ISSN - 2249-555X

Field Level Study on the Utilization of Dyeing Industry Effluent Residue on Growth of Cluster Bean *Cyamopsis Tetragonoloba*

KEYWORDS: Field level study, dyeing industry effluent, residue, growth,cluster bean

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ABSTRACT *The present study deals with the field level study on the impact of different quantities of dyeing industry effluent residue(0,200, 400, 600, 800, 1000 and 1200 mg) on growth, biochemical characteristics and yield of Cluster bean Cyamopsis tetragonoloba . It was observed that the germination efficiency was higher in T4 (100%) and lower in T6 (60%). The growth characteristics such as shoot length, root length, total fresh weight, total dry weight, leaf area index and vigour index show a considerable reduction from 1000mg of dyeing industry effluent residue on 15th , 30th and 45th day. Biochemical characteristics such as chlorophyll a, chlorophyll b, total chlorophyll, carotenoids, total soluble sugar and total soluble protein increased up to 800mg of effluent residue whereas anthocyanin, free amino acids, L- proline, and nitrate levels are highest in 1200mg of dyeing industry effluent residue treated plants. Yield performance was highest in 800mg of dyeing industry effluent residue treated plants.*

INTRODUCTION

Textile dyeing industry is one of the oldest and largest industries in India. Majority are located in the states of Tamil Nadu, Punjab and Gujarat. In Tamil Nadu, Coimbatore, Tiruppur, Karur and Chinnalapatti are the major centers for textile dyeing industries. Many Textile processing units in Tamil Nadu use a number of unclassified chemicals that are likely to be from the Red List Group which is said to be harmful and unhealthy (Ravikumar and Dutta, 1996). In Chinnalapatti, Tamilnadu alone 48 dyeing industries are running. Dyeing industry uses more than 8000 chemicals in various processes of textile manufacture including dyeing and printing. Many of these chemicals are poisonous and damaging human health directly or indirectly. Large quantities of water are required for textile processing, dyeing and printing. The daily water consumption for dyeing varies from 30-50 liters per Kg of cloth depending upon the type of dye used. Dyeing section contributes to 15-20% of the total waste water flow. The use of industrial effluents for irrigation has emerged in the recent past as an important way of utilizing waste water, taking the advantage of the presence of considerable quantities of N, P, K and Ca along with other essential nutrients. Due to high cost and scarcity of chemical fertilizers, the land disposal of agricultural, municipal and industrial waste is widely practiced as a major and economic source of nutrients and organic matter for growing cereal crops by poor farmers (Younas & Shahzad, 1998; Jamal et al., 2002). Nutrient supply is the major constraint in the development of Indian agriculture and the cost of organic fertilizers is also increasing due to excess mining of the nutrients as well. The methodology of using dyeing industrial effluent residue for growing vegetable crop plants is not yet standardized. Although few works are available on the physico-chemical characteristics of dyeing industrial effluent and its impact on growth, biochemical characteristics and yield parameters of agricultural crops, specific studies on the impact of dyeing industry effluent residue on growth, biochemical and yield parameters of vegetable crop Cluster bean is totally wanting. It is in this context the present study has been undertaken.

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 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 different quantities from 200 to 2000 mg. From the pilot study it was observed that the dyeing industry effluent residue beyond 1200 mg is not suitable for germination. Hence, in the present study, the quantities between 200 and 1200 mg of dyeing industry effluent residue were chosen. The experimental field is located at KVK (Krishi Vigyan Kendra), Gandhigram, Dindigul district and is situated in the central region of Tamilnadu at 10° 3'N latitude and 77 ° 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 seven treatments supplied with different quantities of zinc electroplating industry effluent residue such as 0, 200,400, 600, 800, 1000 and 1200mg for treatment 0 (control), 1, 2, 3, 4, 5 and 6 respectively and had three replications in the field layout. The experimental field was irrigated by well water. Ten plants were raised in each micro plot with appropriate spacing between rows and plants. The growth parameter such as shoot and root length, fresh and dry weight, vigour and leaf area index, biochemical parameters such as chlorophyll a, chlorophyll b, total chlorophyll, carotenoides, anthocyanin, total soluble sugar, total soluble protein, L-proline, free amino acids and leaf nitrate and yield were estimated after 45 days.

Volume : 5 | Issue : 12 | December 2015 | ISSN - 2249-555X

RESULTS AND DISCUSSION

Impact of different quantities of dyeing industry effluent residue on growth characteristics of Cluster bean Cyamopsis tetragonoloba is presented in Table 1. It was observed that the germination efficiency was higher in T_4 (100%) and lower in T_6 (60%). The germination percentage was suppressed at high dose of effluent due to high osmotic pressure because of osmotic pressure of the effluent at higher concentration of total salts make inhibition more pronounced and prominent (Dhanam 2009). The shoot and root length of cluster bean showed an increase over control up to T_4 in field trial and decreased gradually in higher concentrations. Growth performance (root and shoot length, number of secondary roots) of radish and onion were decreased by paper mill effluent (Srivastava ,1991). The fresh and dry weight was higher in T_4 (800mg of residue). Behra and Misra (1982) reported the distillery effluents on rice seedlings, showed that the fresh and dry weight of seedlings have reverse relationship with effluent concentration. The vigour and leaf area index showed an increase over control up to T_4 (800 mg) in field trial. Mishra and Gupta (2012) recorded the average concentration of the distillery effluent ranging between 25-30 % showed maximum vigour index.

Table 1 Impact of different quantities of dyeing industry effluent residue on growth characteristics of Cluster bean Cyamopsis tetragonoloba

Parameters	Treatments						
	T_0	T_1	T_2	T_3	T_4	T_5	T_6
Germination(%)	70	80	90	90	100	80	60
Shoot length (cm)	19.5 ± 0.10	14.3 ± 0.03	21.6 ± 0.01	27.4 ± 0.02	34.6 ± 0.08	26.6 ± 0.11	13.5 ± 0.03
Root length (cm)	8.5 ± 0.01	9.8 ± 0.06	9.9 ± 0.01	10.6 ± 0.08	12.3 ± 0.02	11.7 ± 0.07	8.5 ± 0.03
Total Fresh weight(g)	13.7 ± 0.02	15.4 ± 0.03	20.6 ± 0.04	24.3 ± 0.03	28.1 ± 0.05	19.6 ± 0.07	16.1 ± 0.05
Total Dry weight (g)	15.7 ± 0.02	7.4 ± 0.04	7.6 ± 0.04	8.3 ± 0.03	8.9 ± 0.05	6.6 ± 0.02	4.1 ± 0.05
Leaf area index (cm^2)	14 ± 0.04	15 ± 0.01	18 ± 0.06	21 ± 0.01	23 ± 0.01	18 ± 0.06	16 ± 0.03
Vigour index (%)	2360 ± 0.01	3064 ± 0.90	4560 ± 0.06	5120 ± 0.10	5530 ± 0.80	4233 ± 0.90	3625 ± 0.05

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

Impact of different quantities of dyeing industry effluent residue on biochemical characteristics of Cluster bean *Cyamopsis tetragonoloba* is presented in Table 2.The contents of chlorophyll a, b and total chlorophyll showed an increase over control upto 800 mg for field trial and decreased gradually in further higher quantity of dyeing industry effluent residue. This is in conformity with the findings on radish (Vijayaragavan *et al.* 2011) with sugar mill and cluster bean (Rajan *et al. 2014*) on zinc electroplating industry effluent. Increase in chlorophyll content at lower quantity of residue may be due to favorable effect of elements such as iron, magnesium, potassium, zinc and copper present in the effluent on pigment system. It may be also due to the formation of enzyme chlorophyllase which is responsible for chlorophyll degradation (Neelam and Sahai, 1998) the reduction in the chlorophyll content at higher concentrations of the effluent might be due to the high osmotic effect which might be responsible for the reduction of the uptake of magnesium, potassium and other essential elements and ultimately affects the pigment synthesis and photosynthesis (Kadioglu and Algur, 1990). The anthocyanin was high in 1200 mg. It is generally accepted that anthocyanin fulfill important physiological functions involved in adaptation to and reduction of numerous stresses (Hughes and Smith, 2007; Gould *et al*, 2008).

The total soluble sugar content increased in control and upto 800 mg field trial and decreased gradually in the higher quantity of dyeing industry effluent residue. The reduced amount of sugar in the plants treated with higher concentrations of the effluent might be due to the utilization of the sugars in metabolic activities in order to meet this conditions (Pulver and Ries, 1973). The protein content increased over control upto 800 mg and decreased gradually in the higher quantity of dyeing industry effluent residue due to stress. Dhanam (2009) reported increased level of protein in paddy seeds raised in petriplates at lower concentrations of dairy effluent. The increase in protein content of green gram at lower concentration and then the content decreased at higher concentrations with sugar mill effluent was observed. In the present study proline content was observed to decrease in 800 mg and increased gradually in further higher quantities in cluster bean. El-Sayed *et al.* (1995) observed remarkable increase in leaf proline content of all tested cultivars as irrigation water salinity increased. In the present study of free amino acids content in cluster bean decreased with the increase in effluent residue upto 800 mg l^{-1} and increased gradually in further higher concentrations. Suresh Kumar and Mariappan (2013) reported an increase of free amino acids content in *Chloroxylon Swietenia* with increasing the concentration of sugarcane mill effluent. In the present study, the nitrate content in cluster bean decreased with the increase in effluent residue upto 800 mg l^{-1} in field trial and increased gradually in further higher concentrations. Sawney and Naik (1972) reported that the nitrate reduction and photosynthetic reactions play an important role in the generation of reducing power as well as in the synthesis of enzymes. So the continuous supply of nitrate is required by the plants, in the absence of which the reduction activity of enzyme nitrate reductase will be inhibited.

Table 2 Impact of different quantities of dyeing industry effluent residue on biochemical characteristics of Cluster bean Cyamopsis tetragonoloba

Parameters	Treatments						
	T_0	T_1	T_2	T_3	T_4	T_5	T_6
Chlorophyll a (mg/gfw)	0.82±0.53	1.17±0.27	1.62±0.14	1.75±0.54	2.16±0.88	1.41±1.21	1.21±0.53
Chlorophyll b (mg/gfw)	0.7±0.05	0.91±0.20	8.8±0.89	1.25±0.73	1.33±0.31	1.12±0.08	1.01±0.42
Total Chlorophyll (mg/gfw)	1.22±0.41	2.18±0.47	2.42±0.94	2.75±0.09	3.16±0.12	2.11±0.82	1.35±0.08
Carotenoid (µmole/gfw)	0.70±0.42	1.10±0.14	1.25±0.16	1.52±0.01	1.79±0.02	1.64±0.10	1.45±0.01
Anthocyanin (µmole/gfw)	1.23±0.01	1.94±0.04	1.31±0.06	1.04±0.08	2.53±0.63	3.04±0.25	3.50±0.06
Total sugar (µmole/gfw)	1.54±0.09	2.14±0.14	3.09±0.04	3.15±0.12	3.28±0.09	2.72±0.21	2.50±0.04
Total protein (mg/gfw)	7.29±0.26	8.89±0.29	10.02±0.46	11.20±0.24	12.99±0.27	11.08±0.06	9.01±0.21
L-proline (mg/gfw)	4.63±0.46	5.10±0.60	5.15±0.24	5.801±0.84	5.52±0.72	5.75±0.42	6.20±0.63
Free amino acid (mg/gfw)	4.21±0.01	3.92±0.23	3.56±0.07	3.32±0.09	4.06±0.02	4.40±0.02	4.8±0.02
Leaf nitrate (mg/gfw)	5.20±0.10	5.05±0.09	4.93±0.66	3.58±0.03	3.42±0.02	6.12±0.01	7.81±0.02

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

Effect of various quantities (200, 400, 600, 800, 1000 and 1200 mg) of dyeing industry effluent residue on yield of Cluster bean *Cyamopsis tetragonoloba* is presented in Table 3.Yield parameters such as length, weight and number of the cluster bean showed increase over control upto 800 mg l^{-1} and decreased gradually in the further higher concentrations (Sharma and Kansal, 1984).The field experiments conducted on the use of paper and pulp mill effluent for irrigation to maize, sunflower, groundnut and soybean registered 19.3, 29.9, 5.9 and 4.8% higher grain yield, respectively over fields irrigated with ground water. The yield increase from 6.9 to 13.9% in different sugarcane varieties grown with paper and pulp mill effluent over ground water has also been recorded. (Udayasoorian *et al.* 1999). Weights, lengths & number of seeds of wheat (*Triticum aestivum* L). decreases as the concentration of textile and dairy effluent increases (LavVarma and Jyoti Sharma, 2012)

Volume : 5 | Issue : 12 | December 2015 | ISSN - 2249-555X

Table 3 Effect of various quantities (200, 400, 600, 800, 1000 and 1200 mg) of dtyeing industry effluent residue on Length (cm), Weight (g) and Number of Cluster bean Cyamopsis tetragonoloba (L.) Taub. on 45th day.

Treatment	Length Number	Weight	
T_0	10 ± 0.02	3.5 ± 0.12	12 ± 0.06
T_1	11 ± 0.04	4.8 ± 0.11	15 ± 0.01
T_2	13 ± 0.01	9.1 ± 0.02	18 ± 0.01
T_3	13 ± 0.04	11 ± 0.02	18 ± 0.03
T_4	16 ± 0.03	13 ± 0.03	20 ± 0.03
T_5	8.1 ± 0.01	8.2 ± 0.02	14 ± 0.01
T_6	6.6 ± 0.09	4.9 ± 0.05	10 ± 0.05

ACKNOWLEDGMENT: Authors are thankful to Department of Biology, Gandhigram

Rural Institute – Deemed University ,Gandhigram, India for offering facilities to carry out this research work.

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