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Effect of Textile Effluent on The Growth And Pigment Content of *Tagetes erecta* L. (Var. Pusa Basanti)"

KEYWORDS: Chlorophyll, Effluent, Growth, Plant, Textile

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ABSTRACT *The effect of different concentrations of sawdust treated and untreated textile effluent on plant growth and pigment content of Tagetes erecta (var. Pusa basanti) were evaluated in a pot level experiment. The seedlings of Tagetes were sown in soil-filled pots and irrigated with four different concentrations (25%, 50%, 75% and 100% v/v) of sawdust treated or untreated textile effluent. The data for various attributes were collected 60 days after sowing. It was observed that higher concentrations of effluent decreased the growth while the lower concentration (25%) of sawdust treated textile effluent was effective in increasing the growth of Tagetes erecta when compared with control. The increase in growth was associated with increased photosynthetic pigments, carotenoids, anthocyanins. The better growth of plants irrigated with (25%) of sawdust treated textile effluent suggested that effluent could be used for irrigation in nutrients deprived environments but only after proper dilution.*

1. INTRODUCTION

The wastewater from textile manufacturing is typically alkaline and has high BOD (700 to 2,000 mg L^{-1}) and COD (150 to 12,000 mg L^{-1}) loads [1]. Pollutants in textile effluents include suspended solids, mineral oils (e.g. anti foaming agents, grease, spinning lubricants), organic compounds, non-biodegradable or low biodegradable surfactants (alkylphenol ethoxylates) and halogenated organics from solvents used in bleaching [2]. The highly variable and complex chemical structure of the dyes and textile effluent make them difficult to remove using conventional wastewater treatment systems. In many parts of the world, wastewater is used for the irrigation of various crops including agronomic, horticultural and tree crops. There are several reports of both beneficial and damaging effects resulting from irrigation of crops with effluents from various industries. e.g. distillery [3], dyeing [4] and textile [5]. In the present study, *Tagetes erecta* var. Pusa basanti (marigold) was used as a test plant for the analysis of the growth and pigment content under different concentrations of sawdust treated and untreated textile effluent.

2. MATERIAL AND METHODS

2.1 Effluent collection and analysis

Effluent was collected from the main outlet of Chenab textile mill, Kathua, Jammu, Jammu and Kashmir in plastic containers and divided in two parts; one part of the effluent was treated by the method as recommended by Izadyar and Rahimi [6] i.e. using sawdust as adsorbent. This part of effluent was termed as treated effluent (TE) and the other part of effluent was termed as untreated effluent (UE).

2.2 Experimental design

The experimental setup was designed in the Department of Environmental Sciences, University of Jammu, Jammu, Jammu and Kashmir. Nine treatments were made; each consisted of three replicates. E_0 was taken as control in which ordinary tap water was used for the irrigation of plants. TE_{25}, TE_{50}, TE_{75} and TE_{100} were irrigated with sawdust treated effluent concentrations of 25%, 50%, 75% and 100%, respectively and for the UE_{25}, UE_{50}, UE_{75} and UE_{100}, untreated effluent concentration of 25%, 50%, 75% and 100% were used for irrigation, respectively.

2.3 Plant material, growth and treatment conditions

The seeds of *Tagetes erecta* were sown in the month of October in trays maintaining proper spacing and irrigated with respective treatment viz. tap water or different concentration of treated or untreated effluent. On 30^{th} day after sowing (DAS), the seedlings were transplanted one each in earthen pots having 220 mm diameter and 2 kg capacity maintaining three replicates for nine treatments. The pots were irrigated daily at the rate of 200 ml pot^{-1} with different effluent concentrations of treated and untreated effluent upto 60^{th} DAS.

2.4 Growth data

The plants were uprooted on 60^{th} DAS from the pots of each treatment and examined for various growth parameters viz. root length, shoot length, plant length, fresh weight, dry weight and moisture content.

1.5Pigment content

The leaf samples of the plants were analyzed for chlorophyll and carotenoid estimation according to method described by Arnon [7] and Duxbury and Yentsch [8] respectively. Anthocyanin quantification was performed using method adopted by Deikman and Hammer [9].

2.6 Statistical analysis

The data observed in the experiment were statistically analyzed using SPSS Inc (V 16.0) software for mean and standard error estimation. The quantitative changes observed for various parameters due to application of different concentration of effluent were evaluated for the level of significance at 5% using Duncan's Multiple Range Test (DMRT).

3. Results and discussion

The growth parameters showed a gradual decline from 25% to 100% (treated and untreated textile effluent) with increase in the effluent concentration (Table 1). The lower concentrations (25% treated and untreated textile effluent) favoured the better growth of seedlings due to optimum quantities of micro- and macro-nutrients available in the effluent essential for plant growth. Saxena [10] also reported

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that the low amount of oxygen in dissolved form due to the presence of higher concentration of solids in the effluent reduced the energy supply through anaerobic respiration resulting in restriction of the growth and development of the plant at higher effluent concentrations.

Table 1: Effect of different concentrations of treated and untreated textile effluent on growth parameters (root length, shoot length, root shoot ratio, plant length, biomass and moisture content)[1] of *Tagetes erecta* L. Pusa basanti

Treatments	Root length (cm)	Shoot length (cm)	Root shoot ratio	Plant length (cm)	Fresh weight (g)	Dry weight (g)	% Moisture
Control (E_0)[2]	$11.23^{ab} \pm 0.08$	$24.80^{a} \pm 0.90$	$0.45^{ab} \pm 0.014$	$36.03^{a} \pm 0.97$	$24.13^{b} \pm 1.28$	$5.05^{b} \pm 0.37$	$79.09^{ab} \pm 0.43$
Treated effluent (TE)[3]							
TE_{25}	$11.73^{a} \pm 0.33$	$25.76^{a} \pm 0.08$	$0.45^{a} \pm 0.011$	$37.50^{a} \pm 0.41$	$27.80^{a} \pm 0.51$	$5.73^{a} \pm 0.12$	$79.37^{a} \pm 0.09$
TE_{50}	$10.46^{b} \pm 0.08$	$23.26^{b} \pm 0.14$	$0.44^{ab} \pm 0.001$	$33.73^{b} \pm 0.23$	$19.56^{c} \pm 0.38$	$4.07^{c} \pm 0.07$	$79.17^{ab} \pm 0.10$
TE_{75}	$9.20^{c} \pm 0.11$	$20.53^{c} \pm 0.08$	$0.44^{ab} \pm 0.003$	$29.73^{c} \pm 0.20$	$13.56^{f} \pm 0.45$	$3.36^{de} \pm 0.04$	$75.15^{d} \pm 0.49$
TE_{100}	$8.26^{de} \pm 0.17$	$18.86^{d} \pm 0.17$	$0.43^{ab} \pm 0.005$	$27.13^{d} \pm 0.35$	$9.56^{g} \pm 0.48$	$2.41^{f} \pm 0.15$	$74.75^{d} \pm 0.40$
Untreated effluent (UE)[4]							
UE_{25}	$10.50^{b} \pm 0.15$	$22.9^{b} \pm 0.10$	$0.45^{ab} \pm 0.004$	$33.40^{b} \pm 0.25$	$17.35^{d} \pm 0.01$	$3.75^{cd} \pm 0.02$	$78.39^{ab} \pm 0.10$
UE_{50}	$9.26^{c} \pm 0.06$	$20.63^{c} \pm 0.03$	$0.44^{ab} \pm 0.002$	$29.9^{c} \pm 0.10$	$15.48^{e} \pm 0.49$	$3.48^{d} \pm 0.04$	$77.44^{bc} \pm 0.46$
UE_{75}	$8.3^{cd} \pm 0.06$	$19.70^{cd} \pm 0.10$	$0.44^{ab} \pm 0.001$	$28.53^{cd} \pm 0.16$	$12.26^{f} \pm 0.58$	$2.93^{e} \pm 0.14$	$76.07^{cd} \pm 0.27$
UE_{100}	$7.53^{e} \pm 0.63$	$17.63^{e} \pm 0.78$	$0.42^{b} \pm 0.017$	$25.16^{e} \pm 1.41$	$7.21^{h} \pm 0.51$	$2.35^{f} \pm 0.08$	$67.23^{e} \pm 1.33$

Within each column, values not followed by the same letter are significantly different at $p \leq 0.05$
[1]Mean ± SE of three replicates
[2] E_0: tap water
[3]TE_{25}, TE_{50}, TE_{75}, TE_{100}: 25, 50, 75 and 100% of sawdust treated textile effluent, respectively
[4]UE_{25}, UE_{50}, UE_{75}, UE_{100}: 25, 50, 75 and 100% of untreated textile effluent, respectively

The chlorophyll a, chlorophyll b, carotenoids, total chlorophyll and anthocyanin recorded the highest values at TE_{25} while lowest at UE_{100}. However, chlorophyll a/b ratio showed an increasing trend with increasing concentrations of effluent (Table 2). The increase in pigment content at low effluent concentration may be due to optimum levels of nitrogen and other minerals present in the effluent while as increased mineral content at the higher concentrations of effluent interact antagonistically with physiological conditions necessary for the synthesis of chlorophyll [11]. Carotenoid is also a photosynthetic pigment which functions as non-enzymatic antioxidant protecting plants from oxidative stress by changing the physical properties of photosynthetic membranes with involvement of xanthophyll cycle [12]. The anthocyanin showed a decreasing trend with corresponding increase in the effluent concentrations of the treated and untreated effluent irrigated plants as in stress conditions, plants produce reactive oxygen [13] and anthocyanin acts as scavenger of these reactive oxygen intermediate [14].

Table 2: Effect of different concentrations of treated and untreated textile effluent on pigment content[1] ($mg\ g^{-1}$ fresh weight) of *Tagetes erecta* L. var. Pusa basanti

Treatments	Chlorophyll a	Chlorophyll b	Chlorophyll a/b ratio	Carotenoid	Total chlorophyll	Anthocyanin
Control (E_0)[2]	$1.48^{b} \pm 0.04$	$0.436^{b} \pm 0.014$	$3.40^{e} \pm 0.049$	$0.72^{a} \pm 0.017$	$1.99^{ab} \pm 0.025$	$0.485^{ab} \pm 0.014$
Treated effluent (TE)[3]						
TE_{25}	$1.60^{a} \pm 0.04$	$0.473^{a} \pm 0.008$	$3.38^{e} \pm 0.087$	$0.73^{a} \pm 0.032$	$2.08^{a} \pm 0.049$	$0.507^{a} \pm 0.001$
TE_{50}	$1.43^{b} \pm 0.02$	$0.406^{b} \pm 0.008$	$3.52^{cde} \pm 0.007$	$0.70^{ab} \pm 0.026$	$1.83^{c} \pm 0.010$	$0.377^{c} \pm 0.005$
TE_{75}	$1.26^{c} \pm 0.02$	$0.346^{cd} \pm 0.003$	$3.64^{bcd} \pm 0.045$	$0.55^{c} \pm 0.023$	$1.64^{d} \pm 0.037$	$0.347^{de} \pm 0.015$
TE_{100}	$1.02^{d} \pm 0.04$	$0.27^{e} \pm 0.011$	$3.76^{ab} \pm 0.024$	$0.48^{cd} \pm 0.016$	$1.43^{e} \pm 0.103$	$0.320^{ef} \pm 0.002$
Untreated effluent (UE)[4]						
UE_{25}	$1.45^{b} \pm 0.02$	$0.413^{b} \pm 0.008$	$3.51^{de} \pm 0.069$	$0.70^{ab} \pm 0.037$	$1.86^{bc} \pm 0.032$	$0.472^{b} \pm 0.007$
UE_{50}	$1.32^{c} \pm 0.01$	$0.366^{c} \pm 0.008$	$3.60^{bcd} \pm 0.065$	$0.63^{b} \pm 0.011$	$1.73^{cd} \pm 0.02$	$0.358^{cd} \pm 0.013$
UE_{75}	$1.21^{c} \pm 0.03$	$0.33^{d} \pm 0.010$	$3.68^{abc} \pm 0.00$	$0.53^{c} \pm 0.026$	$1.58^{d} \pm 0.051$	$0.323^{ef} \pm 0.002$
UE_{100}	$1.0^{d} \pm 0.06$	$0.263^{e} \pm 0.017$	$3.82^{a} \pm 0.063$	$0.41^{d} \pm 0.027$	$1.13^{f} \pm 0.052$	$0.302^{f} \pm 0.003$

Within each column, values not followed by the same letter are significantly different at $p \leq 0.05$
[1]Mean ± SE of three replicates
[2] E_0: tap water
[3]TE_{25}, TE_{50}, TE_{75}, TE_{100}: 25, 50, 75 and 100% of sawdust treated textile effluent, respectively
[4]UE_{25}, UE_{50}, UE_{75}, UE_{100}: 25, 50, 75 and 100% of untreated textile effluent, respectively

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4. CONCLUSION

The growth parameters and pigment content of *Tagetes erecta* receiving various concentrations of treated and untreated effluent showed a declining trend with increasing effluent concentrations. The highest values were recorded at TE_{25} (25% of treated textile effluent) while lowest at UE_{100} (100% of treated textile effluent). The decrease in parameters at higher concentrations may be attributed to reduction in water absorption and other metabolic processes due to excessive quantities of nitrates, bicarbonates and chlorides in the effluent.

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