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Impact of textile wastewater on the growth parameters of *Brassica juncea* (L.)

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ABSTRACT

Disposal of industrial wastewater is a widespread dilemma that can be sorted out by using wastewater as an alternate source of irrigation after the addition of some amendment. In this way, the problem of disposal of wastewater not only will be resolved but also paucity of irrigation water can be kept off in the future. The present study was performed to evaluate the impact of different concentrations of textile wastewater along with tap water for enhancing growth of *Brassica juncea*. The irrigation of *Brassica* was done with different mixtures of tap water and wastewater (75:25, 50:50, 25:75, and 00:100) in addition to tap water as control. The results revealed that TW_{25} (75:25) wastewater concentration showed improved root length, shoot length, plant height, fresh biomass and dry biomass. The outcomes suggest that wastewater utilization along with tap water mixing might be an effective approach for enhancing growth of *Brassica*.

KEYWORDS: Biomass, Growth, Textile industry, Wastewater

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INTRODUCTION

Industrialization and overexploitation of the country's resources be it land or water has resulted in environmental pollution and degradation of resources. Increasing urban population and the consequent industrialization draws huge quantity of water and releases large quantity of wastewater. The chemical composition of industrial effluents vary starkly, depending on type of industry, nature of produce, quality of inputs and effluent treatment facilities. The problem is further aggravated by the disposal of these effluents by industries in the receiving water bodies, which is one of the major sources of water pollution[1, 2] These released pollutants find their way into aquatic ecosystem such as rivers, ponds and lakes, posing a risk to the health of human and ecosystem[3].

The reuse of wastewater for irrigation in agriculture is one of the oldest forms of water reclamation. There is evidence of the reuse of wastewater in agriculture since ancient Greek and Roman civilizations[4]. While recycled water is a relatively small component of water supply overall, in some countries it has a prominent role, especially for agriculture, as in Kuwait where reused water accounts for up to 35% of total water extraction. In agriculture, the UN has estimated that at least 20 million hectares in 50 countries are irrigated with raw or partially diluted wastewater i.e. around 10% of total irrigated land[5]. Hence, with the growing demand for water and its rising scarcity, the future demands of water for agricultural use cannot be met by freshwater resources alone[6]. The reuse of wastewater in irrigation can make a significant contribution to the integrated management of our water resources.

In recent years, much interest has been exhibited in the use of diluted effluents for irrigating crops. The effluent with fertilizer value can be recycled for use in irrigation[7]. However, irrigation of the plants with raw effluents may adversely affect the plant growth and development. The alteration in growth rate and metabolic activities due to the toxicity of the pollutants are correlated with physiological processes in plant cells, which affect the respiration, photosynthesis and mitotic activities of plant[8]. So, the present study was performed to evaluate the impact of different concentrations of textile wastewater on the growth parameters of *Brassica juncea* (L.) var. Pusa Bold.

MATERIALS AND METHODS

Collection of textile wastewater: Wastewater was collected from the main outlet of Chenab textile mill, Kathua, Jammu, Jammu and Kashmir in plastic containers and stored at low temperature.

Experimental design: The experimental setup consisted of five treatments, each represented by three replicates. W_0 was taken as control in which ordinary tap water was used for the irrigation of healthy, viable seeds of *Brassica juncea* in an incubator at 25±1°C for 7 days. The other treatments

TW_{25}, TW_{50}, TW_{75} and TW_{100} were irrigated with textile wastewater in different mixtures of tap water and wastewater i.e. 75:25, 50:50, 25:75, and 00:100, respectively.

Growth parameters

Root length: Three seedlings were taken and their root lengths were measured from the tip of primary root to base of hypocotyle and it was expressed in centimeters (cm).

Shoot length: The shoot lengths were measured from the base of primary leaf to base of hypocotyle and it was expressed in centimeters (cm).

Plant length: By adding the shoot and root lengths of already selected plants the plant lengths were calculated and expressed in centimeters.

Biomass: Dry weight of the plant samples was determined by the procedure given by APHA[9]. After harvesting the plant; root and shoot were separated and dried at 65°C until a constant weight was obtained. Fresh weight was taken as green weight.

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 textile wastewater were evaluated for the level of significance at 5% using Duncan's Multiple Range Test (DMRT). Also, correlation between various parameters was calculated at 0.05 and 0.01 level of significance.

RESULTS AND DISCUSSION

The wastewater was brownish black in colour and the physico-chemical parameters of textile wastewater revealed that the values of various parameters i.e. Cl (780.66 mg L^{-1}), Fe (5.52 mg L^{-1}), COD (1135.97 mg L^{-1}), NO_3 (318.64 mg L^{-1}) and PO_4 (95.73 mg L^{-1}) exceeded the permissible BIS limit IS 2490-2009 for disposal of effluents in the inland surface water[10]. The results of statistical investigations of different concentrations of textile wastewater as compared to control showed inhibitory effect on growth of *B. juncea* and the severity of effects increased with increasing the concentration of wastewater.

The shoot length, root length and plant length of *B. juncea* treated with various concentrations of textile wastewater showed significant differences among treatments at $p<0.05$ as shown in Table 1. Control (W_0) recorded maximum values of shoot length, root length and plant length. Among treatments with wastewater, maximum values were recorded in TW_{25} (8.27 cm, 5.27 cm and 13.53 cm) while minimum in TW_{100} (0 cm, 0.2 cm and 0.2 cm) followed by TW_{75} (1.1 cm, 0.5 cm and 1.6 cm).

Table 1. Effect of different concentrations of textile wastewater on growth parameters of *Brassica juncea*

Treatments	Growth Parameters[1]		
	Shoot length	Root length	Plant length
Control (W_0)[2]	$8.80^a \pm 0.115$	$8.20^a \pm 0.057$	$17.00^a \pm 0.173$
Textile wastewater (TW)[3]			
TW_{25}	$8.27^b \pm 0.088$	$5.27^b \pm 0.088$	$13.53^b \pm 0.176$
TW_{50}	$4.63^c \pm 0.088$	$2.73^c \pm 0.12$	$7.37^c \pm 0.202$
TW_{75}	$1.10^d \pm 0.115$	$0.50^d \pm 0.115$	$1.60^d \pm 0.23$
TW_{100}	-	$0.20^e \pm 0.057$	$0.20^e \pm 0.057$

Within each column, values not followed by the same letter are significantly different at $p \leq 0.05$

[1]Mean $\pm$ SE of three replicates

[2] W_0: tap water

[3]TW_{25}, TW_{50}, TW_{75}, TW_{100}: 25, 50, 75 and 100% of textile wastewater, respectively

Similarly, fresh weight and dry weight of both shoot and root (Fig. 1 and 2) showed a declining trend with corresponding increase in concentration of textile wastewater i.e. the highest values for fresh weight shoot, dry weight shoot, fresh weight root and dry weight root were recorded at TW_{25} (1.463 g, 0.038 g, 0.102 g and 0.016 g) while lowest at TW_{100} (0 g, 0 g, 0.005 g and 0.002 g) followed by TW_{75} (0.237 g , 0.014 g, 0.014 g, and 0.007 g).

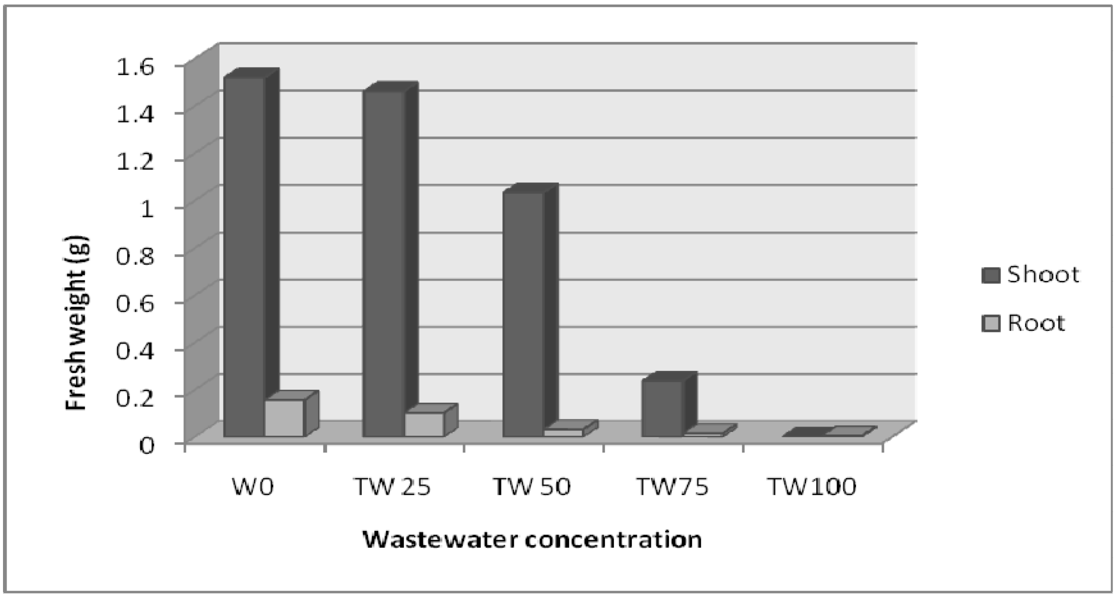

Fig 1. Effect of different concentrations of textile wastewater on fresh weight (g) of *Brassica juncea*

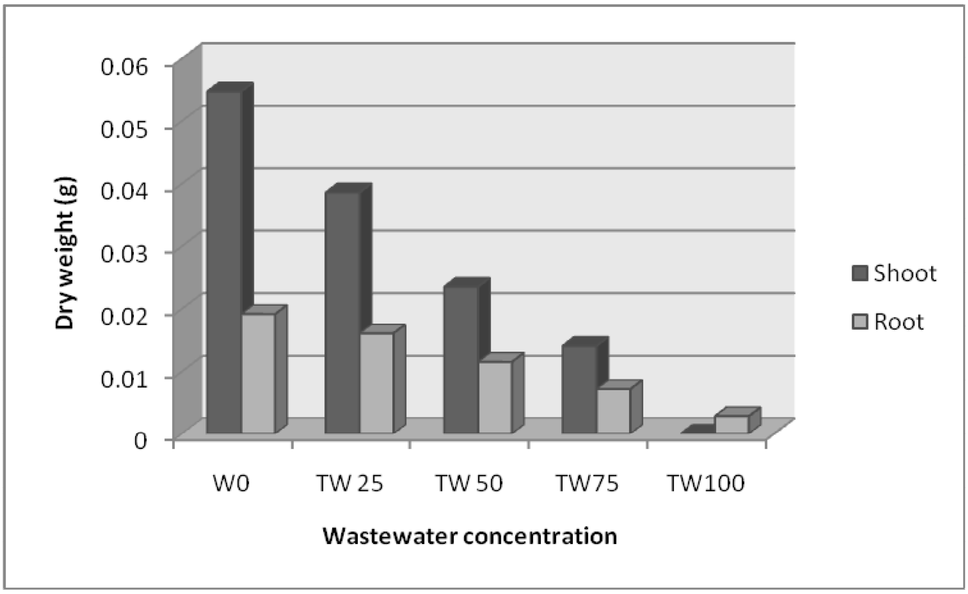

Fig 2. Effect of different concentrations of textile wastewater on dry weight (g) of *Brassica juncea*

The results of the statistical analysis of the growth parameters of *B. juncea* showed that there was significant difference among the treatments at probability level of $p<0.05$. The correlation matrix for various growth parameters of *B. juncea* treated with different concentrations of textile wastewater is given in Table 2. It is clear from table that parameters shoot length, root length, plant length, fresh weight shoot, fresh weight root, dry weight shoot and dry weight root at different treatments are highly correlated to each other at ($r>0.961$) 0.01 and ($r>0.925$) 0.05 level of significance.

Table 2. Correlation analysis of various growth parameters of *Brassica juncea* treated with different concentrations of textile wastewater

	Fresh weight shoot	Dry weight shoot	Fresh weight root	Dry weight root	Shoot length	Root length	Plant length
Fresh weight shoot	1						
Dry weight shoot	0.941*	1					
Fresh weight root	0.877	0.965**	1				
Dry weight root	0.976**	0.991**	0.936*	1			
Shoot length	0.990**	0.961**	0.928*	0.983**	1		
Root length	0.925*	0.978**	0.987**	0.962**	0.956*	1	
Plant length	0.971**	0.980**	0.965**	0.984**	0.991**	0.987**	1

*. Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

All the growth parameters decreased with increasing wastewater concentration. At higher concentration nutrients in wastewater were raised too high to become toxic resulting in retarded growth[11]. Moreover, the decrease in the root lengths at higher effluent concentrations may also be attributed to the direct contact of roots with pollutants present in effluent causing collapse and inability of roots to absorb water[12, 13]. Similar observations were also noticed by Malaviya and Sharma [14] while studying impact of dye industry effluent on growth behaviour of *Pisum sativum*.

CONCLUSION

The growth parameters showed a gradual decline with increase in the concentration of textile wastewater. In study, the results showed that textile wastewater treatment TW_{25} is less toxic and thus suitable for the growth of *Brassica juncea*. Therefore, it can be concluded that the lower concentration of textile wastewater can be beneficial for plant growth but higher concentrations could be toxic and retard the proper growth of plants.

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