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Toxic Effect of Textile Dyeing Effluents on Germination, Growth, Yield and Nutritional Quality of Okra (*Abelmoschus esculentus*)

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Abstract: An experiment was conducted to find out the toxic effect of textile dyeing effluents on germination and seedling stage for the production of okra. There were eight treatments comprising seven stages of textile dyeing effluents along with ground water as control treatment for irrigation purpose and okra (Lady's finger) was used as plant material. In most of the cases ground water irrigation (T_1 treatment) treated plant showed the best result regarding plant characteristics such as germination percentage (100 %), fresh (92.43 g) and dry (10.20 g) weight of plant, yield/plant (67.97 g) which were statistically similar to neutralization treatment (T_5). On the contrary mixed effluent from equalization tank (T_8 treatment) showed the lowest result of germination percentage (66.67 %), fresh (57.87 g) and dry (5.78 g) weight of plant and yield/plant (24.64 g). T_1 treatment showed the highest amount of ascorbic acid (1.34 mg/100 g) and β-carotene (0.08 mg/100 g) and T_8 treatment showed the lowest amount (0.65 mg/100 g and 0.02 mg/100 g respectively). The accumulation of heavy metals such as Zn, Fe, Cu, Pb accumulated in fruits at the rate of 3.95-9.73, 3.34-9.61, 4.43-11.31 and 2.79-8.72 ppm respectively. Among these T_2 (7.52 ppm), T_4 (6.57 ppm), T_7 (9.73 ppm) and T_8 (7.85 ppm) treated sample containing Zn; T_2 (10.33 ppm), T_4 (8.39 ppm), T_7 (11.31 ppm) and T_8 (8.67 ppm) treated sample containing Cu and T_2 (8.23 ppm), T_3 (8.09 ppm), T_4 (4.20 ppm), T_6 (6.30 ppm), T_7 (6.19 ppm) and T_8 (8.72 ppm) treated sample containing Pb exceed the WHO recommended permissible limit that bears the most concerning issues for human health hazards.

Keywords: Textile, Effluents, Okra, Germination, Growth, Nutritional Quality

1. Introduction

Bangladesh is an agricultural country, where industrialization is taking place in a gradually increasing phase. The important industries are textiles, lather tanning, fertilizer, sugar, chemical, pharmaceutical, oil refining etc. Among these, textile industries are rapidly expanding day by day. There are 2030 small and large knit dyeing industries in Bangladesh [1]. These industries are major source of effluents due to the nature of their operations which requires high volume of water that eventually results in high wastewater generation. The most common textile wet processing set up consists of desizing, scouring, bleaching, mercerizing, dyeing as well as finishing process. Among these dyeing is the process of adding color to the fibers, which normally requires large volume of water and reported that to dye 1 kg of cotton goods with reactive dyes requires an average of 70-150 L water, 0.6 kg NaCl and 40 g reactive dyes, alkalis and others pretreatment and dyeing auxiliaries [2]. After accomplishment of dyeing the used water is discharged as wastewater or effluents. Haque (2008) [3] stated that dyeing factory of 10 tons production capacity generates nearly 100 to 150 m^3 of waters per hour. The wastewater from textile processing contains huge residue of dyestuff, which are major source of heavy metal, salt, organic halogens (AOX), acid, alkalis, carcinogenic aromatic amines and color [4, 5]. Dyeing effluents are characterized by high bio-chemical oxygen demand (BOD), Chemical oxygen demand (COD), sodium and other dissolved solids as well as micro nutrients and heavy metals [6]. Considering these facts, textile industries are considered as harmful for our natural environment such as soil, plants, aquatic life and human being as well. As for higher establishment and operating cost of an effluent treatment plant (ETP) most of the dyeing industries of small or medium categories do not use ETP properly and sometimes they dispose of their raw effluent directly into the environment through a bypass line to save the cost.

Industrial wastes are the major source of heavy metals in the surface water, ground water and soils [7]. On the other hand, heavy metals such as Cadmium, Copper, Plumbum, Nickel and Mercury may be present in soil from the parent materials during soil formation [8]. Soil is a supporting layer for all organisms in the world. The most important thing is soil acts as a medium for plant growth which can recycle the nutrient and resources needed by plant. Soil will absorb heavy metals from the polluted wastewater as well as ground water and these will cause side effect for vegetable growth. As root grows in the soil, it will absorb water and nutrients in solution [9]. Heavy metals that are attached with soil water and soil particles will be absorbed by plant roots and accumulated in vegetables [10]. Jolly *et al.* (2009) [11] did a study to determine the heavy metals level in vegetables from selected markets in Lagos, Nigeria where they had found the presence of Cadmium and Zinc but the level complied with FAO\WHO standard. The concern of the consumers health were also given priority by the researchers where a number of studies have been conducted to access health risk of the consumers due to heavy metals contaminated vegetables consumption [12]. Higher concentrations of heavy metals in human bodies may induce tumors and mutations and are capable of causing genetic damage to germ cells [13].

It is seen that several studies were done on this above mentioned issue in different countries of the world. Regarding the issue there is only few research work has been done in Bangladesh with leafy vegetables. But there is no research work so far has been done with fruit crops namely okra. This is very popular vegetable in Bangladesh and has good nutritional value and taste. This vegetable is possible to cultivate in the effluents discharged areas. The present study was undertaken to observe the toxic effect of textile dyeing effluents on growth and yield of okra and to find out the suitable stages of textile effluents for safety reutilization as irrigation.

2. Material and Methods

2.1. Collection of Textile Effluents

Different stages of textile dying effluents were collected in pre cleaned plastic bottle from Tex Euro Bd. Ltd, a 20 tons dyeing capacity knit composite factory which is situated near Gazipur, Bangladesh. The effluents were stored at 4^0C temperature to avoid their changes of physiochemical properties. Various physio-chemical characteristics were analyzed at the laboratory of Dhaka University of Engineering Technology (DUET), Gazipur, Bangladesh.

2.2. Selection of Different Stages of Textile Dyeing Effluent

There are several steps in knit dyeing process. Scouring and bleaching, dyeing, soaping, fixing and softening are very common steps in cotton (yarn and knit) fabric dyeing process. In some processes only less harmful organic chemical are used. Therefore, it has been assumed that the wastewater coming from this processing step would have no significant harmful impact on environment. On the other hand, in soaping, fixing and softening treatment process, organic based eco-friendly chemicals are used in most of the cases. In some process, only fresh hot or cold water is used to wash the fabric for cleaning. Therefore, effluents after different processing steps were selected for irrigation, as treatment variables to cultivate okra (Table 1).

Table 1. *Identification of different stages of dyeing effluent and groundwater samples.*

Sample ID	Sample collection step
T_1	Groundwater (Control)
T_2	Second wash after scouring and bleaching
T_3	Enzyme treated water
T_4	2nd wash after bath drain
T_5	Neutralization treatment
T_6	2nd wash after Soaping
T_7	Fixing treatment water
T_8	Mixed effluent from equalization tank

2.3. Laboratory Analysis of Textile Dyeing Effluent

The physicochemical parameters such as pH, temperature, electrical conductivity, dissolved oxygen (DO), chemical oxygen demand (COD), biochemical oxygen demand (BOD), total suspended solids (TSS), total dissolved solids (TDS), and nitrate (NO_3^-), phosphate (PO_4^{-3}), sulphate (SO_4^{-2}), chloride (Cl^-) and some heavy metals were determined in the environmental laboratory at the Dhaka University of Engineering and Technology (DUET), Gazipur. The pH and temperature of wastewater was determined using portable HACH pH meter. Determination of other parameters such as nitrate (NO_3^-), sulphate (SO_4^{-2}), phosphate (PO_4^{-3}) was carried out in the laboratory using DR-2800™ portable Spectrophotometer. Electrical conductivity was determined by conductivity meter (EC150, HACH). Biochemical oxygen demand (BOD) was measured by dilution method [14]. Keeping samples 5 days in an incubator at 20°C after measuring initial DO of samples. Dissolve oxygen (DO) was measured by chemical method. Chemical oxygen demand (COD) was determined by dichromate digestion method. Chloride was determined by Mohr's silver-nitrate method. Suspended solids (SS) was measured gravimetrically while total solid was obtained by the sum of SS and TDS. Heavy metals (nickel, zinc, copper, chromium, lead, and cadmium) determination was carried out using Atomic Absorption Spectrophotometer (SPECTRA A.A-55B, VARIAN, and Australia) as per standard methods.

2.4. Polybag and Pot Experiment

Five hundred viable seeds of okra were randomly selected from the stock. 24 polybag were taken to conduct the germination test. 24 medium sizes (50 cm x 35 cm) of plastic pots were used for growing okra and filled with by as required ordinary garden soil and washed well by tap water and then pour distilled water as to flush through all the salts that was present in the soil. The pots were irrigated with underground water as control treatment and seven different stages of dying effluent. 250 ml of each stages effluent were applied. For observation of growth, seedlings were picked from each of the pot and recorded the dry and fresh weight. Then individual plant was picked up and kept at 70°C in oven for 3 days. Then their dry weights were recorded. The process was replicated for three times and the experiment was laid out following the randomized complete block design (RCBD). The values were subjected to one-way analysis of variance (ANOVA) and DMRT for comparison of means to determine statistical significance. Statistical analysis was performed using MSTAT-C program.

2.5. Nutritional Analysis

2.5.1. Estimation of Ascorbic Acid (mg/100 g)

Ten gram of sample was weighted and taken in a warring blender. The sample was homogenized with warring blender by adding 50 ml distilled water. The homogenized solution was transferred into a 100 ml volumetric flask and then centrifuged for 20 minutes at the speed of 4000 rpm. The supernatant liquid was collected in the 100 ml volumetric flask again. This was the extract solution for the determination of ascorbic acid. The ascorbic acid was determined as per the procedure described by pleshkov (1976) [15]. Ten ml of the extract was taken in a conical flask. Then 5 ml of 5% KI, 2 ml of 2% starch solution, 2 ml of 100% glacial acetic acid were added to it. Finally it was titrated with 0.001 N of KIO_3 solutions. Free ascorbic acid content was quantified as per procedure described by pleshkov (1976) [15] using the following formula: Ascorbic acid content (mg/l00 g) = $[(F.V_1.V_2.100)/ (V_3.W)]$

Where, F = 0.088 mg of ascorbic acid per ml of 0.001 N KIO_3, V_1 = Titrated volume of KIO_3 ml, V_2 = Total volume of the sample extract ml, V_3 = Volume of the extract (ml) taken for titration and W = Weight of the sample taken (g)

2.5.2. Estimation of β-carotene

One gram of sample was crushed thoroughly and mixed with 10 ml acetone: hexane (4:6) solution. This sample was centrifuged and optical density of the supernatant was measured by double beam spectrophotometer (Model: APEL, UV- VIS Spectrophotometer, PD – 303 UV, PD 33-3-OMS-101 b, Japan) at 663 nm, 645 nm, 505 nm and 453 nm. Calculation was done by the following formula [16]

β-carotene (mg/l00g) = $0.216\ (OD_{663}) + 0.452(OD_{453}) - 1.22(OD_{645}) - 304(OD_{505})$

Where, bold letters indicates optical density.

3. Results and Discussion

3.1. Physiochemical Properties of Wastewater and Groundwater

Table 2. *Physio-chemical parameters of textile dying effluent.*

Parameters	Irrigation standard (DOE)	Treatments							
		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
pH	6.5-8.5	7.2	9.1	6.1	8.2	7.1	7.4	7.3	9.5
TDS (mg/l)	2100	300	910	650	2070	1840	470	1290	3320
TSS (mg/l)	200	30	40	50	60	66	40	40	310
EC (µs cm^{-1})	1200	350	850	900	1350	550	480	700	4200
DO (mg/l)	4.5-8	6.5	5.85	6.12	4.58	5	5.8	4.77	0.58
BOD (mg/l)	100	1.5	68	2	23	83	143	203	223
COD (mg/l)	400	4	755	610	98	195	317	393	450
Cl^- (mg/l)	1000	31	8	5	2500	58	64	42	2700
$NO3^-$ (mg/l)	10	1.5	0.8	0	0.6	0	0.3	0.8	0.8
PO_4^- (mg/l)	15	0.52	0.52	0.81	0.23	0.27	0.19	1.06	0.4
SO_4^{-2} (mg/l)	1000	0	9	2.5	38	0	5	8	65
Copper (ppm)	3	BDR	BDR	BDR	0.0890	0.0040	0.0050	0.0064	0.1110
Zinc (Zn) ppm	10	BDR	BDR	BDR	0.9140	0.1920	0.3160	0.3840	0.5940
Iron (Fe) ppm	1.0	BDR	BDR	BDR	0.0870	0.0039	0.0326	0.3406	0.7306
Lead (Pb) ppm	0.1	BDR	BDR	BDR	0.0050	0.0027	0.0229	0.0237	0.0262

Note: DOE= Department of Environment, Bangladesh, BDR= Below the detectable range
T_1 = Groundwater (Control), T_2 = Second wash after scouring and bleaching, T_3 = Enzyme treated water, T_4 = 2nd wash after bath drain, T_5 = Neutralization Treatment, T_6 = 2nd wash after Soaping, T_7 = Fixing treatment water, T_8 = Mixed effluent from Equalization tank

The pH of different wastewater samples were varied between 6.1 and 9.5 while T_2 and T_8 were exceeded the recommended value (6.5 to 8.5) of DOE for irrigation water quality standard and the value were 9.1 and 9.5 respectively. The concentration of total dissolved solids (TDS) was found well above in sample T_8 (3320 mg L^{-1}) than the irrigation standard (2100 mg L^{-1}) suggested by DOE. The concentration of total suspended solids (TSS) in T_8 was 310 mg L^{-1} which was much higher than the prescribed value (200 mg L^{-1}) of DOE for irrigation. The value of electrical conductivity EC in T4 and T_8 wastewater samples were 1350 and 4200 µs cm^{-1} respectively which exceeded the standard limit (1200 µs cm^{-1}). Dissolved oxygen (DO) is very important for aquatic life. The DO of different studied samples was laid in this range except T_8 which contained the lowest DO (0.58 mg L^{-1}). The value of biochemical oxygen demand (BOD) in T_6, T_7 and T_8 wastewater samples were exceeded the standard limit (100 mg L^{-1}) of DOE for irrigation. The highest chemical oxygen demand (COD) was detected in T_2 followed by T_3 and T_8 which were exceeded the irrigation standard (400 mg L^{-1}) of DOE. Moreover, other element contents such as sulphate, nitrate, phosphate, lead, copper, nickel, cobalt, chromium and zinc were within the standard limit for irrigation purpose (table 2).

3.2. Germination Percentage

Germination percentage varied significantly among the treatments at 2 DAS and 5 DAS but there is no significant variation among the treatments at 3 DAS and 4 DAS (Figure 1). In case of 2 DAS the germination percentage ranged between 0 to 33.33% where the highest germination percentage observed in the T_1 (33.33%) and T_7 (33.33%) treatments and the lowest in the T_8 (0.00%) treatment which was statistically similar to T_4 (6.67%), T_6 (6.67%) and T_2 (13.33%) treatment. In case of 3 DAS and 4 DAS there is no significant variation among the treatments. In case of 5 DAS treatment T_1 and T_5 showed the highest result of (100%) germination. However, T_8 showed the lowest result of (66.67%) germination. The other treatments showed the moderate germination percentage which ranged from 73.33% -93.33%.

From the above findings it is assumed that the germination rate is almost inhibited with increasing concentration of effluents. It may also occur due to high pH and high temperature of the effluent. Ramana, *et al.* (2002) [17] showed that effect of different concentrations (0, 5, 10, 15, 20, 25, 50, 75 and 100%) of distillery effluent (raw spent wash) on seed germination in some vegetable crops viz., tomato, chili, bottle gourd, cucumber and okra and stated that higher was the concentration lower was the germination percentage.

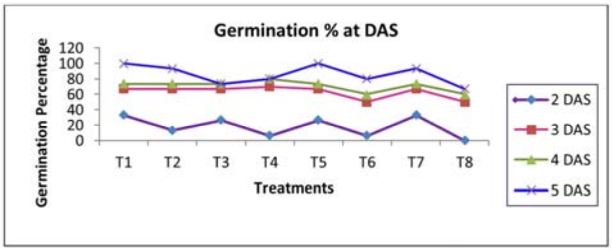

Figure 1. *Germination percentage at different days after sowing.*

T_1 = Groundwater (Control), T_2 = Second wash after scouring and bleaching, T_3 = Enzyme treated water, T_4 = 2nd wash after bath drain, T_5 = Neutralization Treatment, T_6 = 2nd wash after Soaping, T_7 = Fixing treatment water, T_8 = Mixed effluent from Equalization tank

3.3. Fresh and Dry Weight of Plant at 3rd Leaf Stage

Fresh weight of plant at 3rd leaf stage was found the highest in T_1 treatment (6.72 g) and the lowest was in T_8 treatment (4.30 g) (Figure 2).The other treatments varied from 5.26 g - 6.18 g. In case of dry weight of plant at 3rd leaf stage the highest was found in T_1 treatment (0.729 g) and the lowest was in T_8 treatment (0.383 g). There is no significant difference within the other treatments. Similarly Khan *et al.* (2009) [18] showed that plant growth promoting factor largely depend on the irrigation water which determines the external and internal characteristics of plant. The application of textile dyeing wastewater into soil for irrigation purposes raises the soil pH, EC and SAR values which reduce nutrient uptake by vegetative growth of plant. Since among the different stages of textile effluents used in the present study T_8 treated samples contains several constituents that caused negative impact on plant growth habit and provided the lowest fresh and dry weight as well.

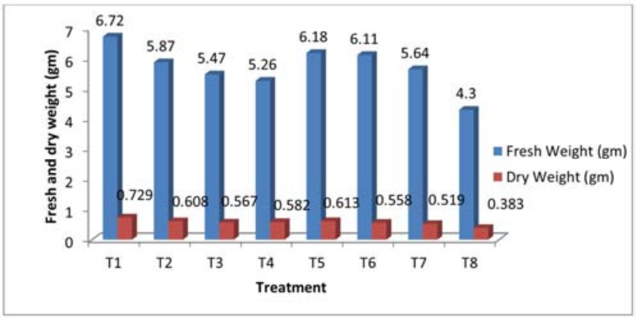

Figure 2. *Effect of textile dyeing effluent on fresh and dry weight of plant.*

T_1 = Groundwater (Control), T_2 = Second wash after scouring and bleaching, T_3 = Enzyme treated water, T_4 = 2nd wash after bath drain, T_5 = Neutralization Treatment, T_6 = 2nd wash after Soaping, T_7 = Fixing treatment water, T_8 = Mixed effluent from Equalization tank

3.4. Fruit Characteristics and Yield

The highest number of fruits was observed in T_1 treatment (7.0) and the lowest number of fruit was observed in T_8 treatment (3.33) (Table 3). The other treatments provided 6.33-4.00 fruits. Length of fruit was the highest in T_1 treatment (15.67 cm) and the lowest in T_8 treatment (10.5 cm). Other treatments varied from 14.03-12.40 cm. In case of width of fruit the highest was found in 1.49 cm in T_1 treatment and the lowest in T_7 treatment (1.29 cm). The highest fresh weight of fruit was found in T_1 treatment (9.71 g) and the lowest was found in T_8 treatment (6.16 g). Dry weight of fruit was found the highest in T_1 treatment (0.95 g) and the lowest in T_8 treatment (0.63 g). The dry weight of other treatments varied from 0.90-0.74 g. Yield/plant was found the highest in T_1 treatment (67.97 g) and the lowest in T_8 treatment (24.64 g). The result showed a great variation in case of yield/ plant. Adamo *et al*. (2005) [19] found that no. of okra fruit varied from 5-15 when it is irrigated with waste water and the length and width of fruit varied from 12-20 cm and 1.3-1.6 cm respectively which were more or less identical with the findings of present work. However, further increase in BOD reduced the productivity appreciably. High amount of chloride and high concentration of color provide from textile effluents also responsible for low production. Ahmed *et al.* (2011) [20] also reported that higher concentration of heavy metals in wastewater are potent in regarding plant growth and development and adversely affect the yield.

Table 3. *Effect of textile dyeing effluent on fruit characteristics and yield.*

Treatment	No of fruit/plant	Length of fruit (cm)	Width of fruit (cm)	Fresh weight/fruit (g)	Dry weight/fruit (g)	Yield/ plant (g)
T_1	7.00 a	15.67 a	1.49 a	9.71 a	0.95 a	67.97 a
T_2	4.00 cd	12.53 bc	1.34 bc	7.97 ab	0.80 abc	26.54 e
T_3	5.00 bcd	12.65 bc	1.34 bc	7.71 ab	0.78 abc	54.25 b
T_4	5.67 abc	12.64 bc	1.32 c	7.91 ab	0.74 bc	44.85 cd
T_5	6.33 ab	14.03 ab	1.43 ab	8.57 a	0.85 ab	38.55 d
T_6	5.33 abc	13.04 b	1.32 c	9.39 a	0.90 ab	50.05 bc
T_7	4.67 bcd	12.40 bc	1.29 c	9.26 a	0.84 ab	43.24 cd
T_8	3.33 d	10.50 c	1.31 c	6.16 b	0.63 c	24.64 e
CV (%)	13.18	10.73	3.69	14.05	13.20	9.39

T_1 = Groundwater (Control), T_2 = Second wash after scouring and bleaching, T_3 = Enzyme treated water, T_4 = 2nd wash after bath drain, T_5 = Neutralization Treatment, T_6 = 2nd wash after Soaping, T_7 = Fixing treatment water, T_8 = Mixed effluent from Equalization tank

3.5. Concentration of Ascorbic Acid and β-carotene

The highest amount of ascorbic acid was found in T_1 treatment (1.34 mg/ 100 g) and the lowest was found in T_8 treatment (0.65 mg/ 100 g). Other treatments ranged from 1.02-0.68 mg/ 100 g (Figure 3). In case of β-carotene T_1 treatment gave the highest amount (0.08 mg/100 g) while T_4 and T_8 treatment gave the lowest amount of β-carotene (0.02 mg/100 g). Other treatments ranged between 0.07 and 0.03 mg/ 100 g. Hussain *et al.* (2010) [21] stated that textile effluents with heavy metals caused a reduction in parameters like chlorophyll content, protein, carbohydrate, ascorbic acid and β-carotene. Hence plants treated with mixed effluent from equalization tank (T_8 treatment) showed lower result of ascorbic acid and β-carotene than that of treated with groundwater and other effluents.

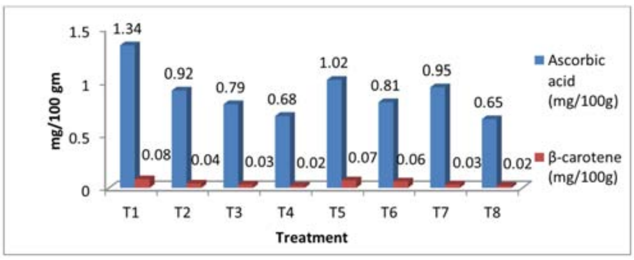

Figure 3. *Effect of textile dyeing effluent on ascorbic acid and β-carotene of okra.*

T_1 = Groundwater (Control), T_2 = Second wash after scouring and bleaching, T_3 = Enzyme treated water, T_4 = 2nd wash after bath drain, T_5 = Neutralization Treatment, T_6 = 2nd wash after Soaping, T_7 = Fixing treatment water, T_8 = Mixed effluent from Equalization tank

3.6. Heavy Metals Accumulation in Edible Part After Harvest

Zinc concentration was found the highest in T_7 treated okra (9.73 ppm) and the lowest in T_1 treatment (3.95 ppm) (Table 10). According to WHO/FAO (2007) [22] critical level of zinc ions in edible portion of different vegetables is 5.00 ppm. Fruits of T_2, T_4, T_7 and T_8 treatments exceed this level, so these may cause harm to our health if we intake these fruits. Fe was found the highest in fruit for T_8 treatment (9.61 ppm) and the lowest in T_1 treatment (3.34 ppm). Cu was found the highest in fruit of T_7 treatment (11.31 ppm) and the lowest in T_1 treatment (4.43 ppm). According to WHO/FAO (2007) critical level of Cu ions in edible portion of different vegetables is 8.00 ppm. Fruits of T_2, T_4, T_7 and T_8 treatments exceed this level, so these may cause harm to our health if we intake these fruits. Lead concentration was found the highest in okra of T_8 treatment 8.72 ppm and T_1 gave the lowest of 2.79 ppm. According to WHO/FAO (2007) critical level of Pb ions in edible portion of different vegetables is 4.00 ppm (Table 4). In this present research work it was observed that fruits of T_1 and T_5 treatments didn't exceed this level. Fruits of other treatments exceed this level, so these may cause harm to our health if we intake these fruits.

Table 4. *Accumulation of heavy metal (ppm) in fruit of okra.*

Treatment	Zinc(Zn) ppm	Iron (Fe) ppm	Copper(Cu) ppm	Leadm (Pb) ppm
T_1	3.95 d	3.34 d	4.43 d	2.79 d
T_2	7.52 ab	5.03 c	10.33 ab	8.23 a
T_3	4.65 cd	4.38 c	5.70 d	8.09 a
T_4	6.57 bc	7.66 b	8.39 bc	4.20 c
T_5	4.11 d	3.40 d	5.51 d	3.73 c
T_6	4.30 d	4.29 c	6.31 cd	6.30 b
T_7	9.73 a	9.42 a	11.31 a	6.19 b
T_8	7.85 ab	9.61 a	8.67 bc	8.72 a
CV (%)	12.55	6.92	13.11	13.87

4. Conclusion

It is concluded that Textile dye industrial untreated effluent significantly influence growth parameters of okra crop due to toxic effect of chemicals and heavy metals. Growth and yield performance of okra was the highest in groundwater. Furthermore, in accounting of textile dyeing effluents effect it has been revealed that, among the studied seven stages of dyeing wastewater neutralization treatment (T_5) performed the best than that of others regarding growth and yield of okra. Nutritional qualities of okra varied remarkably and observed that the highest amount of ascorbic acid and β-carotene were found in groundwater (T_1) treated sample which was statistically identical with the findings of neutralization treatment (T_5). So, it can say that all suitable textile dyeing effluents for irrigation should be neutralized properly before discharge to agricultural land to ensure the accumulation of heavy metals in different plant parts within the safe limit by WHO standard. Mixture of less polluted dyeing wastewater can be used in vegetables cultivation to observe the growth, yield, food value and heavy metals accumulation to provide cost effective wastewater neutralization technique. As uptake of heavy metals by plant depend on many factors therefore, further research is needed to precisely identify the suitable steps of dyeing wastewater discharge for the betterment of human, agriculture as well as textile industries owners.

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