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Impact of Dyeing Industry Effluent on Soil and Crop

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Abstract:

The effect of dyeing industry effluent on agricultural soil, growth pattern and yield of wheat (*Triticum vulgare*) crop were investigated. The study involved cultivation of wheat on the tub soil through irrigation with the effluent collected from Bangladesh Dyeing and Finishing Industry ltd., Savar. Both treated and untreated effluent was analyzed and utilize in irrigation for crop cultivation. By studying various physico chemical properties and heavy metal and in terms of SAR and SSP value it was found that the treated effluent from the dyeing industry was suitable for irrigation. On irrigation of soil with the treated effluent an increase in water soluble salts, pH, electrical conductivity, cation exchange capacity, nitrogen, phosphorous, potassium, sodium, calcium, magnesium and iron contents of the soil for effluent concentration of 2.5 to 5% were observed but all these parameters were found to decrease when the soil is irrigated with the effluent, concentration from 10% and above. Plant height, leaf area, seed dry weight, root dry weight, number of seeds obtained from the wheat plant, protein and carbohydrate content in wheat seeds obtained from the plant irrigated with 2.5, 5% treated effluent also showed an increasing trend and decreased from 10% and above. In case of untreated effluent no sequential order was observed for the above mentioned parameters and showed a lower data value than the treated effluent. However the rate of seed germination decreased in both the cases (treated and untreated effluent) than the control but treated effluent showed a better result than the untreated effluent.

Keywords: Agricultural soil, Dyeing industry, Effluent, SAR, SSP

1.0 Introduction:

With the industrial development in Bangladesh, the waste management systems did not develop accordingly. Almost all industries are seen to discharge their wastes into water and on land without any treatment or after partial treatment. Of the environmental elements, water is the most affected as the big industries are usually situated on the river banks and due to continuous receiving of the effluents the toxicity of these river water increases day by day. The environmental pollution created by the industries has now become a burning issue of the nation (Bhuiyan, M.A.H. *et. al*., 2011) (Islam and Jolly, 2007) (Jolly and Islam, 2006). The major polluting industries like textile and dyeing, paints, tanneries, oil refineries, chemical complexes, fish processing units, fertilizer factories, cement factories, soap and detergent factories including light industrial units of Bangladesh discharge directly untreated toxic effluents in the rivers (Jolly, Ph. D. thesis, 2011).

A survey in 1999 revealed that the water of some major rivers around greater Dhaka city had been completely polluted. The report concluded that the water of these rivers posed a serious threat to public life and was found unfit for human use (Diffuse pollution conference Dublin, 2003).

Though the industrial effluent is a great burden for a country, it has some useful aspects which may be utilized for beneficial purposes. Instead of disposal of wastewater into the environment, there has been its wide use in both developed and developing countries including India and Pakistan for agricultural irrigation and other purposes after its treatment (Steel and Beg, 1954) (Day and Tucker, 1972) (Ajmal *et.al.,* 1984) (Sahai et. al. 1985). This type of practice in Bangladesh has not yet started. Since the generation of industrial effluent is a continuous process; it can be used to meet the substantial irrigation requirements in Bangladesh. The industrial effluent as an alternative means of irrigation can offer a number of advantages. It contains various trace elements which can satisfy the need of micronutrients of crop plants. The environment can be saved from its hazardous effects and utilizing the effluent the dependency on groundwater can be reduced to a great extent.

The textile and dyeing industries have occupied a major position in the industrial sector of Bangladesh with the increasing demand of ready-made garments for local consumption as well as export business. Around 600-700 textile, dyeing and washing industries have been set up around Dhaka, at Narayangonj, Tejgaon, Savar, Tongi and Gazipur areas during the last few years (Faizul Khan, 2005).

Approximately 30 million gallons of untreated industrial wastewater are discharged everyday in and around Dhaka city. Thus billions of gallons of industrial effluent are mixing daily with our environment mainly with water.

The present study was carried out to characterize dyeing industry effluents in terms of their physicochemical properties and trace element contents to assess their quality as irrigation water as well as evaluate their suitability through their application at varying concentrations in crop cultivation on agricultural soil.

2.0 Materials and Methods:

2.1 Effluent Collection:

The effluent used for irrigation of soil in crop production was collected monthly in 20-litre plastic container from Bangladesh Dyeing and Finishing Industries Ltd., Savar (Environmental management plans). The collected effluent after bringing to the cultivation spot was kept undisturbed in the container for about two hours for the settlement of some solid particles at the bottom of the container and then decanted into a plastic bucket.

2.2 Collection of Agricultural Soil:

The soil for crop cultivation was collected from a regularly cultivated agricultural land in Bandar Upzilla in Narayangonj district (Hossain, 1992).The pit method was followed for soil collection. Five square pits, each 0-30 cm depth were dug using a steel-made spade on a land of about 1327 square meters. A sufficient quantity of soil was collected from the sides of each pit. The collected sample from all pits were thoroughly mixed on the spot and carried in thick polyethylene bags.

2.3 Irrigation of Agricultural Soil with Effluent for Crop Cultivation:

In this study a commonly cultivated crop, wheat (***Triticum Vulgare***) was grown on agricultural soil on earthen tubs through irrigation with dyeing industry effluent in different percentage level (2.5, 5, 10, 25 and 50 V/V). The cultivation was carried out in a screen house (Fig1) in the campus of Atomic Energy Centre Dhaka.

Fig.1: Cultivation of Wheat Crop in Screen House

2.4 Effluent Treatment and Irrigation Plan:

2.4.1 Chemical Treatment of the Effluent:

The collected effluent was divided into two equal parts for irrigation purposes. One part of the effluent was chemically treated using a simple chemical precipitation method (Islam, 2006) for removal of colour before using for irrigation and the other part was used without treatment. Both untreated and treated effluents were used for irrigation at the concentrations of 2.5, 5, 10, 25 and 50% (v/v) prepared through dilution of the effluent with groundwater.

2.4.2 Soil Preparation and Irrigation for Cultivation:

To study the impact of the effluent, wheat crop was grown on soil-loaded earthen pots having no leakage. Seven kilograms of soil was placed in each of the 25 cm-diameters earthen pots and irrigated daily with 500 ml of different concentrations of effluents. Four sets, each having six pots filled with the same amount of soil were used. Two sets were irrigated with untreated effluent and the other two sets were irrigated with treated effluent using the same amount of effluent of different concentrations.

In each case one set was only soil (without plant) and the other was wheat-cultivated soil. The irrigation was continued until the crops were matured for sampling. For control groundwater was used for irrigation.

2.4.3 Collection and Preparation of Plant and Soil Samples after Cultivation:

When the plants were matured they were cut off at the base and data were recorded for their different parts per plant. Number and mass of seeds produced per plant were recorded. Root system of each plant was carefully taken out of the soil, so that fine roots were not removed and washed free of soil by gently soaking it in a bucket of water. All plant samples were dried in an oven at 70^{o} C to constant weight. The samples were ground to fine powder in a carbide mortar by a pestle and preserved in a desiccator until analysis.

The effluent-treated soil samples in the earthen pots were allowed to dry naturally and the soils were properly homogenized with a clean wooden spatula in a plastic bowl. An adequate amount of each sample was collected in a polyethylene bag and preserved in desiccators until further processing. The samples were dried in an oven at 70^{o} C overnight as per requirements of the methods where necessary before analysis.

2.5 Methods of Analysis:

2.5.1 Analysis of Various Parameters in Soil and Plant Samples:

The properly dried soil samples were ground in an agate mortar with a pestle and passed through a sieve of 100 meshes. Various physicochemical characteristics including pH, EC, cation exchange capacity(CEC) and organic matter**,** available Na, K, Ca, Mg, Fe, N, P, water-soluble salts were measured by adopting standard methods (Edward Rubins, 1975)**.** An isotopic source-excited X-ray Fluorescence (EDXRF) method was used for trace element analysis in wheat seed **(**Ali 1995)**.** Protein and carbohydrate in crop seeds have been measured using difference method described in detail elsewhere (AOAC, Official Method of Analysis, 1984).

3.0 Results and Discussion:

The dye industry effluent used for irrigation of pot soil was analyzed for its various physicochemical characteristics and the results obtained by Jolly *et al.* are shown in the Table.1 as the average values of eight monthly samples (Jolly et.al., 2009)**.** For the use of industrial effluent for the irrigation purpose, the permissible values of physicochemical characteristics and trace elements recommended by the Department of Environment, Bangladesh (DoE) are also shown in the Table 1. It is evident from the comparison that most of the investigated physicochemical characteristic and elemental data are below the corresponding DoE recommended values.

Table 1: Physicochemical Characteristics and Trace Element Levels in Dyeing Industry Effluent (mg L^{-1} or Otherwise Stated)

Physicochemical Characteristics	Untreated Effluent	Treated Effluent	Trace Elements	Untreated Effluent	Treated Effluent
Colour	Deep green	Colorless	Cr	0.27±0.06	<0.004
Odor	Unpleasant	Odor free	Mn	0.24±0.06	0.05±0.01
pH	7.83±0.1	5.13±0.02	Fe	3.29±0.08	4.57±0.09
EC mS cm^{-1}	1.81±0.02	2.00±0.09	Ni	0.42±0.05	0.24±0.03
Dissolved residue	0.128±0.0004	-	Cu	1.51±0.07	0.86±0.04
COD	180.73±0.15	-	Zn	1.62±0.06	0.69±0.04
K	67.2±1.5	43.93±0.95	Rb	0.27±0.05	0.13±0.03
Ca	62.90±1.37	94.54±1.39	Sr	1.46±0.08	0.78±0.05
Na	88.45±4.58	88.17±4.57	Pb	<0.01	<0.01
Mg	8.87±1.41	10.64±1.45	Cd	<0.003	<0.003
SO_4^{-2}	34.34±0.69	34.52±0.64			
PO_4^{-3}	2.63±0.01	34.30±0.01			
Cl^{-1}	78.03±1.27	117±0.85			
N	2.11±0.13 %	1.83±0.10%			

The suitability of treated and untreated effluents for irrigation was determined by plotting the respective sodium absorption ratio (SAR) and EC values of the effluents where SAR was calculated based on Na, K, Ca and Mg concentrations of effluents indicates that both the treated and untreated effluents have high salinity value and low sodium content**.** The fitted Wilkox's diagram (plotted the soluble sodium percent against EC values) indicated only the treated effluent to be suitable for irrigation purpose. However, the impact of both treated and untreated effluents were practically studied by applying these effluents on agricultural soil for irrigation in crop production. The impact of an effluent on the soil depends on its concentration as well as the levels and nature of its chemical constituents. In order to reduce any effect that might come from the organic pollutants, the effluent was diluted at different concentrations (0, 2.5, 5, 10, 25 and 50%) with groundwater and the pot soils were irrigated using these effluents (both treated and untreated) during cultivation.

Table 2: Effect of Different Concentrations of Untreated and Treated Dyeing Industry Effluents on the Chemical Properties of Original Soil

Effluent Added (%)	Water Soluble Salts (mg kg^{-1})	pH	EC (mS cm^{-1})	CEC (meq/100 g of soil)	Organic Matter (%)	Available Nutrients (meq/100g)						
						N, %	P (µg/g)	K	Na	Ca	Mg	Fe (µg/g)
Original Soil	526 ±2	7.08 ±0.04	0.80 ±0.02	3.82 ±0.03	2.05 ±0.04	0.076 ±0.01	2.175 ±0.01	0.160 ±0.002	0.317 ±0.012	0.166 ±0.008	0.113 ±0.001	45.81 ±0.02
Groundwater (control)												
0	528 ±2	7.10 ±0.04	0.81 ±0.02	3.84 ±0.03	2.10 ±0.01	0.078 ±0.01	2.179 ±0.01	0.162 ±0.002	0.319 ±0.012	0.168 ±0.008	0.114 ±0.001	46.12 ±0.02
Irrigated with Untreated Effluent												
2.5	518 ±2	7.11 ±0.04	0.81 ±0.03	3.81 ±0.03	2.20 ±0.04	0.064 ±0.01	2.173 ±0.01	0.161 ±0.003	0.318 ±0.014	0.167 ±0.007	0.113 ±0.002	45.61 ±0.03
5	511 ±2	7.12 ±0.04	0.82 ±0.01	3.80 ±0.04	2.41 ±0.05	0.062 ±0.01	2.169 ±0.01	0.160 ±0.002	0.314 ±0.012	0.166 ±0.007	0.106 ±0.001	45.02 ±0.02
10	507 ±2	7.15 ±0.04	0.79 ±0.02	3.79 ±0.03	2.51 ±0.04	0.058 ±0.01	2.163 ±0.01	0.157 ±0.003	0.311 ±0.012	0.163 ±0.006	0.098 ±0.002	44.30 ±0.04
25	500 ±2	7.17 ±0.03	0.78 ±0.02	3.70 ±0.03	2.60 ±0.04	0.055 ±0.01	2.150 ±0.01	0.155 ±0.002	0.309 ±0.012	0.160 ±0.007	0.091 ±0.002	43.02 ±0.02
50	489 ±2	7.2 ±0.03	0.76 ±0.02	3.58 ±0.03	2.75 ±0.04	0.050 ±0.01	2.131 ±0.01	0.15 1±0.002	0.304 ±0.013	0.153 ±0.008	0.082 ±0.002	31.62 ±0.02
Irrigated with Treated Effluent												
2.5	538 ±2	7.13 ±0.03	0.90 ±0.02	3.85 ±0.04	2.16 ±0.01	0.091 ±0.01	2.182 ±0.01	0.166 ±0.001	0.324 ±0.011	0.172 ±0.003	0.117 ±0.001	46.21 ±0.03
5	542 ±2	7.17 ±0.03	0.91 ±0.02	3.86 ±0.04	2.20 ±0.04	0.110 ±0.01	2.198 ±0.01	0.169 ±0.002	0.32 ±0.011	0.17 7±0.002	0.121 ±0.001	47.51 ±0.05
10	51 ±2	7.1 ±0.04	0.90 ±0.02	3.85 ±0.04	2.26 ±0.05	0.078 ±0.01	2.179 ±0.01	0.161 ±0.001	0.31 ±0.013	0.170 ±0.003	0.113 ±0.001	44.52 ±0.02
25	510 ±2	7.22 ±0.04	0.89 ±0.02	3.80 ±0.02	2.35 ±0.04	0.075 ±0.01	2.172 ±0.01	0.159 ±0.001	0.314 ±0.014	0.167 ±0.002	0.103 ±0.001	38.55 ±0.03
50	50 ±2	7.29 ±0.05	0.88 ±0.02	3.72 ±0.03	2.44 ±0.04	0.069 ±0.01	2.161 ±0.01	0.156 ±0.003	0.309 ±0.012	0.163 ±0.002	0.094 ±0.002	33.42 ±0.03

Table 3: Effect of Different Concentrations of Dyeing Industry Effluent on Physicochemical Properties of Wheat Cultivated Pot Soil

Effluent Added (%)	Water Soluble Salts (mg kg^{-1})	pH	EC (mS cm^{-1})	CEC (meq/100 g of soil)	Organic Matter (%)	Available Nutrients (meq/100g)						
						N, %	P (µg/g)	K	Na	Ca	Mg	Fe (µg/g)
Groundwater (control)												
0	518.4 ±1.8	7.08 ±0.04	0.78 ±0.02	3.87 ±0.03	2.15 ±0.01	0.076 ±0.01	2.168 ±0.01	0.143 ±0.04	0.293 ±0.11	0.143 ±0.07	0.104 ±0.02	24.0 ±0.03
Irrigated with untreated effluent												
2.5	514.4 ±1.9	7.11 ±0.03	0.86 ±0.02	3.80 ±0.04	2.2 ±0.04	0.054 ±0.01	2.164 ±0.01	0.150 ±0.005	0.290 ±0.011	0.159 ±0.006	0.106 ±0.001	36.11 ±0.03
5	514.0 ±1.6	7.14 ±0.03	0.89 ±0.02	3.72 ±0.04	2.43 ±0.05	0.053 ±0.01	2.161 ±0.01	0.150 ±0.005	0.288 ±0.010	0.158 ±0.005	0.100 ±0.001	36.02 ±0.02
10	513.7 ±1.6	7.19 ±0.04	0.98 ±0.02	3.69 ±0.04	2.55 ±0.04	0.051 ±0.01	2.156 ±0.01	0.148 ±0.004	0.287 ±0.012	0.157 ±0.006	0.092 ±0.002	35.85 ±0.04
25	512.2 ±1.6	7.21 ±0.04	0.98 ±0.02	3.55 ±0.02	2.64 ±0.04	0.049 ±0.01	2.146 ±0.01	0.147 ±0.003	0.286 ±0.011	0.155 ±0.004	0.087 ±0.001	35.61 ±0.02
50	512.0 ±1.7	7.26 ±0.05	1.00 ±0.02	3.48 ±0.03	2.78 ±0.04	0.046 ±0.01	2.127 ±0.01	0.144 ±0.003	0.285 ±0.010	0.149 ±0.006	0.080 ±0.002	24.73 ±0.02
Irrigated with treated effluent												
2.5	519.6 ±1.9	7.17 ±0.04	0.84 ±0.03	3.90 ±0.03	2.17 ±0.01	0.079 ±0.01	2.172 ±0.01	0.153 ±0.004	0.294 ±0.010	0.163 ±0.005	0.10 ±0.003	34.10 ±0.03
5	525.0 ±1.5	7.20 ±0.04	0.95 ±0.01	3.98 ±0.04	2.24 ±0.04	0.089 ±0.01	2.279 ±0.01	0.154 ±0.004	0.295 ±0.011	0.16 ±0.004	0.110 ±0.003	34.51 ±0.05
10	516.2 ±1.5	7.25 ±0.04	0.71 ±0.02	3.79 ±0.03	2.29 ±0.05	0.070 ±0.01	2.170 ±0.01	0.150 ±0.005	0.290 ±0.011	0.16 ±0.005	0.106 ±0.002	34.02 ±0.02
25	514.0 ±1.6	7.32 ±0.03	0.69 ±0.02	3.60 ±0.03	2.37 ±0.04	0.068 ±0.01	2.165 ±0.01	0.150 ±0.003	0.289 ±0.011	0.161 ±0.006	0.098 ±0.001	29.55 ±0.03
50	507.2 ±1.5	7.35 ±0.03	0.68 ±0.02	3.49 ±0.03	2.48 ±0.04	0.063 ±0.01	2.156 ±0.01	0.148 ±0.002	0.287 ±0.010	0.159 ±0.005	0.091 ±0.002	26.44 ±0.03

The effects of different dilutions of treated and untreated effluents on the chemical composition of soils without crops are presented in the Table 2 in which the untreated effluent-soil was seen to show lower concentrations for soluble salts and available nutrients than the treated effluent-soil. The dye chemicals present in the untreated effluent might reduce the availability of elements after their absorption onto soil. The soil was moderately rich in organic matter and hence the medium cation exchange capacity (Alexander 1961). The EC was medium due to medium concentrations of most of the elements as mentioned above (Table.1). Generally CEC is expected to increase with the increase in organic matter, but in this case the CEC was observed to decrease with the increasing organic matter content. Probably the soil organic matter content of humus and clay does not proportionally increase with the increasing organic matter content of the soil from the addition of the effluent. Similarly, though CEC is expected to increase with the increase in pH, in the present case CEC decreases. This might be due to the decrease in dissociation rate of hydrogen ion due to increasing addition of effluent. The physicochemical characteristic values and the available nutrient levels showed increasing trend for 2.5-5% and decreasing trend for 10-50% treated effluent- irrigated soils.

The increasing mineralization rate of organic matter and hence the more availability of nutrients in the soil irrigated with 2.5-5% treated effluents and the decreasing mineralization rate of organic matter and hence the less availability of nutrients in the 10-50% treated effluent-irrigated soils might be responsible for these observation (Alexander,1961) (Ajmal et. al., 1984) (Igbounamba,1972). For untreated–effluent irrigated soil, a decreasing trend of values was shown by each parameter with respect to the control value. The pot soils with wheat crops were irrigated with various concentrations of both untreated and treated effluent and analyzed for physicochemical characteristics and available nutrients.

Table 4: Effect of Different Concentrations of Dye Industry Effluent on Germination of Wheat Seeds

Effluent Concentration	Germination of Wheat Seeds (%)	
	Untreated Effluent	Treated Effluent
0 (control)	95±1	95±1
2.5	76±2	95±1
5	77±2	95±2
10	64±1	88±4
25	59±4	81±2
50	54±5	74±3

Table 5: Plant Height, Leaf Area, Average Dry Mass of Various Parts of Wheat Plant Grown on Soil Irrigated with Different Dye Effluent Concentrations

Effluent Con. (%)	Plant Height (cm)	Leaf Area (cm^2)	Seed Dry Weight ($g\ p^{-1}$)	Root Dry Weight ($g\ p^{-1}$)	Number of Seeds ($plant^{-1}$)	Seed Weight ($g\ p^{-1}$)
Groundwater (Control)						
0	81.65±3.9	27.8±0.73	15.81±0.03	0.5570±0.003	150	20.96±0.03
Untreated Effluent						
2.5	72.19±3.2	26.9±0.71	14.47±0.05	0.5498±0.002	145	18.85±0.03
5	69.32±2.9	25.3±0.70	12.35±0.04	0.5234±0.002	137	16.76±0.02
10	68.24±3.1	24.6±0.69	11.25±0.04	0.5184±0.002	129	14.72±0.03
25	66.12±3.1	22.9±0.68	10.21±0.04	0.5123±0.001	124	13.59±0.04
50	64.98±2.8	21.3±0.71	9.20±0.05	0.5036±0.003	121	11.87±0.02
Treated Effluent						
2.5	83.47±3.0	28.2±0.74	16.92±0.05	0.5932±0.001	159	21.15±0.03
5	86.32±3.8	30.6±0.70	18.19±0.03	0.6423±0.003	178	23.31±0.03
10	81.29±3.5	26.4±0.78	13.92±0.05	0.5436±0.003	149	19.92±0.04
25	80.21±3.7	26.1±0.68	12.86±0.05	0.5389±0.002	141	17.89±0.02
50	77.35±3.1	25.2±0.67	11.79±0.03	0.5130±0.003	139	16.76±0.03

Table 6: Trace Element Concentrations in Wheat Seeds Grow through Effluent Irrigation

Effluent Applied for Irrigation (%)	Mn	Fe	Cu	Zn
Irrigated with Groundwater(Control)				
0	69±18	367±58	19.6±3.3	138±28
Irrigated with Untreated Effluent				
2.5	66±18	339±68	19.4±3.7	136±29
5	63±17	303±60	18.4±4.1	124±28
10	59±18	272±55	18.3±4.3	120±24
25	48±14	264±57	17.8±3.9	115±23
50	41±16	231±47	15.2±3.8	106±25
Irrigated with Treated Effluent				
2.5	76±21	426±65	19.8±4.6	142±26
5	80±17	429±56	20.4±4.2	150±18
10	68±17	293±38	18.9±3.8	136±15
25	57±14	280±32	18.1±3.5	121±15
50	48±10	261±31	16.3±3.1	118±12

Table 7: Protein and Carbohydrate Contents of Wheat Seed Grown on Effluent-Irrigated Soil

Effluent Applied (%)	Protein Content Of Seeds (%)	Protein Content of Seeds Plant^{-1} (g)	Inc/Dec in Seed Protein Content Plant^{-1} (%)	Carbohydrate Content of Seeds (%)	Carbohydrate Content of Seeds Plant^{-1} (g)	Inc/Dec in Carbohydrate Content Plant^{-1}
Groundwater (control)						
0	12.184±0.21	2.55	-	68.264±0.54	14.31	-
Untreated Effluent						
2.5	10.484±0.21	1.98	-22.35	62.935±0.53	11.86	-17.12
5	9.03±0.22	1.51	-40.78	57.479±0.54	9.63	-32.70
10	8.923±0.23	1.31	-48.63	52.854±0.53	7.78	-45.63
25	8.521±0.21	1.18	-53.73	51.682±0.61	7.02	-50.94
50	7.60±0.21	0.90	-64.71	45.182±0.59	5.36	-62.54
Treated Effluent						
2.5	12.795±0.23	2.71	+6.27	69.384±0.56	14.67	+2.52
5	13.334±0.22	3.11	+21.96	70.032±0.54	16.32	+14.05
10	11.049±0.21	2.20	-13.72	66.351±0.55	13.22	-7.62
25	10.251±0.21	1.83	-28.24	63.334±0.53	11.33	-20.82
50	9.112±0.22	1.53	-40.00	57.174±0.52	9.58	-33.05

The results given in the Table 3 showed that the available nutrients from crop-soil irrigated with treated effluent were higher than those in crop-soil irrigated with untreated effluent. But in both cases, the values were lower than the corresponding values in original soil indicating the uptake of nutrients by the plants. It was also observed that the wheat plants took up more nutrients from the treated effluent–irrigated soil than from untreated effluent-irrigated soil and hence was the reflection to yield of wheat seed and its food values. The percentage of seed germination with the concentrations of 2.5-5% treated effluent increased, but at higher concentrations of this effluent (10-50%) the rate was found to increasingly reduce (Table. 4). The wheat plants irrigated with treated effluent of 2.5-5% showed increases in their heights, leaf areas, seed dry weights, root dry weights, number of seeds, seed weights compared to the control plants (Table. 5) (Jolly *et. al.* 2008). Plant height showed a maximum increase of 86.32 cm grown on soil irrigated with 5% treated effluent concentration. The leaves of maximum area were found in the plants irrigated with 5% treated effluent. The increased growth response of the plants as well as the yield of crops (number of seeds per plant and the dry mass of seeds per plant) grown on soils irrigated with 2.5-5% treated effluent concentration can be attributed to the effluent's contribution of the nutrients to the pot soil and the availability of nutrients (Jolly *et. al*., 2008). The untreated effluent irrigation in this cultivation was found to affect plant growth and the crop-yields (Jolly, Ph.D. thesis, 2011). The uptake of some elements, i.e. Mn, Fe, Cu and Zn by the crop plants was checked. The elemental concentrations in the treated effluent irrigated plants were higher than those in the untreated effluent-irrigated plants (Table. 6) and the maximum concentration were found for 5% treated effluent-irrigation which supplied the plants with the adequate amount of nutrients for the proper growth. So dye industry effluent after treatment may serve as a source of nutrients for plant growth. However, as the effluent concentration increased to 10% and above a reduction in plant height and leaf areas was recorded. The negative trend in plant growth at higher effluent concentrations (10% and above was attributed to the interaction of Ca with the other nutrients. As CaO used in treatment procedure, the additional "free" Ca is not absorbed onto the soil. Much of the free Ca forms nearly insoluble compounds with other elements making them less available (Singh and Mishra, 1987)**.** The seed dry weight and the root dry weight of wheat dry weight of wheat crop irrigated with treated effluent were higher than those irrigated with untreated effluent (Table 5). The root dry weight and the seed dry weight increased from 2.5-5% and then it started to decrease from 10-50% treated effluent irrigation. The seed and rood dry weights plant^{-1} with respect to the control values (15.81 g seed p^{-1}, 0.56 g root p^{-1}) increased to maximum values of 18.19 g root p^{-1}

and was 0.64% for irrigation with 5% treated effluent There appeared a positive relationship between the increments in root and seed dry weights. The crop (seed) yields of wheat plant irrigated with treated both type of effluents were shown in the Table 4. It was found that the percentage of germination of the wheat seed in the treated effluent was higher than that in the untreated effluent and was comparable to that in the control. Wheat plants grown on soil irrigated effluent were higher than that irrigated with untreated effluent. A positive yield response to low effluent concentration was reported earlier for crops in several studies (Ajmal and Nomani 1984) (Scott. A.;*Calcium Basics*). The results of total protein and carbohydrate contents obtained in seeds of wheat crop grown on soil irrigated with untreated and treated effluents are given in the Table7. The seed protein contents in wheat crop grown on soil irrigated with 2.5, 5, 10, 25 and 50% effluents were 10.48, 9.03, 8.92, 8.52 and 7.60%, for untreated effluent and 12.79, 13.33, 11.05, 10.25and 9.11% for treated effluent, respectively. The seed protein contents were found to show increasing trend for 2.5-5% and decreasing trend for 10-50% treated effluent irrigation. The maximum increase in seed protein content plant^{-1} with respect to the control value (2.55 g) was +21.96% for irrigation with 5% treated effluent. The seed protein contents were found to decrease on irrigation with the increasing concentrations of untreated effluent. The seed carbohydrate contents in wheat grown on soil irrigated with 2.5, 5, 10, 25 and 50% effluents were 62.93, 57.48, 52.85, 51.68, 45.18%, for untreated effluent and 69.38, 70.03, 66.35, 63.33, 57.17% for treated effluent, respectively. The similar increasing and decreasing trend were also observed for carbohydrate content in wheat seed for treated effluent irrigation. The maximum increase in seed carbohydrate content plant^{-1} with respect to the control value (14.31 g) was +14.05% for 5% treated effluent irrigation. The increase in the protein and carbohydrate contents of seeds at the low effluent concentration of 2.5, 5 % might be due to the facts that the nitrogen taken by the plants at their later stage of growth was transferred to the seeds (Jonker, 1964).

4.0 Conclusion:

The following points were inferred from this study:

- The irrigation of agricultural soil with 2.5 to 5% treated effluent from dye factory enhanced the growth of crops increasingly compared to the water irrigation (control).
- The irrigation with 5% treated effluent was the best for this purpose and could fulfill the fertilizer requirements of crops.
- But a negative effect was observed from the irrigation with 10% to 50% treated effluent.
- Soil pH is raised in the treated effluent irrigated soil than the untreated effluent irrigated one with the increasing per cent of effluent.
- The soil pH shows an alkaline tendency in both the cases.
- Hence the treated dyeing industry effluent may be suitable for fields with acidic soils.
- Thus the use of the effluent after treatment not only solves the disposal problem but also serves as an additional source of fertilizer in liquid form.

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