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EFFECTS OF INDUSTRIAL WASTEWATER ON VEGETATIVE GROWTH AND PIGMENTATION OF OIL YIELDING AND VEGETABLE CROPS

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Abstract: When we tested various industrial wastewater samples collected from different industries they shown high amount of toxic chemical components, and the samples are unfit for irrigation or for any kind of activity. Irrigation of untreated wastewater for long time leads to soil pollution by accumulating toxic salts in the soil. The regular growth of plant get effected by this water like improper growth, low chlorophyll content, low carotenoids content, low yield, etc. Three different types of oil yielding plants (Mustard, Ground nut and Sunflower) and three different types of vegetable crops (Tomato, Chilly and Brinjal) has grown by using different industrial wastewater samples. The primitive parameters of vegetative growth (imbibition, seed germination and vigour index) and nutritional components (chlorophyll a, b and carotenoids) have been observed in all the samples after growing for a particular time period. The imbibition test of seed samples in industrial wastewater samples have not shown significant variation compared to imbibition in distilled water sample. All the seeds in all wastewater samples absorbed almost negligible difference but in the percentage of germination there is significant difference. The tests for nutritional compositions have also shown significant decrease in chlorophyll a, b and carotenoids in all varieties.

***Index terms*:** Industrial wastewater, oil yielding crops, vegetable crops, soil test, chlorophyll

I. Introduction:

To meet water requirements, farmers are now using industrial wastewater (Rezapour *et. al.*, 2019). Industrial wastewater is a by-product of manufacturing or commercial activities. Water is required in every step of productions of different industries. To conform to environmental protection laws, certain things must be removed from the wastewater i.e., wastewater treatment. This includes removal of organic matter, inorganic (Sodium, Potassium, Calcium, Magnesium, Copper, Lead, Nickel, and Zinc), pathogens, and nutrients (most notably nitrogen and phosphorus). So, proper wastewater treatment must be conducted before use it for agricultural or any other domestic use. The best way to treat the wastewater is to treat wastewater at the manufacturing facility itself to reduce their effects on plant health. This can be accomplished with the right wastewater treatment technology (Aivalioti *et. al.*, 2014). Textile wastewater contains a large variety of dyes and chemical that make the environmental hazardous in its chemical composition (Yaseen and Scholz, 2016, Sharma *et. al.*, 2007). Dyeing and finishing industry are mainly responsible to produce a large amount of wastewater. Textile industry release wastewaters with high suspended solids, chemical oxygen demand, heat, color, acidity, and other soluble substances. Materials in textile wastewater which need to be eliminated are mainly COD, BOD, nitrogen, heavy metals and dyestuffs or colorants. Pharmaceutical wastewater is a high concentration of organic matter, microbial toxicity, high salt, and it is difficult to biodegrade, hence it is highly complex. Hence it is harmful to plant health. Even after secondary treatment, there are still traces amounts of suspended solids and dissolved organic matters are persistent in the treated water (Guo *et. al.*, 2017) and it causes some damage to the plant body. Many areas that are becoming industrialized in the world like south west areas of Mysuru city, Karnataka, India, do not have the technology to dispose of the waste with lesser effects on the environment. Both untreated and partially treated wastewater was commonly fed back into a Kabini river and few lakes surrounding to the industries it causes water pollution.

Granite cutting plant is one such industry that releases polluting and turbid effluent surrounding this area (Nanjanagudu). This effluent mainly contains many solids that harm the environment. Hence it requires treatment before disposal (Sharada *et. al.*, 2015). The use of wastewater may have both positive and negative potential impacts on crop production. Treated wastewater may supply organic matter and mineral nutrients to the soil that are beneficial to crop production, and reduce the cost of fertilizer application (Van der hoek *et. al.*, 2002). Industrial effluents containing toxic compounds have strong influence on the normal development of growth of crop plants, seed germination and lower crop yield (Sajid *et. al.*, 2015). Apart from plant health the industrial wastewater also affects varies physical and chemical aspects of the agricultural soil such as pH, salinity, concentration of varying minerals and salts, water holding capacity, etc. The accumulation of heavy metals in the soil due to high usage of industrial wastewater for irrigation can lead to a reduction of yield and quality of the crop in the agricultural lands which are depended on this industrial wastewater to grow crops. Heavy metals are responsible for MDA (malondialdehyde) formation of excessive amount, mainly in chloroplast and mitochondria of leaves, root and Shoot (Ali *et. al.*, 2014). Irrigating soil using treated wastewater is damages to soil quality and also crop development and quality (three broad areas – environmental impacts, public health impacts and economic impacts)(Ofori *et. al.*, 2021). Evaluation of physical, chemical and microbiological characteristics of a Dusky Red Latosol, the yield and the quality of lettuce after cultivation with treated wastewater on irrigation was done by Urbano *et. al.*, 2017. Similarly, the effect of purified industrial wastewater discharged from the Moroccan Company of cardboard and paper of Kenitra city on the growth of tomato plant were carried out by Daifi *et. al.*, 2015.

The aim of the present study is to assess the possibility whether treated wastewater from textile, pharmaceutical and granite industry could safely be used to irrigate crop plants or not. At this point of view to demonstrate, three widely growing oil yielding plants, such as Sun flower – *Helianthus annuus*, Ground nut – *Arachis hypogaea,* and Mustard – *Brassica nigra* and three widely growing vegetable plants, they are Chilli – *Capsicum frutescens,* Tomato – *Solanum lycopersicum,* and Brinjal – *Solanum melongena* has been selected. These crops can be easily grown in the areas with moderate temperature and water availability such as subtropical regions.

II. Materials and Methods:

Collection of treated wastewater from industrial sites:

A clean pair of new disposable gloves was worn each time a different location is sampled. Water samples were collected from three different industrial sites (textile, pharmaceutical and granite industry) of Nanjangudu, Mysuru district, Karnataka state, in a 10 litre cane which was previously washed with 10% HNO_3 for 48 hr. The samples were taken in the afternoon between 1 pm to 3 pm. The samples were immediately brought to the laboratory and tested for physico-chemical parameters.

Methods for physico-chemical analysis of wastewater sample:

The physico-chemical parameters of wastewater samples, such as pH, electrical conductivity, total solids, and total dissolved solids were analysed.

Temperature (T): The temperature of the samples was noted at the time of sampling using a precision of thermometer (0.1 ^{o}C accuracy).

Colour and Odour: The colour intensity of water and soil were observed from naked eyes. The odour is assessed using qualitative human receptor.

Hydrogen ion potential: The pH of the samples was measured by Equptronics digital pH meter model EQ610. Calibration of the pH meter was accomplished by pH 4 buffer solution and then dipped into the sample solution and after a minute, the reading was noted from the display.

Electrical Conductivity (EC): The instrument used for the purpose was Equptronics conductivity bridge-model EQ660B. The conductivity cell was dipped into the sample and the specific conductance was noted in Milli Siemens.

Acidity: 100 ml of water sample will be taken in a flask in which two drops of methyl orange are added; it turned pink and then titration with 0.05N NaOH solution. Light yellow colour is the end point. Now added 3-4 drops of phenolphthalein indicator and continued to titrate it until the end point from yellow to pink is changed. The following formula is used to calculate the acidity,

Acidity = NaOH total titration vol. in ml× 0.05N× 1000× 50/ ml of sample

Alkalinity: Take 100 ml water sample and add 2 drops of phenolphthalein indicator. The solution turns pink and titration with the dil. HCl. The end point come with sharp disappear of pink colour, volume of dil. HCl will be noticed. In the same flask 2-3 drops of methyl orange will be added and the colour of the solution turns yellow. Further titration continued and a new end point reached when a solution in the flask is just turning to pink. Total alkalinity will be calculated by following formula,

Alkalinity = Total HCl× 0.1N HCl×1000×50/ml of the sample

Hardness: The hardness of the sample was measured by using the EDTA Titrimetric Method. 50 ml of sample will be taken in a conical flask. 1-2 ml of buffer solution and 1-2 drops of EBT indicator will be added into the flask. The solution turns wine red. The sample will be titrated against standard EDTA titrant. The sample will be titrated up to the end point till the colour turn from wine red to blue and notice the reading. The following formula was used to calculate total hardness,

Hardness (mg/l) = EDTA used (ml) × 1000/ ml of sample.

Total suspended solids (TSS): For this a known volume of sample will be titrated through oven dried pre-weighted filter paper and the residue containing filter paper was oven dried at 100 ºC and again weighed. TSS of the sample will be calculated by using the following formula,

TSS (mg/l) = initial weight of filter paper- final weight of filter paper

Total dissolved solids (TDS): Water sample will be taken and then filtered it to remove suspended particles. 250 ml of clear filtrate will be evaporated in an oven at 100 °C in porcelain disc. Measurement is observed by - TDS (mg/l) = W2-W1×1000/ V

Total Solids (TS): Total solids (include both suspended and dissolved solids) was calculated by using the formula - TS (mg/l) = TSS+TDS

Dissolved Oxygen (DO): Water sample was collected without bubbling in the 250 ml glass bottle. 2 ml each of Manganous sulphate and the alkali Iodide azide solution will be added right at the bottom of the bottle with separate pipettes. The bottle will shake at least six times. The brown precipitate formed allowed to settle, 2 ml Con. H_2SO_4 will be added and shaken the bottle to dissolve the brown precipitate. 50 ml of solution is taken in a flask and then titrate it with a Sodium thiosulphate solution till the colour change to pale straw. Two drops of starch solution are added to the flask and the colour of the content changed from pale to blue solution that is titrated again with thiosulphate solution till the blue color disappears. The total amount of Sodium thiosulphate will be observed and dissolved oxygen content in water (mg/l) is calculated by following formula,

DO (mg/l) = (8* × 1000× N) ×v/V

Biological Oxygen Demand (BOD): The dilution water will be prepared by adding 1 ml of each Phosphate buffer solution, Magnesium sulphate solution, Calcium chloride solution, Ferric chloride solution to 1000 ml distilled water. 2 ml water sample will be added and aerated. The DO of undiluted sample will be determined which designated as DO zero. The desired percentage mixture was prepared by adding sample dilution water. One bottle will be filled with the mixture and designated as DO 1 and the other one with dilution water (blank) designated as DO 2. Both bottles will be incubated at 20 °C for 5 days and after incubation, the DO will bedetermined. The BOD will be obtained by the following formula, BOD (mg/l) = [{(DO2-DO1) ×100} (DO2-DO0)}]

Chemical Oxygen Demand (COD): 50 ml of water sample will be taken in triplicates of 100 ml flask and triplicates of the blank will also prepare. 5 ml of K_2CrO_7 solution will be added to each 6 flasks. Then kept these flasks at 100 ° C in water bath for an hour. The samples will be allowed to cool for 10 minutes and then 5 ml of KI will be added, then add 10 ml of H_2SO_4 in each flask. The content of each flask will be titrated in 0.1M $Na_2S_2O_3$ till the appearance of pale yellow colour. 1 ml of starch solution is added due to which the solution turns pale yellow to blue and titrated it again until the blue colour disappear completely. COD will be calculated by applying the formula,

COD of the sample (mg/l) = 8× C× (B-A)/S

Total Chlorides: Known amount of distilled water was transferred to a conical flask and 1 ml of Potassium chromate indicator was added to prepare a black solution. The contents were titrated against $AgNO_3$ till the light yellow colour changes to red colour. Titration was repeated to obtain concurrent values. The chlorides are estimated using the following formula,

Chlorides in mg/l = (A-B) ×N×35.45×1000/10

Dissolved carbon dioxide: Water sample of about 20 ml is pipetted into a clean conical flask. Add few drops of Phenophthalin indicator into the water sample. Titrate the water sample against 0.05 N NaOH till the solution turns pale pink in colour which is the end point. The dissolved carbon dioxide is estimated using the formula,

Dissolved Co2 mg/l = Volume of NaOH × N of NaOH × 100/ Volume of sample taken

Collection of soil sample from study area:

Multiple sampling spots were selected in the field based on the visual observation; the surface litters at the sampling spot were removed. A 'V' shaped cut was made to a depth of 15 cm in the sampling spot and the soil was collected. Samples were mixed thoroughly and foreign materials like roots, stones, pebbles and gravels were removed. Quartering was done by dividing the mixed soil samples into four equal parts. The two opposite quarters were discarded and the remaining was mixed. The sample was collected in polythene bag brought to a laboratory for further analysis.

Methods for physico-chemical analysis of soil sample:

The physicochemical properties of soil such as colour, temperature, moisture content, pH, electrical conductivity and soil texture were self analysed whereas for the micro nutrients such as Organic carbon, Nitrogen, Phosphorus, Potassium oxide, Sulfur, zinc, Boron, Iron, Manganese, Copper, etc. in soil sample was tested at a government recognized soil testing laboratory, Mysuru.

Colour- The colour of the soil was determined by comparison of soil sample with the color chips in the standard Munsell soil color charts. It allows for direct comparison of soils anywhere in the world and assigned soil to the corresponding Munsell notation. Soil color by Munsell notation is one of the standard methods used to describe soils for soil survey.

Temperature - The temperature of the soil was measured using the classical thermometer. **Moisture content -**The moisture content in the soil was determined by gravimetric method. The moist soil samples were weighed immediately and then dried to constant weight in an oven at 105 ^{0}C for 24 hrs. The sample was weighed after cooling it in desiccators.

Moisture weight % = Loss of weight on drying/weight of oven dry soil × 100

Hydrogen ion concentration - The soil suspension of distilled water in 1:5 ratio is prepared and pH is determined from unfiltered suspension using a digital pH meter.

Electrical conductivity - The soil suspension was prepared in the ratio 1:5 using distilled water and electrical conductivity was measured using a conductivity meter at 25 ^{0}C.

Soil texture - This is determined by Jar method, one third portion of the jar is filled with clean soil sample and water is filled in the jar and placed for 24 hrs then using a ruler layer of soil is measured and percentage of soil measured by using the formula,

Soil % = Layer height / total height of soil.

Collection of seed samples for the present study:

The good quality seed was collected from the local seeds, distributing market (Devraja market, Mandimohalla), Mysuru.

Method for analysis of physical purity of seeds:

This is done by a random cup method this is the method suitable for seeds requiring working sample up to 10 grams. After a preliminary mixing the seed is poured uniformly over the tray contain 6-8 small cups. The seeds that fall into the cup are considered for as the working sample. The purity analysis of a seed sample refers to the determination of the different components of the purity viz., pure seeds, other crop seeds, weed seeds and inert matter.

Percentage of components =

Weight of individual component / weight of all components × 100

Method for analysis of seed imbibitions rate:

When seeds are immersed in water, they swell due to imbibitions. This swelling up causes a temporary increase in the volume of the cell. Weigh around 20 raisins that are dry on an electronic balance. Make note of the weight into the small beaker, add some distilled water. Shift the weighed raisins to the beaker. Leave the raisins soaking in water for around 2 to 3 hours. Once soaked, shift the raisins from the beaker to a Petridis placed in a blotting paper. Make note of the weight of the dry raisins.

Percentage of water Absorbed = final weight – initial weight / initial weight × 100

Percentage of seed germination and vigour index

The small seeds were placed on the disc with moist paper and arrange in concentric rings of 15 seeds at the outermost ring 9 seeds in the middle and 1 at the centre. The germination of the seed was considered by the appearance of radical after 2 days. The measurement of root length and shoot length was taken after 4 days and calculated for vigour index.

Method to estimate the chlorophyll and carotenoid contents:

The leaf samples were collected from the potted samples in the morning and were subjected to spectrophotometric analysis of pigments. While handling the leaf samples in the laboratory, precautions were taken so as to avoid the mechanical or other damage. All the samples were washed under tap water to remove dust particles and other unwanted particles from the surface of leaves and were then analyzed for the determination of Chlorophyll-a, Chlorophyll- b, total Chlorophyll and Carotenoids. The Quantitative estimation of chlorophyll-a, chlorophyll- b and total chlorophyll was carried out by the DMSO method (Hiscox and Israelstam, 1978).

One gram of fresh cut leaf material was suspended in test tubes containing 4 ml of DMSO. Test tubes were incubated at 60 °C for 20 min. The supernatants were pooled and volume was made up to 10 ml by adding DMSO. The chlorophyll extract was read in a spectrophotometer (Model ELICO SL 171) at 662 nm, 645 nm and 470 nm for chlorophyll a, b and carotenoids, respectively. The amount of chlorophyll a, chlorophyll b and total chlorophyll was calculated by using the formulae of Wellburn and Lichtenthaler (1983).

$$\text{Chlorophyll a (mg / L)} = 11.75 \times A_{662} - 2.35 \times A_{645}$$

$$\text{Chlorophyll b (mg / L)} = 18.61 \times A_{645} - 3.96 \times A_{662}$$

Total chlorophyll = chlorophyll a + chlorophyll b.

The carotenoid content was calculated using the following formula:

$$\text{Total carotenoids (mg/L)} = 1000\times A_{470} - 2.27\times C_a - 81.4\times C_b / 227$$

Where, C_a = Total chlorophyll a,

C_b = Total chlorophyll b

III Results and discussion:

The wastewater collected from various industrialized areas around the Mysore city (Nanjangudu industrial area) are analysed for physico-chemical analysis by following various methods which are mentioned in methodology part.

The readings of various physicochemical parameters are listed, the industrial wastewater samples are tested along with the distilled water and tap water, for the comparative study of these water samples. The temperature of distilled water and tap water was at normal room temperature of 25 °C. The temperature of industrial wastewater samples was within the prescribed Bureau of Indian Standards.

Sl. No.	Parameters	UNITS	DW	TW	WWS-1	WWS-2	WWS-3	BIS
1.	Temperature	°C	25	25	28	28	28	40
2.	Colour	NA	NONE	NONE	NONE	Pale Yellow	Milky White	NONE
3.	Odour	NA	NONE	NONE	unpleasant	unpleasant	NONE	NONE
4.	pH	NA	6.08	6.90	7.50	8.1	7.75	5.5-9
5.	Electrical conductivity	mS	0.25	1.0	0.86	1.75	1.16	NA
6.	Alkalinity	mg/L	-	390	420	620	500	NA
7.	Chlorides	mg/L	-	469	367.26	52.60	52.60	600
8.	Total hardness	mg/L	5	281	187	420	196	300
9.	TDS	mg/L	400	500	1050	1800	1550	2100
10.	TSS	mg/L	20	102	134	650	700	200
11.	TDO	mg/L	20.8	31.36	24	8	17.2	NA
12.	TDCO2	mg/L	-	0.0575	NIL	0.025	NIL	NA
13.	COD	mg/L	0.0	142.4	174.4	126.4	195.2	250
14.	BOD	mg/L	-	11	56	63	79	100

Table 1: Physicochemical parameters of various collected water samples.

Note: BIS, (Bureau of Indian Standards) – Tolerance limits for the industrial effluent on land forirrigation under government regulations for wastewater, DW- Distilled water, TW- Tap water, WWS- Wastewater sample.

Sl. No.	Units	Parameters	Values
1	-	pH	8.06
2	mS/cm	EC	0.27
3	mg/Kg	OC	1.52
4	mg/Kg	N	0.35
5	mg/Kg	P_2O_5	15
6	mg/Kg	K_2O	611
7	mg/Kg	S	8.15
8	mg/Kg	Zn	0.18
9	mg/Kg	B	0.20
10	mg/Kg	Fe	5. 72
11	mg/Kg	Mn	1.53
12	mg/Kg	Cu	0.40
13	%	Clay	32.69
14	%	Silt	57
15	%	Sand	9.61

Table 2: Physicochemical parameters of the collected soil samples

Sample	Working Sample (in grams)	Inert matter	Other seeds	Impure seeds	Pure seeds
Mustard					
R1	10	0.189	0	0.1005	9.7105
R2	10	0.208	0.112	0.5	9.18
% R1	-	1.89	0	1.005	97.105

% R2	-	2.08	1.12	5	91.8
Average %	-	1.985	0.56	3.0025	94.4525
Ground nut					
R1	40	0.146	0	2.56	37.294
R2	40	0.201	0	3.4	36.399
% R1	-	0.365	0	6.4	93.235
% R2	-	0.5025	0	8.5	90.9975
Average %	-	0.4337	0	7.45	92.1163
Sunflower					
R1	25	2.28	0.018	0.01	22.692
R2	25	1.17	0.09	0.12	23.62
% R1	-	9.12	0.072	0.04	90.768
% R2	-	4.68	0.36	0.48	94.48
Average %	-	6.9	0.216	0.26	92.624
Chilli					
R1	15	0.0202	0.0302	0.4216	14.5280
R2	15	0.0445	0.0614	0.4309	14.4631
% R1	-	0.134	0.201	2.810	96.85
% R2	-	0.296	0.409	2.872	96.42
Average %	-	0.215	0.305	2.841	96.63
Tomato					
R1	07	0.1311	0.0202	0.3592	6.489
R2	07	0.1241	0.0311	0.4465	6.398
% R1	-	1.872	0.288	5.131	92.7
% R2	-	1.772	0.444	6.378	91.4
Average %	-	1.822	0.366	5.754	92.05
Brinjal					
R1	15	0.241	0.101	0.125	14.532
R2	15	0.223	0.092	0.040	14.643
% R1	-	1.606	0.673	0.833	96.88
% R2	-	1.486	0.613	0.266	97.62
Average %	-	1.546	1.286	0.549	97.25

Table 3: Physical purity test observations of Mustard, Ground nut, Sunflower, Chilli, Tomato and Brinjal seeds.

Sl. No.	Type of Crops	% of water absorption															
		Tap water				Sample 1				Sample 2				Sample 3			
		1	2	3	Avg.	1	2	3	Avg.	1	2	3	Avg.	1	2	3	Avg.
01	Mustard seeds	25.54	44.33	57.32	42.3	30.56	50.96	63.23	48.2	26.14	44.13	54.33	41.5	26.94	45.13	58.33	43.4
02	Groundnut seeds	27.98	35.26	49.02	37.4	20.92	30.80	42.63	31.4	24.24	34.71	47.70	35.5	20.03	30.46	41.47	30.6
03	Sunflower seeds	20.76	39.52	59.28	39.8	23.50	41.65	61.60	42.2	25.89	41.65	65.19	44.2	23.87	40.02	61.37	41.7
04	Chilli seeds	34.42	36.57	36.52	35.8	20.81	34.93	42.48	32.7	23.71	32.60	41.84	32.7	30.45	31.02	40.37	33.9
05	Tomato seeds	43.20	47.04	52.05	47.4	49.20	50.01	58.05	52.4	46.92	50.25	59.35	52.1	48.10	53.76	58.56	53.4
06	Brinjal seeds	51.86	59.04	61.14	57.3	13.04	20.51	28.38	20.6	29.54	33.32	47.24	36.7	19.50	25.37	32.14	25.6

Table 4: Percentage imbibition of seed samples in tap water and collected water sample 1, 2 and 3.

Sl. No.	Seed samples	Number of seed samples for each treatment	Distilled Water	Tap Water	Sample 1 (%)			Sample 2 (%)			Sample 3 (%)		
					25	50	100	25	50	100	25	50	100
01	Mustard seeds	25	72 %	76 %	72%	64%	40%	68%	72%	48%	76%	40%	40%
02	Groundnut seeds	12	50 %	67 %	50%	25%	17%	42%	34%	9%	59%	50%	25%
03	Sunflower seeds	12	50 %	59 %	75%	84%	92%	67%	59%	34%	75%	67%	67%
04	Chilli seeds	25	46 %	61 %	31%	52%	39%	46%	48%	57%	56%	41%	53%
05	Tomato seeds	25	38 %	54 %	26%	43%	30%	45%	48%	52%	49%	54%	59%
06	Brinjal seeds	25	40 %	56 %	28%	56%	32%	40%	40%	60%	52%	44%	52%

Table 5: Percentage seed germination in different concentrations of industrial wastewater samples.

Sl. No.	Seed samples	Number of seed samples for each treatment	Dis. H_2O	Tap Water	Sample 1			Sample 2			Sample 3		
					25 %	50 %	100%	25 %	50 %	100%	25 %	50 %	100%
01	Mustard seeds	25	600.2	767	609.8	660.9	588.3	502	303.3	260	506	280.9	200
02	Groundnut seeds	12	925	1855	2355	4623	5820	887.8	900.6	764.3	904.4	745.3	573.4
03	Sunflower seeds	12	508.5	523.4	791.5	237.5	41.7	500	498.6	80.9	489.4	376.2	403.4
04	Chilli seeds	25	98	132	49	123	65	94	98	120	80	83	97
05	Tomato seeds	25	145	162	63	161	82	110	109	148	68	75	98
06	Brinjal seeds	25	103	157	59	143	75	101	100	139	78	85	103

Table 6: Vigour index test of seeds treated with industrial wastewater samples.

Sample	Amount of Chl a (µg/ml)	Amount of Chl b (µg/ml)	Total amount of chlorophyll	Amount of carotenoids (µg/ml)
Mustard				
Dist. Water	15.93	30.3	46.23	0.83
Tap Water	9.92	20.93	30.85	0.63
Sample 1	8.23	20.37	28.6	0.51
Sample 2	9.38	21.47	30.85	0.61
Sample 3	7.22	19.6	26.82	0.68
Groundnut				
Dist. Water	30.33	44.9	75.23	0.82
Tap Water	26	39.22	65.22	0.9
Sample 1	20.11	28.3	48.41	0.72
Sample 2	8.56	19.76	28.32	0.65
Sample 3	19.35	20.16	39.51	0.71
Sunflower				
Dist. Water	10.47	26.56	37.03	0.47
Tap Water	7.77	34.84	45.61	0.26
Sample 1	8.42	20.84	29.26	0.6
Sample 2	9.53	23.77	33.3	0.45
Sample 3	7.14	17.65	24.79	0.42
Chilli				
Dist. Water	8.56	24.23	32.79	0.45
Tap Water	5.68	32.42	38.1	0.24
Sample 1	6.59	18.29	24.88	0.4
Sample 2	7.23	21.46	28.69	0.43
Sample 3	5.15	15.27	20.42	0.40
Tomato				
Dist. Water	8.56	24.23	32.79	0.45
Tap Water	5.68	32.42	38.1	0.24
Sample 1	6.59	18.29	24.88	0.4
Sample 2	7.23	21.46	28.69	0.43
Sample 3	5.15	15.27	20.42	0.40
Brinjal				
Dist. Water	8.56	24.23	32.79	0.45
Tap Water	5.68	32.42	38.1	0.24
Sample 1	6.59	18.29	24.88	0.4
Sample 2	7.23	21.46	28.69	0.43
Sample 3	5.15	15.27	20.42	0.40

Table 7: Quantitative determination of chlorophyll a, b and carotenoids in leaves DMSO method.

As the preliminary test shows much difference between distilled water and the wastewater samples in terms of colour, odour, etc. which indicates the presence of toxic chemicals in the industrial wastewater samples and are extremely harmful for irrigation as well as for animal consumption, the pH of all 3 samples are showing moderate basicity (pH of above 7), hardness also been reported as very high which indicating the presence of the chlorides, nitrates and sulphates of calcium and magnesium in high concentration, COD test shows the high COD levels in all 3 test samples which indicating the anaerobic conditions of the water, the BOD levels of the test samples also been analysed as in higher side compared to distilled water, this is mainly due to releasing the wastewater into the open areas and the tests for other components also shown high variations with respect to distilled water and tap water (table 1). The water samples of tap, distilled and WWS-1 had no colour. The WWS-2 and WWS-3 had milky white and pale yellow colour respectively. The water samples of tap and distilled water had no odour whereas the WWS-1, WWS- 2 and WWS-3 had chemical and bleach odour. The water samples had different pH levels. The distilled water should be neutral with a pH of 7.0, but because it absorbs carbon dioxide from the atmosphere, it was slightly acidic with a pH of 6.08. The WWS-2 had the highest pH level of 8.01 among all the samples. The conductivity is a measure of water's capability to pass electrical flow. The more the ions are present, the higher will be the conductivity of water. The electric conductivity of the water samples was tested in laboratory using electric conductivity meter (EQ660B). The results reflect that the mean of WWS-2 had maximum conductivity among all samples, which is 1.72 ± 0.05 mS.

Alkalinity is a measure of the acid- neutralising capacity of water. The pure distilled water has a pH 7.0 it has an alkaline of zero. Water with pH above 7 is alkaline. The alkalinity of the various water samples TW, WWS-1, WWS-2 and WWS-3 were 390, 420, 620, 500 mg/L respectively. Water containing chloride concentration of less than 150 mg/L of chloride is safe for most crops, provided that proper irrigation management practices are applied. The chloride contents in TW, WWS-1, WWS-2, WWS-3 were estimated and revealed that, 469, 367.26, 52.60, 52.60 ± 2 mg/L.

Total hardness is the measurement of the mineral content in water samples. From the tests conducted the WWS-2 had the highest total hardness of 420 mg/L. Whereas, the samples DW, TW, WWS-1 and WWS-3 had a total hardness of 5, 281, 187, and 196 ± 2 mg/L. Total dissolved solids and Total suspended solids, both are determined using the same equation. TDS in WWS-2 is more i.e., 1800mg/l. where as in the TSS it contains more in the WWS-2 and WWS-3 i.e., 650 mg/l and 700mg/l. The total dissolved carbon di oxide is nil in the DW, WWS-1 and WWS-3. Chemical oxygen demand is less compared to the BIS. Biological oxygen demand is the amount of dissolved oxygen is needed more in the WWS-3 i.e., 79 mg/l compares to other water samples.

The soil collected from nearby agricultural land located in The Nanjangudu area, Mysore, Karnataka. This soil is selected to grow the different crop plants to study the effect of industrial waste water on the plant growth. The soil is given to the analysis in soil testing lab Mysore, located in Nazarbad, Mysore. The report shows normal conditions of the soil and which is perfect for the plant growth (Table 2). In the chemical analysis the Phosphate amount was maximum i.e., 15 mg/Kg. The organic Carbon 1.52 mg/Kg, Nitrogen 0.35 mg/Kg, Potassium 6.11 mg/kg, Sulphur 8.15 mg/Kg, Zinc 0.18 mg/kg, Boron 0.20 mg/Kg, Iron 5.72 mg/Kg, Manganese 1.53 mg/Kg and Copper 0.40 mg/Kg. The jar test is done to know the type of soil we have. The water and soil mixed well leaves for 24 hours to settle. After 24 hours we see the distinct layers. The first layer is the clay which is very less in weight, second layer is the silt and third layer is the sand which as more weight so it settles at the bottom. The soil sample contained the maximum amount of silt viz, 57%, clay 33% and sand 10%. Hence, from the soil texture chart, it is identified as silty clay loam soil. Silty soil is usually more fertile than other types of soil, it promotes water retention and air circulation.

The physical purity test is done for the selected seed samples. To ensure the seeds are perfectly checked for physical damages and to avoid the errors which may affect the final results (Table 3). Imbibition test is done for all 6 test seeds in water samples (Tap water, Sample-1, Sample-2, Sample-3), this test shows how the seeds are reacting with different water samples in terms of absorption of water. As the quality of water plays a major role in the absorption of water from the seeds and this ultimately affects the germination of seeds. The percentage of water absorption by different crop seeds was illustrated in Table 4. The seed germination test is done by seeds are treated with different concentrations (25%, 50% & 100%) of different industrial wastewater samples (Table 5). Comparatively the seeds which are treated with industrial waste water are showing less germination than that of seeds which are treated with tap water and distilled water. Similar work carried out by Kanwal *et. al.,* 2020, study was designed and executed to investigate the effect of Pb on germination, seedling growth, physiological, biochemical, mineral contents and yield of wheat. Treated wastewater of Oil and Natural Gas Corporation, can be suggested that the treated wastewater of ONGC is most suitable for the cultivation of vegetable crops. The approach of utilizing treated wastewater for raising crops is towards minimizing cost of fertilizers and conservation of water resources (Gadhia *et. al.,* 2014). In Table 6, Vigour index test of seeds was shown that very less vigour index recorded in Chilli, Brinjal and Tomato compare with Sunflower, Mustard and Groundnut.

DMSO method is used to estimate the amount of chlorophyll and carotenoids in the leaf of test crop plants, which is grown by using different industrial wastewater samples. As a result, the industrial wastewater is significantly showing the effect on the crop plants on plant growth it can cause serious economic lose to the farmers. The total amount of chlorophyll and carotenoids in the plants treated with industrial wastewater shown less content of pigments compared with control. Hence, the industrial wastewater samples are not suitable for the selected plants for their growth and development (Table 7). Differential effects of wastewater were observed on fresh and dry biomass of seedlings in all vegetables. It may have different effects on different crops, depending upon the nature of wastewater and sensitivity of a vegetable plant species to wastewater (Uzma *et. al.*, 2016). The stimulatory effects of wastewater in the present study may be attributed to the presence of several essential nutrients in the wastewater, while the negative effects can be attributed to the presence of toxic substances. The environmental impacts caused by using wastewater in agri-culture can be positive and negative.

IV Reference:

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