International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2014): 5.611

Effect of Mixed Industrial Effluent on the Growth of Abelmoschus Esculentus

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Abstract: ***The present study has been carried out to see the effect of mixed industrial effluent collected from Okhla Industrial Area phase-II, New Delhi-110025, India on seed germination and growth of the Okra (Abelmoschus esculentus). The Okra seeds were placed on the petri-dishes lined with cotton and covered with filter paper for seed germination and earthen pots were used for recording the plant growth after treating with different concentration of effluents viz controlled (0%), 25 %, 75%, 100 %. Germination percentage of seeds was recorded highest at 25 % concentration of effluent. The plant growth also recorded highest at 25 % concentration of the effluent. The study reveals that the germination of seeds and growth of the plants gradually declined with the increasing concentration of the effluent. The study suggests that the effluent may be used for agricultural purposes if proper dilution is taken up.***

Keywords: Effluent; Pollutant; Seed germination; Abelmoschus esculentus; Effluent Tolerance Index (ETI).

1. Introduction

Industrialization play an important role in the development process but the wastewater disposal has become a global dilemma for the industries because of generation of high volume of effluents, limited space for land based treatment & disposal and high cost of treatment technologies (Kumar & Chopra). Normally wastewater is used for irrigation purposes in many countries which are suffering from low availability of water (Al-Ansari et. al. 2013., Arora et. al. 2008). Pollution is a matter of great concern because of its adverse effects on human health, animals, plants and various exposed materials (Nawaz et. al. 2006). Effluents affect the time of flowering and fruiting number of fruits, weight of fruits and effect on vascular bundles (Uaboi-Egbenni et. al. 2009). The utilization of industrial effluents for irrigation of crop plants is a highly beneficial solution to control the pollution (Medhi et. al. 2008). Industrial waste contains very poisonous salts, alkalis, acids, odour, gases, heavy metals, insecticides etc. These polluted wastes are thrown into the canals, streams or rivers affecting the quality of water, making the water unfit for irrigation purposes and for other uses (Malik et. al. 2003). Seed germination is a fascinating process. The industrial effluents possess various organic and inorganic chemical compounds. The presence of these chemicals will show detrimental effects on the development of plant, germination process and growth of seedlings (Wins and Murugam. 2010, Vijaakumari and Kumudha. 1990, Vijayarengan and Lakshyamanachary. 1993). Treated industrial effluents can be used for irrigation purposes but when the effluent is used without any treatment, toxic substances present in the effluent reduces crop growth and gives severe adverse effect on soil properties (Medhi et. al. 2008). Effluent released with high temperature can raise the temperature of water bodies, reducing the solubility of oxygen in the water and increasing the pH value of the receiving body (Ara begum et. al. 2010, Rao et. al. 1983).

2. Materials and Method

In the present study attempts have been made to investigate pollutants of wastewater effluents of Okhla Industrial Area Phase-II, New Delhi and their effects on seed germination and plant growth of Abelmoschus esculentus. The present study was conducted with five different concentrations of effluent collected from industrial area phase-II New Delhi situated at 28.53 latitude and 77.25 Longitude. The physico-chemical properties of the effluent were analyzed by the procedure of APHA (1992) in the Environmental Science Laboratory, Department of Applied Sciences and Humanities, Faculty of Engineering and Technology, Jamia Millia Islamia, New Delhi, India since 28 August 2014 to 28 October 2014. The sets were made by dissolving calculated amount of effluents in tap water i.e. T_c, T_{25}, T_{50}, T_{75}, T_{100} and by maintaining the ratio of effluent and tap water as-0:100, 25:75, 50:50, 75:25, 100:0 respectively as shows in table -01.

Table 1: Different dilution levels of industrial effluent with different ratios

S.N	*Volume of effluent (%)*	*Volume of tap water (%)*	*Concentration (V/V) Effluent : Water*	*Final concentration (%)*	*Symbol*
1.	0	100	0:100	0	T_c
2.	25	75	25:75	25	T_{25}
3.	50	50	50:50	50	T_{50}
4.	75	25	75:25	75	T_{75}
5.	100	0	100:0	100	T_{100}

Industrial effluent of different concentrations was used to investigate the effect of effluent on seed germination and yearly growth of Abelmoschus esculentus (variety name Arka Anamika) which was bought from Indian Agriculture research Institute (IARI), PUSA, New Delhi. During experiment thirty seeds of Abelmoschus esculentus were collected and sterilized by 0.1 % of mercuric chloride solution which helped to remove the microbes. The seed were then spread on the Petri dishes lined with cotton and covered with filter paper. The seeds were then irrigated with equal Volumes (20 ml) of different concentration of each set of three replicates at certain time interval. The germinated seeds were taken out from petri-dishes when there was no further germination. Pot culture experiment was carried out to study the effect of industrial effluent on the growth of Abelmoschus esculentus. Earthen pots were filled with air dry soil. The collected effluent was considered as 100 percent concentration. Different dilutions of effluent viz 0, 25, 50 75 percent were prepared from 100 percent concentration of effluent by adding tap water. Earthen pots filled with dry soil were prepared for separate treatment with Neem and cow dung. Three replications were maintained for each level of concentration of effluent. One set of earthen pot was arranged without applying any effluent (as control). Tap water was used in control. The pots were irrigated with respective concentrations of effluent and kept for 60 days. After a gap of 15, 30, 45 and 60 days, the root length, shoot length, fresh weight and dry weight were recorded.

Germination Percentage: Germination percentage of seed refers to the initial appearance of the radicle. It was calculated by using the following formula (Mahalingum et. al.2014).

$$Germination\ percentage = \frac{Number\ of\ seed\ germinated}{Total\ number\ of\ seed\ sown} \times 100$$

Effluent Tolerance Index (ETI): The effluent tolerance index was calculated using the formula determined by Turner & Marshal. 1972, Bhale. et. al. 2011.

$$ETI = \frac{Mean\ length\ of\ root\ \&\ shoot\ in\ effluent}{Mean\ length\ of\ the\ largest\ root\ \&\ shoot\ in\ the\ control}$$

3. Results and Discussion

The physicochemical characteristics of the collected effluent are presented in Table-2.

Table 2: Physico-Chemical characteristics of the effluents

S.N	*Parameters*	*Value*
1.	Colour	Brownish
2.	Temperature (Celsius)	33
3.	pH	7.93
4.	EC (µS)	1.68
5.	TDS (mg/l)	620
6.	BOD (mg/l)	288
7.	COD (mg/l)	408
8.	Alkalinity (mg/l)	48.8
9.	Chloride (mg/l)	2613.73
10.	Sulphate (mg/l)	68

The effluent had dark brown color and was alkaline in nature (pH 7.93). The electrical conductivity (EC) value and temperature were recorded as 1.68 µS/ cm and 33^{o}C. The values of BOD, COD, TDS, Alkalinity, chloride and sulphate of the collected effluent were determined as 288, 408, 620, 48.8, 2613.73 and 68 mg/L respectively. The values of BOD, COD and Chloride ions exceeded the ISI tolerance limit, which affect the water quality of receiving bodies and thus were found unfit for irrigation purpose.

The results of seed germination of the Abelmoschus esculentus are presented in table-3.

Table 3: Percentage seed germination with different effluent concentration

Effluent Concentration	*Germination Percentage*
Zero	83.33
25 (%)	86.66
50 (%)	80.00
75 (%)	76.66
100 (%)	70.00

The results show that 86.66 % seed germination was recorded with 25% effluent concentration, which is the highest percentage for the seed germination. The seed germination using control, 50, 75, and 100 % industrial effluent were recorded as 83.33, 80.00, 76.66 and 70 percent respectively. The use of 50 percent and higher concentration of the effluent shows that the germination percentage gradually declines. The results indicate that the lower concentration of the effluent had a marked germination promoting effect on the Abelmoschus esculentus while higher concentration of effluent had inhibiting effect in seed germination. Reduction in seed germination of the effluent is due to the higher amount of pollutant present in the effluent. The results for root length of Abelmoschus esculentus with sets of soil treatments with different effluent concentrations are shows in table-4.

Table 4: Root Length (mm/plant) of Abelmoschus esculentus grown under different concentrations with different soil treatments. (n=3. Mean ± SD)

Soil Treatment	*Effluents concentration*	*Age of the plants (days after sowing)*			
		15	*30*	*45*	*60*
Soil without treatment	0 %	52.6 ± 7.522	77.6 ± 5.131	93.3 ± 7.505	100.0 ± 3.464
	25 %	72.1 ± 10.774	98.3 ± 3.21	97.0 ± 6.557	92.3 ± 3.214
	50 %	78.6 ± 5.392	82.3 ± 3.511	84.6 ± 5.131	88.0 ± 1.802
	75 %	68.0 ± 3.122	71.6 ± 11.846	82.6 ± 4.725	87.1 ± 4.163
	100 %	51.6 ± 8.129	63.3 ± 19.139	75.0 ± 14.177	87.0 ± 2.783
Soil with cow dung treatment	0 %	52.5 ± 7.365	77.6 ± 4.932	93.8 ± 5.619	93.5 ± 8.231
	25 %	65.0 ± 19.467	95.6 ± 4.932	97.8 ± 5.204	98.1 ± 6.291
	50 %	61.3 ± 12.223	82.3 ±3.214	86.1 ± 4.509	87.8 ± 1.755
	75 %	60.5 ± 8.261	81.6 ± 4.041	86.1 ± 6.350	95.6 ± 3.329
	100 %	59.6 ± 1.040	70.0 ± 11.532	86.6 ± 9.865	90.3 ± 0.288
Soil with Neem treatment	0 %	56.3 ± 8.504	82.3 ± 3.511	97.0 ± 5.291	107.3 ± 7.234
	25 %	73.8 ± 13.613	147.3 ± 41.860	98.0 ± 12.165	110.1 ± 6.448
	50 %	79.5 ± 1.322	89.6 ± 11.015	86.3 ± 3.785	99.6 ± 2.843
	75 %	60.6 ± 17.243	72.0 ± 4.000	85.3 ± 7.751	98.0 ± 3.968
	100 %	60.6 ± 1.527	65.6 ± 10.408	85.6 ± 3.818	95.3 ± 15.50

The root length in soil without treatment was recorded the highest at 50 percent concentration for 15 days while the root lengths were recorded as highest with 25 percent concentration for 30, 45 and 60 days.

The highest root length in soil with cow dung treatment and Neem treatment were recorded at 25 percent effluent concentration for 15, 30, 45 and 60 days. The results for shoot length of Abelmoschus esculentus with different sets of soil and effluent concentration are shown in table-5.

Table 5: Shoot Length (mm/plant) of Abelmoschus esculentus grown under different concentrations of effluent with different soil treatments. (n=3. Mean ± SD).

Soil Treatment	*Effluents concentration*	*Age of the plants (days after sowing)*			
Soil without treatment		*15*	*30*	*45*	*60*
	0 %	45.0 ± 4.769	61.6 ± 7.637	107.0 ± 9.165	119.6 ± 23.115
	25 %	67.3 ± 4.618	85.3 ± 17.616	105.3 ± 9.504	138.3 ± 8.326
	50 %	64.6 ± 8.550	79.3 ± 11.676	99.3 ± 1.527	118.3 ± 14.511
	75 %	63.3 ± 9.814	58.6 ± 11.930	86.0 ± 18.734	126.6 ± 13.768
	100 %	52.3 ± 10.016	48.0 ± 28.213	93.0 ± 4.358	111.5 ± 12.031
Soil with cow dung treatment	0 %	48.0 ± 6.726	57.0 ± 4.358	114.3 ± 15.332	118.3 ± 5.346
	25 %	70.6 ± 1.258	79.0 ± 16.822	111.1 ± 10.598	144.3 ± 16.041
	50 %	58.8 ± 2.466	73.3 ± 2.309	97.0 ± 4.444	142.3 ± 42.253
	75 %	45.0 ± 15.716	60.6 ± 7.023	101.6 ± 9.385	138.3 ± 21.097
	100 %	52.0 ± 2.000	56.6 ± 4.163	94.5 ± 5.220	140.6 ± 21.031
Soil with Neem Treatment	0 %	50.1 ± 2.020	73.6 ± 7.767	114.0 ± 16.093	134.8 ± 49.614
	25 %	74.1 ± 2.020	102.6 ± 11.846	120.0 ± 1.500	174.8 ± 14.631
	50 %	69.5 ± 9.987	101.0 ± 19.284	101.0 ± 1.322	154.8 ± 21.426
	75 %	63.5 ± 6.062	78.6 ± 6.429	99.8 ± 2.020	156.0 ± 13.500
	100 %	57.6 ± 2.843	75.6 ± 8.962	96.0 ± 4.924	137.6 ± 33.126

The shoot lengths of the Abelmoschus esculentus were recorded as highest in all sets of soil at 25 percent effluent concentration for all 15, 30, 45 and 60 days except for the soil without treatment and the soil with cow dung treatment which showed the reduction in shoot length. The Effluent tolerance index (ETI) values for root and shoot are shown in table-6.

Table 6: Effluent Tolerance Index (ETI)

Soil Treatment	*Effluent concentration*		*Age of the plants (days after sowing)*			
			15	*30*	*45*	*60*
Soil without treatment	25 %	Root	1.37	1.26	1.03	0.92
		Shoot	1.49	1.38	0.98	1.15
	50 %	Root	1.49	1.06	0.90	0.88
		Shoot	1.43	1.28	0.92	0.98
	75 %	Root	1.29	0.92	0.88	0.87
		Shoot	1.40	0.95	0.80	1.05
	100 %	Root	0.98	0.81	0.80	0.87
		Shoot	1.16	0.77	0.86	0.93
Soil with cow dung treatment	25 %	Root	1.23	1.23	1.04	1.04
		Shoot	1.47	1.38	0.97	1.21
	50 %	Root	1.16	1.06	0.91	0.93
		Shoot	1.22	1.28	0.84	1.20
	75 %	Root	1.15	1.05	0.91	1.02
		Shoot	0.93	1.06	0.88	1.16
	100 %	Root	1.13	0.90	0.92	0.96
		Shoot	1.08	0.99	0.82	1.18
Soil with Neem treatment	25 %	Root	1.31	1.78	1.01	1.02
		Shoot	1.47	1.39	1.05	1.29
	50 %	Root	1.41	1.08	0.88	0.92
		Shoot	1.38	1.37	0.88	1.14
	75 %	Root	1.07	0.87	0.87	0.91
		Shoot	1.26	1.06	0.87	1.15
	100 %	Root	1.07	0.79	0.88	0.88
		Shoot	1.14	1.02	0.84	1.02

The highest effluent tolerance index values are recorded at 25 percent of effluent concentration and the effluent tolerance index generally decreased for root and shoot with increase in the effluent concentration. The fresh weight (Gram/Plant) of Abelmoschus esculentus is shown in table-7.

Table 7: Fresh weight (Gram/Plant) of Abelmoschus esculentus grown under different concentrations of effluent with different soil treatments. (n=3. Mean ± SD).

Soil Treatments	*Effluents concentration*	*Age of the plants (days after sowing)*			
		15	*30*	*45*	*60*
Soil without treatment	0 %	0.298 ± 0.092	0.289 ± 0.153	0.771 ± 0.313	1.093 ± 0.204
	25 %	0.522 ± 0.089	0.802 ± 0.069	1.121 ± 0.991	1.715 ± 0.256
	50 %	0.524 ± 0.158	0.627 ± 0.209	0.938 ± 0.046	1.178 ± 0.153
	75 %	0.537 ± 0.117	0.627 ± 0.209	0.794 ± 0.150	1.449 ± 0.413
	100 %	0.478 ± 0.248	0.549 ± 0.206	0.948 ± 0.143	1.717 ± 0.095
Soil with Cow dung treatment	0 %	0.319 ± 0.171	0.371 ± 0.145	0.914 ± 0.018	1.313 ± 0.100
	25 %	0.499 ± 0.077	0.775 ± 0.046	1.402 ± 0.511	2.216 ± 0.262
	50 %	0.562 ± 0.043	0.775 ± 0.138	1.133 ± 0.248	1.778 ± 0.735
	75 %	0.550 ± 0.122	0.696 ± 0.084	1.031 ± 0.162	1.829 ± 0.313
	100 %	0.580 ± 0.072	0.618 ± 0.103	1.004 ± 0.170	2.075 ± 0.544
Soil with Neem Treatment	0 %	0.364 ± 0.116	0.356 ± 0.112	0.803 ± 0.250	1.990 ± 0.278
	25 %	0.627 ± 0.025	0.934 ± 0.030	1.182 ± 0.149	2.004 ± 0.224
	50 %	0.605 ± 0.091	0.874 ± 0.035	1.028 ± 0.046	1.540 ± 0.279
	75 %	0.564 ± 0.236	0.648 ± 0.142	0.944 ± 0.068	1.802 ± 0.157
	100 %	0.445 ± 0.048	0.549 ± 0.206	0.932 ± 0.188	1.621 ± 0.252

The highest fresh weight was recorded at 75 percent effluent concentration for 15 days duration and at 25 percent effluent concentration for 30 and 45 and 60 days in soil set without treatment. In soil set with cow dung treatment the highest weight was recorded at 100 percent effluent concentration for 15 days but the fresh weight for 30, 45, 60 days was recorded highest with 25 percent of the effluent concentration. The highest fresh weight in soil set with cow dung treatment was recorded at 100 percent effluent concentration for 15 days and the highest value of fresh weight was recorded at 25 percent of effluent concentration for 30, 45 and 60 days. The best results for the fresh weight soil set with Neem treatment were recorded at 25 percent for all days. The dry weight (Gram/Plant) of Abelmoschus esculentus is shown in table-8.

Table 8: Dry Weight (Gram/plant) of Abelmoschus esculentus grown under different concentrations of effluent with different soil treatments. (n=3. Mean ± SD).

Soil treatments	*Effluents concentration*	*Age of the plants (days after sowing)*			
		15	*30*	*45*	*60*
Soil without treatment	0 %	0.085 ± 0.031	0.130 ± 0.071	0.187 ± 0.050	0.329 ± 0.089
	25 %	0.154 ± 0.053	0.351 ± 0.056	0.336 ± 0.103	0.412 ± 0.092
	50 %	0.137 ± 0.027	0.311 ± 0.027	0.305 ± 0.006	0.339 ± 0.062
	75 %	0.144 ± 0.020	0.309 ± 0.123	0.233 ± 0.123	0.310 ± 0.013
	100 %	0.145 ± 0.053	0.244 ± 0.100	0.305 ± 0.092	0.297 ± 0.016
Soil with cow dung treatment	0 %	0.093 ± 0.050	0.181 ± 0.070	0.286 ± 0.047	0.255 ± 0.050
	25 %	0.168 ± 0.025	0.372 ± 0.054	0.283 ± 0.039	0.538 ± 0.129
	50 %	0.164 ± 0.020	0.339 ± 0.061	0.294 ± 0.021	0.401 ± 0.127
	75 %	0.157 ± 0.030	0.341 ± 0.062	0.261 ± 0.142	0.383 ± 0.136
	100 %	0.148 ± 0.021	0.252 ± 0.052	0.294 ± 0.086	0.462 ± 0.137
Soil with Neem Treatment	0 %	0.138 ± 0.073	0.141 ± 0.061	0.202 ± 0.010	0.380 ± 0.115
	25 %	0.139 ± 0.016	0.551 ± 0.079	0.344 ± 0.057	0.440 ± 0.124
	50 %	0.168 ± 0.012	0.401 ± 0.009	0.259 ± 0.055	0.292 ± 0.027
	75 %	0.192 ± 0.081	0.273 ± 0.053	0.228 ± 0.055	0.361 ± 0.058
	100 %	0.125 ± 0.020	0.269 ± 0.147	0.311 ± 0.100	0.398 ± 0.014

The highest dry weight in soil set without treatment was recorded at 25 percent of effluent concentration for all days and in soil set with cow dung treatment the highest value was also recorded at 25 percent of effluent concentration except for 45 days which was found highest for 50 percent of effluent concentration. The highest dry weight in soil set with Neem treatment was recorded at 25 percent of effluent concentration for 30, 45 and 60 days and the highest value was recorded at 75 percent of effluent concentration for 15 days.

4. Conclusion

The present study shows that the mixed effluent which was collected from Okhla industrial area phase-II has considerable amount of pollutants which comes from various plastic-moulding, textile, dye, printing press, electroplating, paper, chemical industries etc. The study shows that the effluent has an adverse effect on seed germination and plant growth of the Abelmoschus esculentus at the higher concentrations of effluents. But low concentration of effluent is less toxic and found suitable for seed germination and growth. The study suggests that the appropriate dilution of the effluent can be made to reduce harmful effects at the time of germination and growth of the Abelmoschus esculentus.

Acknowledgement

Three of the authors namely Sajid Ali, Firoz Ali Ansari and Tabassum Akhtar sincerely acknowledge the financial support provided by University Grants Commission, India.

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