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E-mail: bjsir07@gmail.com

Effect of Industrial Effluents on the Germination and Seedling Growth of Three Leafy Vegetables

Shameem Ara Begum, M. Jahangir Alam, Syed Shayfur Rahman and M. Mizanur Rahman*

Department of Chemistry, Shahjalal University of Science & Technology, Sylhet 3114, Bangladesh

Abstract

This study was conducted to determine the effect of industrial effluents on seed germination and seedling growth of some leafy vegetables under pot culture condition. Waste water sample was collected from natural gas fertilizer factory Limited, Fenchuganj, Sylhet. Four different leafy vegetables were selected as test crop to grow using these effluents. The design of the experiment was randomized complete block. The effects of different concentration of effluent were compared to that of distilled water (control). The results revealed that different concentrations of the extract caused significant inhibitory effect on germination and root elongation but benefited the shoot elongation. Maximum reduction in germination and root length was observed with the increase in effluent concentration, but increasing the shoot length. Bioassays indicated that the effects were proportional to the concentrations of the effluents and higher concentration showed stronger effect. Different physicochemical parameters of water e.g. pH, temperature, conductivity, dissolved oxygen (DO), chemical oxygen demand (COD), turbidity, Total dissolve solids (TSS), total suspended solids (TSS) etc. of the sample was also analyzed. It was found that the values were far apart from the optimum values that require for safe aquatic environment to establish an aquatic ecosystem on water body. It can be concluded that polluted water is becoming a threat for the crops and also for aquatic environment with the passage of time as more and more wastes are becoming a part of it.

Key words: Industrial effluents, Aquatic environment, Seed germination, Seedling growth, Pollution.

Introduction

Environmental pollution is a matter of great concern and has been accepted as a global problem because of its adverse effects on human health, plants, animals, and exposed materials (Irshad *et al*, 1997). Usually the industries, through their effluents pollute different water bodies e.g. river, canal sea etc. Pollutants may be toxic organic and inorganic or dissolve and suspended solids (Moeller *et al*, 1992). Water pollution is a result of addition of large amount of toxic materials (Terry, 1996). The major causes of water pollution can be classified as municipal, agricultural and industrial wastes. Industrial wastewater usually contains specific and readily identifiable chemical compounds (Benard *et al*, 1998). The effluents generated by various processes in industries are directly discharged without any treatment into the nearby water body. This results in increase or decrease of water pH and an increase of temperature, biological oxygen demand (BOD), chemical oxygen demand (COD), heavy metals and toxic chemicals (Santiniketan, *et al*, 1994). Effluents released with high temperature can raise the temperature of the water body, thus reducing the solubility of oxygen in the water. It also increases the pH value of the receiving body. The colloidal particle in the wastewater will increase the turbidity (Antonelli *et al*, 1999). Most of the industries of Bangladesh dispose wastewater without any treatment. Objective of this research was to determine the effect of industrial effluents on seed germination, for which wastewater sample was collected from Natural Gas Fertilizer Factory Limited, Fenchuganj, Sylhet. The germination of red *amaranth* (*Amaranthus tricolor*), *amaranth stem* (*Amaranthus gangeticus*), mustard (*Brassica campestris*), radish (*Raphanus sativus*) seeds were imposed under the influence of industrial effluents.

Materials and Method

The present study was conducted with five different concentrations (treatments) of wastewater collected from natural gas fertilizer factory limited, Sylhet. The treatments were made by dissolving calculated amount of waste water in distilled water i.e. control, 25, 50, 75 and 100%. The following treatments were used in the experiments: T_0 = seeds of

* Corresponding author: E-mail: mizan_sust@yahoo.com

receptor plants grown in distilled water only (control), T_1 = seeds of receptor plants grown in fruits extracts of 25% concentration, T_2 = seeds of receptor plants grown in fruits extracts of 50% concentration, T_3 = seeds of receptor plants grown in fruits extracts of 75% concentration, T_4 = seeds of receptor plants grown in fruits extracts of 100% concentration.

The germination test was carried out in sterile petridishes having 12 cm in size placing whatman no. 40 filter paper on it. Each concentration of effluent was added to each petridish of respective treatment daily in such an amount just to allow the seeds to get favorable moisture for germination and growth. The control was treated with distilled water only. 20 seeds of each type of seed were placed in the petridish at room temperature (26±2)^{o}C. The experiment extended over a period of 7 days to allow the last seed germination and measurement of the root and shoot length. The results were determined by counting the number of germinated seeds and measuring the length of primary root and main shoot on the 7th day of the experiment.

The ratio of germination and elongation were calculated as suggested by (Haque *et al*, 1971).

Relative germination ratio (RGR) = (mean germination of tested plant ÷ germination rate of control) × 100.

Relative elongation ratio (RER) of shoot = (mean shoot length of tested plant ÷ mean shoot length of control) × 100. Relative elongation ratio (RER) of root = (mean root length of tested plant ÷ mean root length of control) × 100.

Effluent taken from industry was subjected to different tests for analysis. Standard methods (Bazai *et al*, 2006) were used to determine pH, conductivity, and total solids, dissolved solids, suspended solids, DO (Dissolve oxygen), BOD (Biological oxygen demand), COD (Chemical oxygen demand). The data were analyzed statistically and the difference between means were compared by LSD followed by DMRT (Duncun, 1957).

Results and Discussion

The out come of the analysis of physiochemical parameter is shown in the Table I. We found that the values were far apart from the optimum values that require in safe aquatic environment to establish an aquatic ecosystem on water body.

Due to degradation in water quality, it became a concern when population growth and industrial development produces a concentration of society's wastes that imperiled public health. Industrial effluents of fertilizer industry contain fertilizer as a waste, which may cause for the increasing shoot length. In addition, fertilizer industry effluent contains many anionic species, which can be beneficial for plant growth but its excessive level could be toxic, retard the growth of the plants. Fertilizer industry effluent may also contain ammonia that might play a role in enhancement of plant growth. Industrial effluents, present in waste water from manufacturing or chemical processes contribute to water pollution, which significantly affect the entire food chain (Howard *et al*, 1985). For the agriculture sector pH value take an important role in plant growth. The standard pH value needed for agriculture is 7-8. If the pH value is higher than standard value then it affects the plant growth. The pH value of industrial effluent was 8.67, this may be the reason for decreasing root length (Nawaz S., 2006). The temperature of industrial effluent is greater than room temperature. The high temperature reduces the solubility of oxygen in the water.

Table I. Physiochemical parameters of water containing industrial effluent collected from natural gas fertilizer factory limited, Fenchugang

Parameters	Result	Optimum values **	
		USPH Standard *	WHO *
Temperature (ºC) Color,	28		
Odor, Taste		Colorless, Odorless, tasteless	
pH	8.67	6.0 - 8.5	6.5 - 9.2
DO	0.93(g/L)	4.0 - 6.0 ppm	4.0-6.0 ppm
BOD	0.5(g/L)	5 ppm	6 ppm
COD	41.33(g/L)	4.0 ppm	10 ppm
Conductivity (µs/cm)	616	300	300
Total dissolve solid	11(g/L)	500 ppm	500 ppm
Total solid	146(g/L)		
Suspended solids (gm/L)	135(g/L)	5.0 ppm	5.0 ppm

* USPH: United States Public Health. WHO: World Health Organization **(source: Agarwal *et al*, 1996)

As a result, fish and plant in the water can be affected (Ramamoorthy, *et al*, 1992).

The data presented in Table II revealed the effect of industrial effluent on seed germination. The germination of mustard (Brassica campestris) was stimulated by varying doses of applied effluent. Maximum germination was noted in T4 (100%) and a minimum in T_0 (control).

Table II. Effect of industrial effluent on the germination of some leafy vegetables grown in pot condition

Treatment	Receptor Plant							
	Mustard *B. campestris*		Amaranth stem *A. gangeticus*		Radish *R. sativus*		Red amaranth *A. tricolor*	
	RGR	PIE	RGR	PIE	RGR	PIE	RGR	PIE
T_0	65	0.00	100	0.00	85	0.00	100	0.00
T_1	75	+15.38 a	75	-25.00a	85	+0.00a	90	-5.26a
T_2	80	+23.08 b	80	-20.00b	95	+11.76b	85	-10.53b
T_3	80	+23.08 b	75	-25.00c	85	+0.00a	80	-15.79c
T_4	95	+46.15 c	70	-30.00	80	+-5.88b	80	-15.79c
Mean	-	26.92	-	25.00	-	13.23	-	11.84
LSD (5%)		3.99						

Within column, values followed by same letter(s) did not differ significantly at 5% level by DMRT. Here, RER = Relative elongation ratio, PIE= Percent of inhibitory effect (-ve sign indicates inhibitory effect and +ve sign means stimulation)

The germination rate of mustard (*Brassica camestris*) increases with increasing concentration of effluent. The Relative germination rates of the amaranth stem (*Amaranthus gangeticus*) were noted maximum in T_0 (100%) and minimum in T_4 (70%). That means the germination rate is almost inhibited with increasing concentration. Similar data were also observed in the case of red amaranth (*Amaranthus tricolor*). The Relative germination rate of was noted maximum in T_0 (100%) and minimum in T_4 (80%). That means the germination rate is decreasing with increasing the concentration of industrial effluent. These results are correlated with the findings obtained by Bazai *et al* (2006), (Nawaz *et al*, 2006)

Table III represents relative shoot elongation ratio of the germinated seeds. The relative shoot elongation ratio of the germinated seeds increased with increasing concentration effluent. Highest stimulation observed in the case of radish (*R. sativus*) at T_4 treatment (+51.60%). Lowest stimulation was observed in the case of mustard (*Brassica campestris*). Nevertheless, for the red amaranth (*Amaranthus tricolor*), the average shoot length is almost same for all concentration but greater than the average shoot length of T_0 (control). Similar results were also reported by (Ramamoorthy *et al*, 1992).

Table IV represents average root length (cm) of the germinated seeds. The average root length of mustard (*Brassica campestris*), amaranth stem (*Amaranthus gangeticus*) and radish (*Raphanus sativus*) are decreased with increasing concentration. Maximum inhibition was observed in the

Table III. **Effect on shoot elongation ratio of the germinated seeds**

Treatment	Receptor Plant							
	Mustard *B. campestris*		Amaranth stem *A. gangeticus*		Radish *R. sativus*		Red amaranth *A. tricolor*	
	RGR	PIE	RGR	PIE	RGR	PIE	RGR	PIE
T_1	105.34	+5.34a	123.23	+23.23a	130.32	+30.32a	110.24	+10.24a
T_2	105.43	+11.07b	105.33	+29.80b	139.01	+39.01b	116.27	+16.27b
T_3	108.25	+20.23c	107.00	+38.89c	144.86	+44.86b	116.27	+16.27b
T_4	103.65	+24.62c	101.82	+41.41c	151.60	+51.60c	118.67	+18.67b
Mean	-	5.67	-	9.34	-	41.45	-	15.36
LSD (5%)		4.07						

Within column, values followed by same letter(s) did not differ significantly at 5% level by DMRT. Here, RER = Relative elongation ratio. PIE= Percent of inhibitory effect. (-ve sign indicates inhibitory effect and +ve sign means stimulation).

Table IV. Effect on root elongation of the germinated seeds

Treatment	Receptor Plant							
	Mustard *B. campestris*		Amaranth stem *A. gangeticus*		Radish *R. sativus*		Red amaranth *A. tricolor*	
	RER	PIE	RGR	PIE	RGR	PIE	RGR	PIE
T_1	87.88	-12.12a	72.92	-27.08a	95.93	-4.07a	80.41	-19.59a
T_2	66.88	-33.12b	58.98	-41.02b	94.70	-5.30a	80.41	-19.59a
T_3	61.65	-38.35c	55.50	-44.50b	82.48	-17.52b	86.15	-13.85b
T_4	44.51	-55.49d	48.26	-51.74c	81.47	-18.53b	90.54	-9.46b
Mean	-	34.77	-	41.08	-	11.36	-	15.62
LSD (5%)		5.70						

Within column, values followed by same letter(s) did not differ significantly at 5% level by DMRT. Here, RER = Relative elongation ratio. PIE= Percent of inhibitory effect. (-ve sign indicates inhibitory effect and +ve sign means stimulation).

case of mustard (*Brassica campestris*) at T_4 (-55.49%). Minimum inhibitory effect was observed in the case of radish (*Raphanus sativus*) at T_1 (-4.07%). These results are in accordance with the results obtained by Rao *et al.*(1983).

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