Journal of Environmental Biology **January 2006,** 27(1) 153-156 (2006)

Impact of fertilizer factory effluent on seed germination, seedling growth and chlorophyll content of gram (*Cicer aeritenum*)

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(Received: 7 June, 2004 ; Accepted: 25 October, 2004)

Abstract : *In the present study effect of fertilizer factory effluent on seed germination, seedling growth and chlorophyll content of gram (Cicer aeritenum) has been carried out, at different concentration of the effluent and time intervals. The effluent is alkaline in nature with strong ammonia odour. The germination percentage of seed, seedling growth and chlorophyll content showed a gradual decline with increase in effluent concentration. At 25% concentration of the effluent, growth promotion in terms of root, shoot length and increase in chlorophyll content recorded at 21days. However, at higher concentrations of the effluent toxic effects were observed at 21days. The study suggests that the effluent can be used safely for Cicer aeritenum cultivation, only after proper treatment and dilution.*

Key words : *Chlorophyll a and b, Fertilizer factory, Effluent, Seed germination, Seedling growth.*

Introduction

The increasing pressure of more and more food production to feed the geometrically growing population throughout the world can be met only through the intensification of agriculture, which requires high yielding varieties, with high input of water and fertilizer. Fertilizer industry is one of the major water consuming industry, responsible for water and soil pollution of considerable magnitude (Sundaramoorthy *et al.,* 2001). Industrial effluents are constantly adding up toxic substances into the ground water reservoir at a very high rate, especially in industrial zones. Many regions all over the globe are heavily depending on ground water for various purposes (Babiker *et al.,* 2004). Ground water contamination by nitrate is a growing problem all over the world, due to intensive use of nitrogenous fertilizers in agriculture (McLay *et al.,* 2001). Considerable literature is available on the effect of fertilizer factory effluent on seed germination and seedling growth of crop plants (Adhikary *et al.,* 1992; Agarwal and Hemlata, 1992; Goswami, 1993; Singh, 1994). Since most of the wastewater is being discharged into the surrounding water bodies, which disturbs the ecological balance and deteriorates the water quality, therefore, present research work has been carried out to study the impact of fertilizer factory effluent at different concentrations and duration of exposure to seed germination and seedling growth of *Cicer aeritenum*.

Materials and Methods

Effluent samples were collected in plastic container of 5-liter capacity from the point of discharge, close to the effluent treatment plant (E.T.P.), of fertilizer factory situated at Jagdishpur, Sultanpur district, Uttar Pradesh. All the container tightly capped and carefully brought to laboratory under cold conditions, for physicochemical analysis, methodology of (APHA, 1995) were followed. The seeds of gram (*Cicer aeritenum)* were purchased from registered seed center at Faizabad and treated with 0.2N mercuric chloride for 2 minute and washed with running water to remove contamination of seed coat, prior to germination studies. Sterilized petriplates prepared with cotton bed and a known volume of different concentration of fertilizer factory effluent (10, 25, 50, 75, and100 percent) was poured into different petriplate. All the seeds, germinated and grown in distilled water served as control. Each treatment including control was performed in triplicate and for every petriplates twenty seeds were used. The petriplates were kept in an incubater and were maintained under standard aseptic physiological conditions at 25±0.5ºC temperature, 16 hrs light (1600 Ft.C fluorescent Philips tubes), and eight hours dark cycle. The numbers of seeds germinated in each treatment

Table – 1: Physicochemical charcteristics of fertilizer factory effluent (mg/l).

S.No.	Parameters	Values
1	Colour	Light Brown
2	Odour	Ammonia
3	Temperature ºC	25 ±1.5
4	pH	7.48±0.30
5	E.C.(u mos/ cm)	9.6±0.15
6	Dissolved solids	380±3.60
7	Suspended solids	150±0.05
8	Dissolved oxygen	2.08±0.01
9	Biological oxygen demand	35±2.51
10	Chemical oxygen demand	310±2.15
11	Total nitrogen	52±3.05
12	Total phosphate	20±2.64
13	Sulphate	70±3.78
14	Chloride	81±3.00
15	Calcium	64±2.01
16	Magnesium	31±2.06

Values are arithmetic mean ± SE of three replicates.

Table – 2: Germination percentage of *Cicer aritenum* in control and fertilizer factory effluent at different time intervals.

S.NO.	Effluent concenration																							
	Control				10%				25%				50%				75%				100%			
	Time in hrs.				Time in hrs.				Time in hrs.				Time in hrs.				Time in hrs.				Time in hrs.			
	Seed sown	2 hrs G	96hrs G	Total G	Seed sown	72hrs G	96hrs G	Total G	Seed sown	72hrs G	96 hrs G	Total G	Seed sown	72hrs G	96hrs G	Total G	Seed sown	72hrs G	96 hrs G	Total G	Seed sown	72hrs G	96hr G	Total G
1	20	18	0	18	20	16	3	19	20	20	0	20	20	20	0	20	20	20	0	20	20	10	0	10
2	20	19	0	19	20	18	2	20	20	20	0	20	20	20	0	20	20	15	1	16	20	6	1	7
3	20	18	0	18	20	19	1	20	20	20	0	20	20	15	0	15	20	18	1	19	20	9	0	9
4	20	12	8	20	20	15	0	15	20	18	0	18	20	17	0	17	20	12	3	15	20	6	3	9
5	20	15	0	15	20	10	1	11	20	17	1	18	20	18	1	19	20	15	2	17	20	7	5	12
Total%	100%	82%	8%	90%	100%	78%	7%	85%	100%	95%	1%	96%	100%	90%	1%	91%	100%	80%	7%	87%	100%	38%	9%	47%

G=Germination percentage.

Table – 3: Changes in chlorophyll a, b and total content of *Cicer aritenum* at different time intervals exposed to fertilizer factory effluent.

	7 Days			14 Days			21 Days		
Treatment	Chlorophyll a	Chlorophyll b	Chlorophyll Total	Chlorophyll a	Chlorophyll b	Chlorophyll Total	Chlorophyll a	Chlorophyll b	Chlorophyll Total
Control	1.731±0.014	0.165±0.015	1.567±0.025	2.427±0.019	0.317±0.012	2.575±0.20	3.012±0.052	0.489±0.025	3.46±0.050
10%	1.376±0.003	0.091±0.010	1.357±0.025	2.061±0.079	0.219±0.063	2.165±0.071	2.801±0.169	0.327±0.045	2.875±0.065
25%	5.066±.055**	8.279±.008**	13.160±.046**	8.095±.006**	10.68±.541**	18.54±.055**	11.41±.419**	12.65±.541**	23.42±.527**
50%	3.069±0.003	1.364±0.09	4.314±0.003	5.226±0.078	2.329±0.106	7.432±0.073	6.773±0.0447	3.520±0.240	10.154±0.402
75%	2.022±0.016	0.750±0.011	2.583±0.015	3.168±0.028	1.148±0.097	4.015±0.025	5.341±0.840	1.974±0.211	7.215±0.842
100%	1.190±.047*	0.144±.012*	1.175±.045*	1.110±.062*	0.212±.024*	1.154±.061*	1.859±.221*	0.369±.082*	2.157±.241*

Values are arithmetic mean± of three replicates.
*p<0.01
**P<0.001

Table – 4: Changes in root and shoot length of *Cicer aeritenum* exposed to fertilizer factory effluent at different time intervals (cm/seedling).

	Days of exposure					
	7 days		14 days		21 days	
Treatment	**Root**	**Shoot**	**Root**	**Shoot**	**Root**	**Shoot**
Control	9.8±.36	15.3±.200	13.06±.251	21.36±.351	15.26±.305	23.96±.251
10%	8.23±.152	13.26±.251	14.23±.251	23.4±.300	17.46±.152	26.36±.305
25%	12.46±.321**	17.13±.152**	18.26±.320**	26.5±.360**	21.5±.435**	32.43±.305**
50%	10.7±.001	14.3±.200	16.16±.240	25.3±.001	19.1±.100	29.13±.152
75%	9.23±.251	12.33±.321	12.26±.251	16.26±.152	14.33±.208	21.7±.200
100%	7.13±.251*	10.3±.105*	10.36±.305*	15.5±..300*	37.4±.351*	19.2±.251*

Values are arithmetic mean ±SE of three replicates

were counted on 7th, 14th, 21st days of the experiment and the germination percentage was calculated. Growth of root, shoot and seedling was measured with the help of meter scale and chlorophyll content estimated following the method of Arnon (1949) using UV-VIS Spectrophotometer 117 model.

Results and Discussion

The physicochemical characteristics of effluent are presented in Table 1. The effluent was light brown in colour, alkaline in nature and contained large amounts of suspended and dissolved solids. It contains considerable amount of nitrogen, chloride, sulphate, calcium, and magnesium. Fertilizer factory posses environmental problems due to discharge of effluents consisting of higher pH, EC, BOD, COD, TDS, total nitrogen, phosphate and sulphate content. The higher EC alters the chelating properties of receiving water system, which create conditions for free metal availability to flora and fauna (Nanda *et al.,* 1999).

The percentage of seed germination on exposure of different concentration and duration (24, 48, 72 and 96 hrs) was recorded in Table 2. The maximum seed germination was recorded at 25% and minimum at 100% of effluent concentrations, as compared to control. At 25% of effluent concentration, increase in root and shoot length is highly significant ($p<0.001$) at 7th, 14th and 21st day, whereas at 100% of effluent concentration, significant decrease ($p<0.01$) in length of root and shoot was recorded at 7th, 14th and 21st days as compared to control, Table 4.

Data of chlorophyll content at different duration of exposure and concentration of effluent is represented in Table 3. At 25% of effluent concentration, increase in chlorophyll a, b and total chlorophyll is highly significant ($p<0.001$) at 7th, 14th and 21st days interval whereas at 50% of effluent concentration, highly significant increase ($p<0.001$) in chlorophyll a, b and total chlorophyll is recorded at 14th day interval only. At 100% of effluent concentration over all decrease in chlorophyll content was recorded at all the time intervals but significant decrease ($p<0.01$) was at 7th, 14th and 21st days time intervals as compared to control. The exposure of lower concentration of effluent to the seedling shows growth promotion, over all development of the seedling and chlorophyll content. Reduction in seed germination percentage at higher concentration of effluent may be due to the higher amount of solids present in the effluent, which causes changes in the osmotic relationship of the seed and water. Thus reduction in the amount of water absorption takes place, which results into retardation of seed germination due to, enhanced salinity. The salt concentration, out side of the seed is known to act as limiting factor and it might be responsible for delay in germination (Adraino *et al.,* 1973). The other possibility of reduction in germination percentage at higher concentration of effluent may be due to presence of excess amount of ammonia in effluent, causing depletion of the Tricarboxylic acid cycle, which reduces the respiration rate and subsequently germination (Kirkby, 1968). According to Saxena *et al.* (1986) the low amount of oxygen in dissolved form due to the presence of higher concentration of solid in the effluent, reduces the energy supply through anaerobic respiration resulting in restriction of the growth and development of the seedling.

The effect of fertilizer factory effluent on seed germination, seedling growth on *Vigna radiate, Arachis hypogea, Glycine max, Oryza sativa* and *Sorghum bicolor* was investigated by Sundaramoorthy *et al.* (2000) and found that the percentage of germination and seedling growth was maximum in the 10% diluted effluent than the control, while undiluted effluent elicited an inhibitory effect, due to excess amount of solid present in effluent. Under the higher concentration of effluent treatment, germinating seeds would get low of oxygen, which restricts the energy supply and retards the growth and development of seedling (Hadas, 1976). Subramani *et al.* (1998) reported a progressive decrease in seedling growth with the increasing concentration of fertilizer factory effluent. Similar finding have been reported by Mishra and Bera, (1996) the lower concentration of tannery effluent had a marked growth promoting effect while higher concentration of effluent showed reduction in seed germination, seedling growth and chlorophyll content in some crops. The inhibition of chlorophyll synthesis probably results from the Cu-induced inhibition of ALA-dehydratase reported by Scarponi and Perucci (1984). Izawa (1977) suggested that the inhibition of chlorophyll may be due to the induced inhibition of Electron Transport System in PS-Π. The significant fall in the chlorophyll content under the higher percentage of effluent concentration might have been due to inhibitory effect of toxicants of effluent on chlorophyll synthesis in exposed plant.

Acknowledgements

Authors are grateful to Ministry of Environment and Forests, New Delhi, India, for financial assistance to carryout the research work.

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