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Full Length Research Paper

Impact of Brewery-Distillery Effluent on Germination, Seedling growth and Pigments of *Cicer arietinum* L. Variety GNG1958

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Abstract
The study was conducted to find the impact of different concentrations of untreated and treated Brewery-Distillery effluent on germination, seedling growth parameters and pigments of Cicer arietinum L. var. GNG1958. It was observed that percent germination was 70% in untreated and 90% in treated effluent whereas percent inhibition was 27% in untreated and 7% in treated effluent at 25% concentration. The seedling length (19.8 cm), fresh weight (0.680 g) and dry weight (0.127 g) were maximum at 25% treated effluent concentration and minimum at 50% untreated effluent as there was no germination at 75% and 100% untreated effluent. The chlorophyll and carotenoid showed a gradual decline with increase in effluent concentration with maximum value at 25% treated effluent.

Key words: *Chlorophyll, Distillery, Effluent, Germination, Growth, Plant*

Introduction

Environmental degradation has become a global phenomenon. Industrialization boosts the economy of the country on one hand and on the other hand acts as threat to environment. Among the various kinds of pollution, the water pollution is the serious problem in India. Increasing number of distilleries in India has resulted into substantial increase in industrial pollutant load. Among various industries, molasses based industries (distilleries) occupy a prominent place in Indian economy (Malaviya and Sharma, 2011b). In general, the wastewater (spent wash) has a high organic load (50,000 mg L^{-1} BOD and 95,000 mg L^{-1} COD) with high electrical conductivity (15 dS m^{-1}) and acidic pH (pH 4.0 to 5.4). The distillery spent wash is a rich source of organic matter and nutrients like nitrogen, phosphorus, potassium, calcium and sulphur, which may have a beneficial effect on crop yields (Ramana *et al.,* 2002). In India, the use of distillery wastewater in agriculture is popular since the inception of the industry. The use of the effluent as a substitute for irrigation water over the years has also led to the realization of its fertilizer potential (Malaviya and Sharma, 2011a). In the present study, effort has been made to study the impact of untreated and treated combined Brewery-Distillery effluent on seed germination, seedling growth parameters and pigment content of *Cicer arietinum* L. variety GNG1958.

Materials and Methods

Seeds of *Cicer arietinum* L. variety GNG1958 were used in the present experiment. The untreated and treated Brewery-Distillery Effluent used in the present study were collected in pre-cleaned containers on weekly basis from M/S Dewans Breweries Ltd. (Brewers and Distillers) located at Talab Tillo, Jammu. The industry was established in 1961 and its present production capacity is 1 lakh bottles per day. The raw materials used were malt, rice or rice flakes, sugar, hops and yeast. The effluent was allowed to settle overnight in a shallow and large trough to minimize the possibility of clogging. Various physicochemical characteristics of the effluent samples were analyzed using standard methods (APHA, 1998).

Experimental Set-up and Experimental Process

The experimental set up was arranged in the Department of Environmental Sciences, University of Jammu, Jammu. Five treatment sets were made, set-1 was taken as control in which tap water was used for irrigation and for set 2, 3, 4 and 5 different concentrations of untreated and treated Brewery-Distillery effluent viz. 25%, 50%, 75% and 100%, respectively were used. Petri plates were prepared by placing sterilized absorbent cotton layer in it. The cotton was moistened with 50 ml of tap water for control and with the same quantity of various concentrations of Brewery-Distillery effluent (25%, 50%, 75% and 100%). Seeds were treated in antifungal solution and washed thoroughly with distilled water before using for experiment. The ten seeds of *Cicer arietinum* L. variety GNG1958 were sown in the petri plates in triplicate. The petri plates were incubated at 25±1^{0}C in a BOD incubator. Germination was recorded daily at a fixed hour and the emergence of the radical was taken as a criterion of germination. Number of seeds germinated per day was counted until the germination of seeds became constant. Germination Index (GI) was calculated by the formula given by Zucconi *et al*. (1981), Delay Index (DI) by following the methodology modified after Kaushik *et al*. (2005), and Vigour Index by Abdul Baki and Anderson (1973). Similarly, some other parameters like percent inhibition, germination value, peak value, speed of germination time were also estimated using formulae adopted from Rao *et al*. (1993) and Czabator (1962). Root and shoot length were measured by using a scale. Root/ Shoot Ratio were calculated in terms of biomass (dry weight). Pigment content like Chlorophyll a,

Chlorophyll b and Total Chlorophyll were measured by the methodology described by Arnon (1949) and carotenoid was calculated by the equation given by Duxbury and Yentsch (1956).

Results and Discussion

Various physicochemical characteristics i.e. pH, electrical conductivity, turbidity, total suspended solids (TSS), chemical oxygen demand (COD), chloride, sodium, nitrate and calcium of untreated and treated Brewery-Distillery effluent were measured. The pH of untreated effluent was acidic (3.51) and it was slightly alkaline (7.46) in treated effluent. Turbidity of untreated and treated effluent was 240 NTU and 004 NTU, respectively. For untreated effluent, the values of TSS (1899 mg L^{-1}) and COD (5280 mg L^{-1}) exceeded CPCB discharge standards (1998) while chloride (454 ppm) was found to be within permissible limits. The values of all other parameters were found to be higher in untreated as compared to treated effluent. The effect of Brewery-Distillery effluent on various germination parameters of *Cicer arietinum* L. var. GNG1958 are shown in Table-1.

Table 1: Effect of different concentrations of untreated and treated Brewery-Distillery effluent on different germination parameters of *Cicer arietinum* L. variety GNG1958

Treatments	Germination percentage	Peak value	Germination value	Germination index	Speed of germination	Vigour index	Delay index	Percent Inhibition
Control (E_0)	97	45	4050	_	10	1818	_	_
Untreated Effluent (UE)[1]								
UE_{25}	70	11.66	812	10.5	7	238	2	27
UE_{50}	20	3.33	66.6	2.75	1	36	_	77
UE_{75}	0	2.85	57	_	0.5	_	_	77
UE_{100}	0	2.85	57	_	1	_	_	77
Treated Effluent (TE)[2]								
SE_{25}	90	40	3200	81.6	9	1532.3	1	7
SE_{50}	90	30	2700	62.1	9	1386	1	7
SE_{75}	80	25.66	2025	27	8	1382	1	17
SE_{100}	77	25.5	1975.8	18.4	8	528	1	20

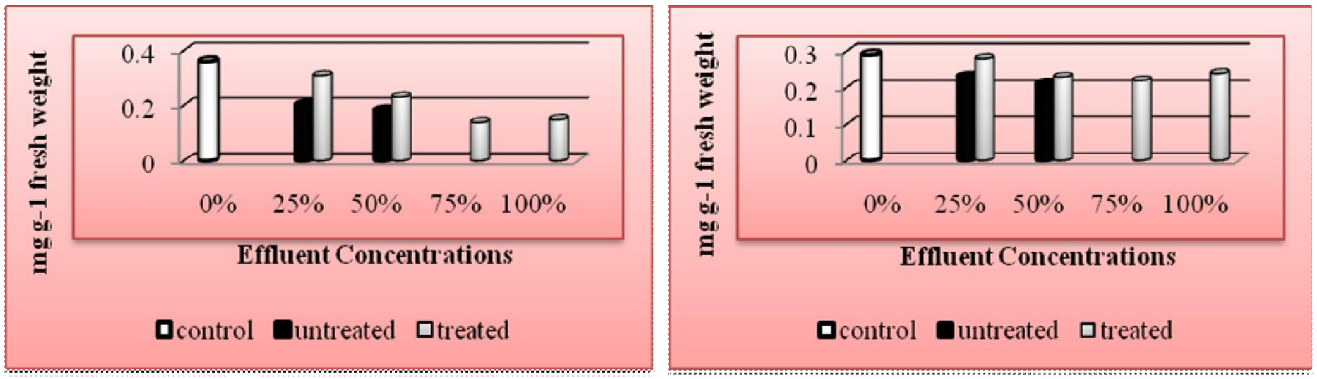
[1] *UE_{25}, UE_{50}, UE_{75}, UE_{100}: 25, 50, 75 and 100% untreated effluent, respectively*
[2] *TE_{25}, TE_{50}, TE_{75}, TE_{100}: 25, 50, 75 and 100% treated effluent, respectively*

It was observed that maximum values for all positive germination parameters i.e. cumulative percent germination (90), peak value (40), germination value (3200), germination index (81.6), speed of germination (9) and vigour index (1532.3) were found in 25% treated effluent and then decreased with the increase in effluent concentration. The maximum values for negative germination parameters like delay index (0) and percent inhibition (77) were found in all the three concentrations of untreated effluent i.e. 50%, 75% and 100%, which shows that the higher effluent concentration was toxic for the seeds as they were not even able to germinate in 75 and 100% concentration. The seeds take up water during germination in order to hydrolyze the stored food material and to activate their enzymatic systems. As absorption takes place by osmosis, the salt content outside the seeds may act as a limiting factor which might be responsible for the delay in germination (Malaviya *et al*. 2012). Similar results were found by Pandey *et al*. (2007) who studied the effect of various concentrations of treated distillery effluent on germination, speed of germination, peak value and germination value of wheat (*Triticum aestivum*), pea (*Pisum sativum*) and lady finger (*Abelmoschus esculentus*). Germination percentage decreased with increasing concentration of effluent, whereas the germination speed, peak value and germination value increased at 50% concentration and decreased thereafter. Our study is also consistent with the findings of Malaviya and Sharma (2011b) who found that the untreated distillery effluent at lower concentration (20%) favored the germination of *Brassica napus* L.

The effects of Brewery-Distillery effluent on various growth parameters of *Cicer arietinum* L. var. GNG1958 are shown in Table-2 which depicts a decreasing trend with increase in effluent concentration for all the parameters (root length and shoot length, fresh and dry seedling weight, dry root and shoot weight and root-shoot ratio). The maximum values were observed at 25% treated effluent whereas minimum values were revealed at 50% untreated effluent as there was no germination in 75% and 100% untreated effluent concentrations. The maximum values of all these parameters like root length (7.8 cm), shoot length (12 cm), fresh seedling weight (0.680 g) and dry seedling weight (0.127 g) were found in 25% treated effluent which were higher than the values shown by 25% untreated effluent. Similar study on *Capsicum annum* L. var. Agnirekha done by Malaviya *et al*. (2007) observed that distillery effluent showed positive impact on all the growth parameters at lower effluent concentration and then decreased with increase in effluent concentration. The better growth at 25% effluent concentration may be attributed to the growth promoting effect of nitrogen and other mineral elements present in the effluent.

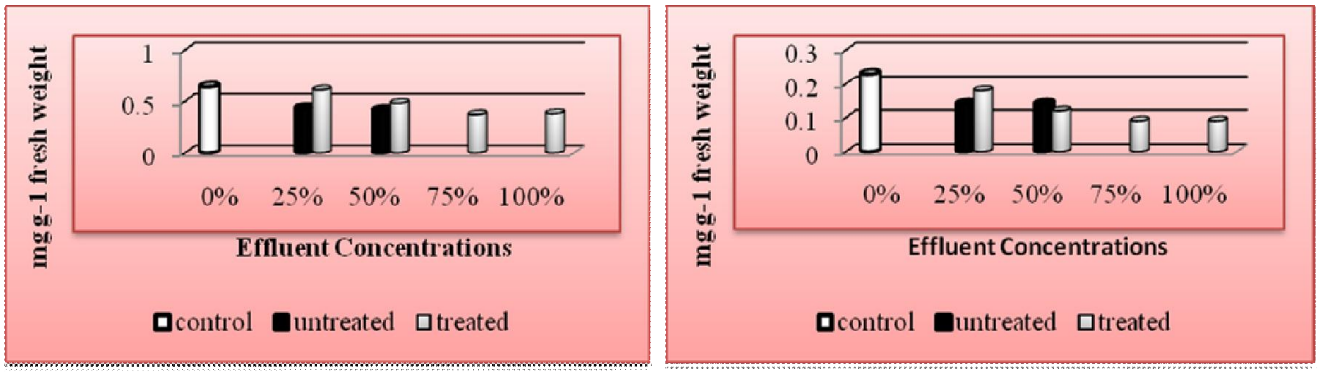
The chlorophyll a, chlorophyll b, total chlorophyll and carotenoid concentrations are shown in the Figure 1 (a and b) and Figure 2 (a and b). The maximum values of pigments in untreated effluent were observed in 25% concentration and minimum in 50% effluent. In

treated effluent, the maximum values of the pigments like chlorophyll a (0.31 mg g^{-1} fw), chlorophyll b (0.28 mg g^{-1} fw), total chlorophyll (0.61 mg g^{-1} fw) and carotenoid (0.18 mg g^{-1} fw) were obtained in 25% concentration which decreased gradually with increase in concentration showing lowest value at 100% effluent.



Chlorophyll **Chlorophyll b**

Fig 1: Effect of different concentrations of untreated and treated Brewery-Distillery effluent on Chlorophyll a and Chlorophyll b of *Cicer arietinum* L. variety GNG1958.



Total Chlorophyll **Carotenoids**

Fig 2: Effect of different concentrations of untreated and treated Brewery-Distillery effluent on Total Chlorophyll and Carotenoids of *Cicer arietinum* L. variety GNG1958.

The results of our study are consistent with that of Karunyal *et al*. (1994), who observed that tannery effluent stimulates the synthesis of chlorophyll in *Gossypium hirsutum, Vigna mungo, Vigna unguiculata* and *Lycopersicon esculentum* at lower effluent concentration (25%) which decreased with increase in effluent concentration. Narain *et al*. (2012) also reported that the chlorophyll a, chlorophyll b and total chlorophyll contents were increased up to 25% concentration and decreased significantly at higher concentrations in *Cicer arietinum* L. irrigated with distillery effluent. Similar observation has been reported by Sahai *et al*. (1985) in *Phaselous radiatus* irrigated with distillery effluent. Chlorophyll content showed reducing trend with decreasing pH probably due to the damage of chloroplast under such acidic conditions.

Conclusion

The present study showed that untreated Brewery-Distillery effluent had toxic effect on germination, seedling growth and pigment content of *Cicer arietinum* L. var. GNG1958 whereas, treated effluent showed beneficial effect at lower effluent concentration (25%) on the above mentioned parameters. The Brewery-Distillery effluent if applied in lower concentrations can serve as a potential source of liquid fertilizer for agricultural crops. Thus it can be suggested that after post-field trials the suitably diluted effluent can be used for cultivation of *Cicer arietinum* L. var. GNG1958.

Table 2: Effect of different concentrations of untreated and treated Brewery-Distillery effluent on growth parameters of *Cicer arietinum* L. variety GNG1958

Treatments	Root length (cm)	Shoot length (cm)	Plant length (cm)	Fresh seedling wt.(g)	Dry seedling wt.(g)	Dry root wt.(g)	Dry shoot wt.(g)	Root-shoot ratio
Control (E_0)	7.6	12.9	20.5	1.346	0.128	0.017	0.021	0.80
Untreated Effluent (UE)[1]								
UE_{25}	1.2	2.1	3.3	0.23	0.12	0.001	0.003	0.55
UE_{50}	0.7	1.1	1.8	0.15	0.08	0.001	0.001	1
UE_{75}	–	–	–	–	–	–	–	–
UE_{100}	–	–	–	–	–	–	–	–
Treated Effluent (TE)[2]								
TE_{25}	7.8	12.0	19.8	0.680	0.127	0.018	0.02	0.9
TE_{50}	5.3	10.1	15.4	0.599	0.123	0.012	0.015	0.8
TE_{75}	2.3	4.5	6.8	0.434	0.099	0.018	0.012	1.5
TE_{100}	1.8	4.7	6.5	0.423	0.104	0.003	0.012	0.25

[1] *UE_{25}, UE_{50}, UE_{75}, UE_{100}: 25, 50, 75 and 100% untreated Brewery-Distillery effluent, respectively*
[2] *TE_{25}, TE_{50}, TE_{75}, TE_{100}: 25, 50, 75 and 100% treated Brewery-Distillery effluent, respectively*

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