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RESEARCH ARTICLE

IMPACT OF UNTREATED BREWERY AND DISTILLERY EFFLUENT ON GERMINATION OF EIGHT VARIETIES OF *CICER ARIETINUM L.*

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ABSTRACT

The aim of the present study was to find the impact of different concentrations of untreated Brewery and Distillery effluent on the germination pattern of eight varieties of Chickpea (*Cicer arietinum* L.). The various physicochemical characteristics of the untreated effluent showed that it was dark brown in color with unpleasant odor having acidic pH 3.51, turbidity 240 NTU and high COD. The eight varieties of *Cicer arietinum* L. used in the experiment were GNG1861, GNG26054, PG065, BGM547, GNG2002, CSJK24AVT-2, BGM571 and GNG1969. For varietal screening, a setup with various concentrations of untreated Brewery and Distillery effluent (25%, 50%, 75% and 100%) and one control set was prepared in petri plates. Among eight varieties, PG065 and BGM571 showed better performance not only at 25% effluent concentration but also survived up to 100% concentration, and were considered to be more tolerant, whereas GNG1861 and GNG26054 were most sensitive to untreated Brewery and Distillery effluent treatment.

INTRODUCTION

Distillery spent wash is the unwanted residual liquid waste generated during alcohol production and pollution caused by it is one of the most critical environmental issue. On an average 8–15 L of effluent is generated for every liter of alcohol produced (Saha *et al.*, 2005). The distilleries are extensively growing due to widespread industrial applications of alcohol such as in pharmaceuticals, food, perfumery, etc. It is also used as an alternate fuel. There are 319 distilleries in India alone, producing 3.25 billion liters of alcohol and generating 40.4 billion liters of wastewaters annually (Malaviya and Sharma, 2011). 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. In India, the use of distillery wastewater in agriculture is popular since the inception of the industry (Pandita and Malaviya, 2015).

Irrigation water is the single most important factor which decides the success of crop productivity in arid and semi arid agro-climatic zones. In the past five decades, the water availability has reduced to half and further reduction is fast approaching. This necessitates using every drop of water that can be recycled back to the crop production. Currently, use of wastewater in agriculture is gaining importance. Crops irrigated with wastewater have given higher yields and reduced the need for chemical fertilizers as they serve as nutrient (Kumar and Chopra, 2012). Various workers have carried out many investigations to find the effect of various industrial effluents on germination of crops (Malaviya and Sharma, 2011; Malaviya *et al*., 2012; Kohli and Malaviya, 2013; Divyapriya *et al*., 2014; Pandita and Malaviya, 2015). In the present experiment, an attempt has been done to find the impact of different concentrations of untreated Brewery and Distillery effluent on the germination pattern of eight varieties of Chickpea (*Cicer arietinum* L.). it is commonly known as Bengal gram or gram, occupying an important place in the pulse cultivation and ranking 3rd amongst the global farming. It is a valuable crop having high energy density, superior amino acid profile and high protein content. The chickpea is rich in protein, calcium, phosphorous and other minerals (Divyapriya *et al*. 2014).

MATERIALS AND METHODOLOGY

Seeds of the eight different varieties of *Cicer arietinum* L. i.e. GNG1861, GNG26054, PG065, BGM547, GNG2002, CSJK24AVT-2, BGM571 and GNG1969 were used in the present experiment. The untreated Brewery and Distillery effluent samples used in the present study were collected in pre-cleaned containers after every week 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 (Pandita and Malaviya, 2015). The effluent was allowed to settle overnight

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in a shallow and large trough for minimizing the possibility of clogging. Various physicochemical characteristics of the effluent samples were analyzed using standard methods (APHA, 1998).

Experimental Set-up and Experiment Process

The experimental set up was designed in the Department of Environmental Sciences, University of Jammu, Jammu. Five treatment sets were made, in which set-1 was taken as control, for that tap water was used for irrigation and in set 2, 3, 4 and 5 different concentrations of untreated brewery and 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 untreated effluent (25%, 50%, 75% and 100%) made with tap water. Seeds were treated in antifungal solution and washed thoroughly with distilled water before using for experiment. The ten seeds of each variety of *Cicer arietinum* L. were placed in the petri plates in triplicate. The petri plates were incubated at 25 ± 1^0C 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. The seed germination of each variety was recorded separately and the percent germination was calculated using following formula.

$$\text{Percent germination} = \frac{\text{number of seeds germinated}}{\text{number of seeds sown}} \times 100$$

RESULTS AND DISCUSSION

The physicochemical characteristics of untreated brewery and distillery effluent are given in Table 1. The effluent used for the present study was dark brown in color having value of 1375 in CU with an unpleasant odor. The physicochemical analysis of untreated effluent showed pH (3.51), EC (2.11mS cm $^{-1}$), turbidity (240 NTU), total suspended solids (1899 mg L^{-1}), total dissolved solids (1055 mg L^{-1}), COD (5280 mg L^{-1}), chloride (454 mg L^{-1}), sodium (459 mg L^{-1}), nitrate (28.04 mg L^{-1}) and calcium (11.40 mg L^{-1}).

It depicts that the range of pH, total suspended solids (TSS) and COD of the effluent were not in the permissible limits of the CPCB discharge standards of 1998.

Table 2 shows the difference in percent germination of eight varieties of *Cicer arietinum* L. (chickpea) on exposure to various concentrations of untreated brewery and distillery effluent. At E_o (control treatment) the maximum percent germination was observed by CSJK24AVT-2 (100), followed by BGM547 (93). GNG26054 and GNG1969 showed the similar value of percent germination (80), followed by GNG1861 (76), PG065 (72), BGM571 (67) and minimum value (57) was found in GNG2002.

At UE_{25} (25% untreated effluent), there was maximum percent germination in all the varieties except GNG2002 and GNG1969, in which percent germination was lowest in comparison to other six varieties. The germination gradually decreased with an increase in effluent concentration i.e. above UE_{25} percent germination value decreased. At UE_{25} the maximum value of percent germination (90) was shown by four varieties of chickpea i.e. PG065, BGM547, CSJK24AVT-2 and BGM571, followed by GNG26054 (80). GNG1861 showed 70% germination, which was followed by the lowest value of percent germination in GNG2002 and GNG1969 (50).

At UE_{50} (50% untreated effluent treatment), the decreasing trend for eight varieties were BGM547 and CSJK24AVT-2 (60), PG065, BGM571 and GNG1969 (50), followed by GNG26054 and GNG2002 (40) and least shown by GNG1861 (20). At 75% effluent concentration, the maximum value of percent germination was found in BGM547 (40), followed by GNG2002 and BGM571 (30) and CSJK 24AVT-2 and GNG1969 (20) and rest of the varieties did not show any germination. Similarly, the decreasing trend of the values of percent germination in 100% effluent included GNG2002 and BGM571 (20), followed by CSJK 24AVT-2 and GNG1969 (10) and rest of the varieties showed nil germination. In two varieties PG065 and BGM571, at UE_{25} (25% effluent concentration) higher percent germination value of (90) was shown as compared to that of control which showed value of 72 and 65, respectively.

Table I Physicochemical characteristics of untreated Brewery and Distillery Effluent and its comparative appraisal with CPCB discharge standards (CPCB, 1998).

Treatments	Untreated Brewery and Distillery Effluent	CPCB discharge standards (CPCB,1998) Into surface water, Indian standards: 2490 (1974)	CPCB discharge standards (CPCB,1998) On land for irrigation, Indian standards: 3307 (1974)
Colour (CU)	1375	_	_
Odour	Unpleasant	Odourless	Odourless
pH	3.51	5.5-9.0	5.5-9.0
Electrical conductivity (mS cm^{-1})	2.11	_	_
Turbidity (NTU)	240	_	_
Total dissolved solids (mg L^{-1})	1055	2100	2100
Total suspended solids (mg L^{-1})	1899	100	100
Chemical oxygen demand (mg L^{-1})	5280	250	_
Chloride (mg L^{-1})	454	1000	600
Sodium (mg L^{-1})	459	_	_
Nitrate (mg L^{-1})	28.04	_	_
Calcium (mg L^{-1})	11.40	_	_

‾ data not given

Table 2 Effect of different concentrations of untreated Brewery and Distillery effluent on Germination of eight varieties of *Cicer arietinum* L.

Variety	GNG 1861	GNG 26054	PG065	BGM 547	GNG 2002	CSJK 24AVT-2	BGM 571	GNG 1969
Treatments								
Control (E_0)	76	80	72	93	57	100	67	80
UE_{25}	70	80	90	90	50	90	90	50
UE_{50}	20	40	50	60	40	60	50	50
UE_{75}	0	0	20	40	30	20	30	20
UE_{100}	0	0	10	0	20	10	20	10

UE_{25}, UE_{50}, UE_{75}, UE_{100}: 25, 50, 75 and 100% untreated Brewery and Distillery effluent, respectively.

The varieties which survived in the 75% and 100% effluent concentration were considered tolerant for the effluent but the varieties of chickpea which didn't even germinate at higher effluent concentrations like 75 and 100%, were considered as sensitive varieties.

From the Table 2, it can be depicted that four varieties PG065, BGM547, CSJK24AVT-2 and BGM571 were found to be comparatively tolerant chickpea varieties for the brewery and distillery effluent, which not only performed better in 25% effluent concentration but were also found to be tolerant with increase in the effluent concentration and survived up to 100% effluent.

Among these four varieties, PG065 and BGM571 showed better performance at 25% effluent concentration in which values of percent germination (90) was better than that of control and they also survived up to 100% effluent concentration. In the rest of four varieties i.e. GNG1861, GNG26054, GNG2002 and GNG1969, first two varieties i.e. GNG1861 and GNG26054 were very sensitive which germinated only up to 50% effluent concentration and above that no germination was observed. In the other two varieties GNG2002 and GNG1969, percent germination values were lower than the other varieties but they still showed germination in higher effluent concentration so, they can be considered transitional between the tolerant and sensitive varieties.

Similar type of varietal screening experiments were conducted by Sundaramoorthy and Lakshmi (2000) using tannery effluent on ten varieties of groundnut in which they found that maximum germination response was shown at lower concentration (10%) of tannery effluent. Kohli and Malaviya (2013) also performed such experiment to study the impact of tannery effluent on germination pattern of ten varieties of wheat (*Triticum aestivum*). At lower effluent concentration (25%), the percent germination was better but with the increase in effluent concentration it decreased. The reduction in percent germination at higher effluent concentrations can be attributed to the presence of high amount of sodium, chlorides and acidic pH of 3.51. Also, at higher concentrations of the effluent, high levels of dissolved solids enhance the salinity and conductivity of solute absorbed by the seeds (Kohli and Malaviya, 2013). The higher concentration of effluent decreases enzyme dehydrogenase activity that is considered as one of the biochemical change which may have disrupted germination (Nagajyoti *et al*, 2008). The different germination values shown by the eight varieties of *Cicer arietinum* L. (chickpea) in the untreated brewery and distillery effluent and control treatment can be attributed to the genetic variability or different genetic makeup of the seeds.

CONCLUSION

The present study concluded that the chickpea varieties PG065 and BGM571 exhibited more tolerance than other varieties at lower concentration of untreated brewery and distillery effluent (UE_{25}) and also survived up to higher effluent concentration while GNG1861 and GNG26054 were most sensitive to untreated brewery and distillery effluent exposure. Thus chickpea varieties PG065 and BGM571 can be used for field-level study to assess their potential to grow in untreated brewery and distillery effluent contaminated soils.

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