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Impact of distillery effluent on germination behaviour of *Brassica napus* L.

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Abstract

The study has been focused on effect of untreated distillery effluent (Devans Breweries Ltd., Jammu) on germination of gobi sarson (*Brassica napus.* L. var. Punjabi Special). Six treatments ($E_{0....}E_{100}$) each having three replicates were made. E_0 was taken as control in which tap water was used for irrigation of the plants. For E_{20}, E_{40}, E_{60}, E_{80} and E_{100}, different concentrations *i.e.* 20, 40, 60, 80 and 100% of effluent were used for irrigation, respectively. The 100% sample of distillery effluent analyzed for various physicochemical parameters showed acidic nature (pH 4.0) and higher values of COD (2496 mg l^{-1}), TDS (799.7 mg l^{-1}) and chlorides (1408 mg l^{-1}). The parameters e.g. percent germination, germination index, speed of germination, and peak value were highest in treatment receiving 20% effluent concentration which also showed minimum values for percent inhibition, germination period, and delay index.

Key words

Distillery effluent, Pollution, Germination, *Brassica napus*

Introduction

Industrial revolution is a great boon to mankind but there is a wide range of environmental impacts created by industries. Majority of these industries are water based. Over 3/4th of fresh water drawn by the domestic and industrial effluents inevitably end up in surface water bodies or in the ground water affecting water quality. Though the industrial use of water is very low as compared to agricultural use, the disposal of industrial effluents on land or surface water bodies make water resources unsuitable for other uses (Behera and Reddy, 2002; Buechler and Mekala, 2005; Ghosh, 2005).

Distilleries are one of the 17 most polluting industries listed by the Central Pollution Control Board. At present, there are 319 distilleries in India with an installed capacity of 3.29 billion lit. of alcohol. The cane–growing states like Uttar Pradesh and Maharashtra have the highest installed capacity constituting more than 40% of the total installed capacity, followed by Madhya Pradesh (14.2%) and Tamil Nadu (9.7%) (Uppal, 2004). For every litre of alcohol produced, molasses based distilleries generate 8-15 l of waste water characterized by high BOD and high COD (Uppal, 2004). The effluent causes apprehension of environmental pollution owing to its very high organic content. Many a times this wastewater is discharged in the water bodies either untreated or partially treated, resulting in depletion of oxygen causing wide spread mortality of aquatic organisms (Hati *et al.,* 2007). As the effluent contains considerable amount of organic matter and plant nutrients, particularly potassium and sulphur, this can be applied to arable land as irrigation water and as an amendment. When applied to crops it may act as a source of plant nutrients (N, K, P, Ca, S, Cu, Mn and Zn) and has been reported to increase the yield of the crops (Pathak *et al.*, 1999; Nagajyothi *et al*., 2009; Nath *et al.*, 2009). In the present study, effort has been made to study the impact of graded doses of untreated distillery effluent on germination of gobi sarson (*Brassica napus* L. var. Punjabi Special).

Materials and Methods

Tested seeds of *Brassica napus* L. var. Punjabi Special were purchased from local seeds store. The garden soil was collected from the Department of Arboriculture, University of Jammu, Jammu. The soil was sun dried, sieved and mixed with farmyard manure (FYM) in the ratio of 3:1 (Soil:FYM). The effluent samples were collected from M/S Devans 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 are malt, rice or rice flakes, sugar, hops and yeast. The wastewater is passed through an effluent treatment unit before its final discharge. For the present study, untreated distillery effluent was used.

The experimental set up was designed in the Department of Environmental Sciences, University of Jammu, Jammu. Earthen Pots having inner diameter of 210 mm and height of 170 mm were filled with equal quantities (2 kg) of prepared soil. These pots were then transferred to the experimental site and arranged in accordance with the experimental design. Six treatments ($E_{0....}E_{100}$) were made; each consisted of three replicates. E_0 was taken as control in which ordinary tap water was used for irrigation of the plants. For $E_{20,}$ $E_{40,}$ $E_{60,}$ E_{80} and E_{100}, different concentrations *i.e.* 20, 40, 60, 80 and 100% of effluent were used for irrigation, respectively. In each replicate, ten seeds of *Brassica napus* L. var. Punjabi Special were sown, giving proper spacing. The untreated effluent used in the study was being obtained at regular intervals from the industry. The effluent was analyzed for its physico-chemical characteristics according to standard procedures (APHA, 1998). Osmotic pressure (Op) was measured by multiplying the value of electrical conductivity with 0.36 (Ayers and Westcot, 1994).

The total number of germinated seeds was counted after every two days starting from the 6th day (d) of sowing upto 30 days and percent germination was obtained. Germination index was expressed as a percentage and calculated by accounting for the number of grown seeds and the average sum of seed's root elongation in a sample as compared to the control (Zucconi *et al.*, 1981). Delay index (delay in germination time over control) was calculated to compare the performance of crop under different effluent concentrations according to Kaushik *et al*. (2005) with a little modification, in which germination time was considered as the time taken for 40% germination. Similarly, some other parameters like, percent inhibition (percent germination of treatment over control), peak value (cumulative percent germination divided by number of days since initial imbibition), germination value (multiplication of peak value and % germination) and speed of germination (rate of seed

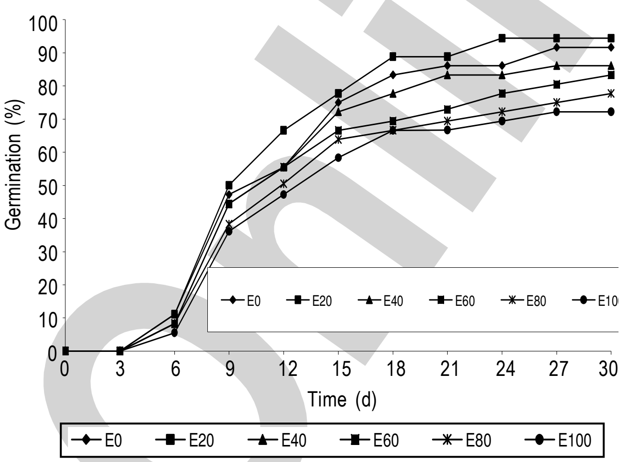

Fig. 1: Effect of different effluent concentratins on germinatin of *B. napus* at regular time interval (E_0-Control, E_{20}-20, E_{40}-40, E_{60}-60, E_{80}-80 and E_{100}-100% effluent concentration)

Table - 1 : Physico-chemical characteristics of untreated distilery effluent

S.No.	Parameters	Values*
1.	Temperature (°C)	45.2 ± 0.2
2.	Colour	light brown
3.	Odour	unpleasant
4.	Total suspended solids (mg l^{-1})	1.708 ± 15
5.	Total dissolved solids (mg l^{-1})	1408 ± 15
6.	pH	5.53 ± 0.0
7.	BOD (mg l^{-1})	793.2 ± 17.0
8.	COd (mg l^{-1})	2496 ± 36.0
9.	Chloride (mg l^{-1})	799.7 ± 25.3
10.	Electrical conductivity (mS cm^{-1})	2.2 ± 0.1
11.	Osmotic pressure (atmospheres)	0.79 ± 0.4

* = Mean ± SD

Table - 2: Characteristics of different concentrations of the distillery effluent

Effluent concentration	pH	EC (mS cm^{-1})	TDS (mg l^{-1})	Op* (atmospheres)
TW	7.90	0.4	256	0.14
20%	6.93	0.8	512	0.29
40%	5.92	1.0	640	0.36
60%	5.68	1.4	896	0.50
80%	5.61	1.6	1024	0.58
100%	5.53	2.2	1408	0.79

TW = Tap water, * OP = EC*0.36 (Ayers and Westcot, 1994)

germination over time) were also estimated using formula adopted from Rao *et al*. (1979) and Czabator (1962).

Results and Discussion

The distillery effluent used for the present study was a light brown coloured odorous waste released from the industry. Analysis of the effluent for its various physico-chemical characteristics showed that it had high values of COD (chemical oxygen demand), Cl^- (chloride concentration), TDS (total dissolved solids) and Op (osmotic pressure) (Table 1). Values of various parameters for different concentrations of the effluent (Table 2) show an increasing trend of EC (electrical conductivity), Op and TDS with increasing concentration of the effluent. Minimum values of EC (0.8 mS cm^{-1}), Op (0.29 atmosphere) and TDS (512 mg l^{-1}) were observed in 20% effluent concentration (E_{20}). Maximum values, on the other hand were observed in 100% effluent concentration *i.e.* 2.2 mS cm^{-1} EC, 0.79 atmosphere Op and 1408 mg l^{-1} TDS, respectively. There was a decreasing trend of pH with increasing concentrations of the effluent. Maximum value of pH (6.93) was observed in 20% effluent concentration and minimum value of pH (5.53) was observed in 100% effluent concentration.

The effect of distillery effluent on various germination parameters of *Brassica napus* L. var. punjabi special are shown in Table 3. It was observed that values for positive germination parameters *i.e.* cumulative percent germination, germination index, germination value, speed of germination, and peak value were found to be highest in treatment E_{20} (20% effluent concentration) and lowest in treatment E_{100} (100% effluent concentration). The

Table - 3: Effect of different effluent concentrations on various germination parameters of *B.napus* after 30 days

Parameters	Treatments*					
	E_0	E_{20}	E_{40}	E_{60}	E_{80}	E_{100}
Cumulative % germination	91.6	94.4	86.1	83.3	77.7	72.2
Germination index (%)	-	103.2	93.0	83.4	75.8	69.0
Delay Index	-	-0.2	0	0	0	+0.2
Speed of germination	3.1	3.3	2.9	2.8	2.6	2.3
Peak value	3.4	3.9	3.2	2.7	2.6	2.6
Germination value	310.5	370.5	273.8	230.7	201.2	192.7
Percent inhibition (%)	-	-2.8	5.5	8.3	13.9	19.4

* E_0 = Control, E_{20} = 20% effluent, E_{40} = 40% effluent, E_{60} = 60% effluent, E_{80} = 80% effluent, E_{100} = 100% effluent

results also show that values for negative germination parameters like delay index and percent inhibition were lowest in case of 20% effluent concentration and increased with increase in effluent concentration.

The value of germination index was found to be highest in E_{20} (103.2) treated with lowest (*i.e.* 20%) effluent concentration. However, germination index was lowest in E_{100} (69.0) treated with highest effluent concentration (100% concentration). This may be attributed to the toxicity caused due to increasing amount of various organic and inorganic compounds present in higher concentrations of effluent. Almost similar observations were made by Padhan and Sahu (1999) while working on the effect of rice mill effluent on seed germination of cereal crops. They found a decrease in the values of germination index when treated with 60 and 75% effluent concentration. On the other hand, the value of delay index in the present study, was found to be lowest in E_{20} (-0.2) and highest in E_{100} (+0.2). It showed that at lower effluent concentration, delay index was lowest whereas it increased with increasing effluent concentrations. Similar trends in the delay index were observed by Kaushik *et al.* (2005) while studying the effect of different concentrations of textile effluent on wheat cultivars.

It has been observed that the germination value was highest in E_{20} (370.5) followed by E_0 (310.5) and E_{40} (273.8) and lowest in E_{100} (192.7). The decreasing trend of germination value of the plants with increasing effluent concentrations may be attributed to the lesser uptake of nutrients and increase in osmotic potential of the soils irrigated with higher effluent concentrations. Ramana *et al.* (2002) while studying the effect of distillery effluent on some vegetable crops observed the similar results. Therefore, plants irrigated with higher concentrations of effluents have lower germination rates. It was also observed that peak value of germination was found to be maximum in E_{20} (3.9) and minimum in E_{100} (2.6) and speed of germination also followed the same trend *i.e.* it was found to be maximum in E_{20} (3.3) and minimum in E_{100} (2.3) whereas percent inhibition was found to be maximum in E_{100} (19.4%) and minimum in E_{20} (2.8%) which can be attributed to the increase in salt content with increasing concentrations of the effluent.

Fig. 1 reveals percent germination of *B. napus* L. upto 30 d duration at regular time interval. The highest record of percent germination (94.4%) was observed in case of treatment E_{20} *i.e.* 20% effluent concentration. It was followed by E_0 (91.6%) and E_{40} (86.1%) and lowest in E_{100} (72.2%). It is evident that there was an increase in germination percentage from E_0 (*i.e.* control) to E_{20} (*i.e.* 20% effluent), but there was a decline in the values with further increase in the effluent concentrations. The inhibitory effect of effluent at higher concentrations may be attributed to the increased osmotic potential of the soil due to increase in the ion concentrations at higher effluent concentrations. The figure also shows that the rate of germination was highest between 6-9 day duration irrespective of the effluent concentrations.

Augusthy and Mani (2000) studied the effect of rubber factory effluent on seed germination and seedling growth of *Vigna radiata*. They found that the values for percent germination were highest in effluent concentrations ranging from 25-50%. They attributed that inhibition of germination at higher concentrations (above 50%) of effluent, may be due to high levels of total dissolved solids which enhance the salinity and conductivity of the solute absorbed by the seeds before germination. Similar results were obtained by Reddy and Borse (2001) while observing effect of pulp and paper mill effluent on *Trigonella foenum graceum*. They observed that at lower concentration (25% effluent), there was a significant increase in the seed germination which gradually decreased with increase in concentration. Rodger *et al.* (1957) reported that high osmotic pressure of the germination solution makes imbibition more difficult and retard germination. Richards (1968) on the other hand observed that it is the total concentration of the solute particles in the solution rather than their chemical nature that is mainly responsible for the inhibitory effects of saline solutions on the growth of crops. All these factors are in conformity with the present study. The above findings lead to the conclusion that untreated distillery effluent enhances germination of *Brassica napus* at lower concentrations whereas higher effluent concentrations cause inhibitory effect. Thus, distillery effluent can be beneficially used for irrigational purpose after proper dilutions and can be discharged safely into the soil.

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References

APHA: Standard methods for the examination of water and wastewater (18th Edn.). American Public Health Association., Washington D.C. (1998).

Augusthy, P.O. and A.S. Mani: Effect of rubber factory effluent on seed germination and seedling growth of *Vigna radiata* L. *J. Environ. Biol.,* **22**, 137-139 (2000).

Ayers, R.S. and D.W. Westcot: Water quality for agriculture. FAO Irrigation and Drainage Papers, **29** (1994).

Behera, B. and V.R. Reddy: Environment and accountability: Impact of industrial pollution on rural communities. *Economic and Political Weekly*, 257-265, January 19 (2002).

Buechler, S. and G.D. Mekala: Local responses to water resource degradation in India: Farmer innovations and the reversal of knowledge flows. *J. Environ. Dev.*, **14**, 410-438 (2005).

Czabator, F.J.: Germination value, an index combining speed and completeness of pine seed germination. *For. Sci.*, **8**, 386-396 (1962).

Ghosh, P.: Drug abuse: Ranbaxy, dutch pharmacy put paid to ground water. *Down to Earth*, **14**, 7-8 (2005).

Hati, K.M., A.K. Biswas, K.K. Bandyopadhyay and A.K. Mishra: Soil properties and crop yields on a vertisol in India with application of distillery effluent. *Soil Till. Res.*, **92**, 60-68 (2007).

Kaushik, P., V.K. Garg and B. Singh: Effect of textile effluents on growth performance of wheat cultivars. *Bioresour. Technol.*, **96**, 1189-1193 (2005).

Nagajyothi, P.C., N. Dinakar, S. Suresh, Y. Udaykiran, C. Suresh and T. Damodharam: Effect of industrial effluent on the morphological parameters and chlorophyll content of green gram (*Phaseolus aureus* Roxb). *J. Environ. Biol.*, **30**, 385-388 (2009).

Nath, K., D. Singh, S. Shyam and Y.K. Sharma: Phytotoxic effects of chromium and tannery effluent on growth and metabolism of *Phaseolus mungo* Roxb. *J. Environ. Biol.*, **30**, 227-234 (2009).

Padhan, A. and K.S. Sahu: Effect of rice mill effluent on seed germination of some cereal crops. *Pollut. Res.,* **18**, 187-189 (1999).

Pathak, H., H.C. Joshi, A. Chaudhary, R. Chaudhary, N. Kalra and M.K. Dwivedi: Soil amendment with distillery effluent for wheat and rice cultivation. *Water, Air and Soil Pollution*, **113**. 133-140 (1999).

Ramana, S., A.K. Biswas, S. Kundu, J.K. Saha and R.B.R. Yadava: Effect of distillery effluent on seed germination in some vegetable crops. *Bioreseour. Technol.*, **82**, 1189-1193 (2002).

Rao, J.V.S., M.R.K. Rama and M.S. Samba: Allelopathic effect of some weed of vegetable crops on the germination and early seedling growth of bajra. *Tropical Ecol.*, **20**, 5-8 (1979).

Reddy, P.G. and R.D. Borse: Effect of pulp and paper mill effluent on seed germination and seedling growth of *Trigonella foenum-graceum* L. (Methi). *J. Ind. Pollut. Control,* **17**, 165-169 (2001).

Richards, L.A.: Diagnosis and improvement of saline and alkaline soils. United States Department of Agriculture, Agricultural Hand Book, **60** (1968).

Rodger, J.B.B., G.G. Williams and R.L. Davis: A rapid method for determining winter hardiness of alfalfa. *Agronomy J.*, **49**, 88-92 (1957).

Uppal, J.: Water utilization and effluent treatment in the India alcohol industry an overview. India-E.U. Workshop on Promoting Efficient water use in Agro-based industries, New Delhi 15-16 January 2004, India.

Zucconi, F., A. Pera, M. Forte and M. De Bertoldi: Evaluating toxicity of immature compost. *BioCycle,* **22**, 54-57 (1981).