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# Effect of distillery effluent on yield attributes of *Brassica napus* L.

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**Abstract**

A pot culture experiment was conducted to study the effect of untreated distillery effluent on yield attributes of gobi sarson (*Brassica napus*. L. var. Punjabi Special) at different effluent concentrations. The effluent showed unpleasant odour, acidic pH, high COD and high chlorides. Five concentrations of the distillery effluent (20, 40, 60, 80 and 100%) were used for irrigation of *B. napus* plants with tap water as control. Various characteristics of siliqua (number of siliqua, average siliqua length, weight of siliqua) and seeds (number of seeds, weight of hundred seeds, economic yield) were quantified to check the variations in the yield attributes of effluent irrigated test plant. Overall, 20% distillery effluent was found to be most effective for highest number and better quality of siliqua (62.0 siliqua plant$^{-1}$; weight of ten siliqua 1.21 g) and seeds (836.3 seeds plant$^{-1}$; weight of 100 seeds 0.39 g), and increased yield (economic yield 2.85 g plant$^{-1}$; stover yield 7.85 g plant$^{-1}$) of the test plant.

**Key words**

Distillery effluent, Plant, Yield, *Brassica napus*

## Introduction

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. There are more than 300 distilleries in India, generating approximately $3.5\times10^{15}$ l of highly organic effluent annually (Chandra *et al*., 2009). The distillery effluent is characterized by high biochemical oxygen demand (BOD), chemical oxygen demand (COD), phenolic compounds, sulphate and heavy metals (Pant and Adholeya, 2007). With the current emphasis on environmental health and water pollution issues, there is an increased awareness of the need to dispose off this waste water safely and beneficially. Use of waste water in agriculture could be an important consideration when its disposal is being planned. However, the safe disposal of industrial effluents on land for irrigation is comparatively a new area of research and hence throws new challenges for environmental management (Buechler and Mekala, 2005). The research work to lessen the deleterious effect of industrial effluents on life and surroundings should be done prior to its disposal. The approach is capable of providing environmentally compatible solution to water pollution problems and augments the traditional irrigational resources for the development of sustainable agriculture. The industrial effluents contain large amounts of nutrients as well as toxic elements. Plants are being used as ecological monitors to assess the toxicity of pollutants (Nath *et al*., 2009).

In India, the use of distillery waste water in agriculture is popular since the inception of the industry. In some water scarce areas, farmers are forced to use the effluent as a substitute for irrigation water but over the years its use has led to the realization of its fertilizer potential also. Various workers have suggested suitable application rates for distillery effluent for ferti-irrigation purposes (Malaviya *et al*., 2007; Kannan and Upreti, 2008). The studies have also shown that the effect of distillery effluent is crop-specific and due care should be taken before using distillery effluent for irrigation purpose (Ramana *et al.,* 2002b). The local studies are essential to determine optimum loading rates in order to avoid the possible reduction in crop yields because of inorganic toxicity. Therefore, in the present study, an attempt has been made to assess the effect of untreated distillery effluents on yield attributes of gobi sarson (*Brassica napus* L. var. Punjabi Special).

## Materials and Methods

The garden soil collected from the Department of Arboriculture, University of Jammu, Jammu was sun dried, sieved and mixed with farmyard manure (FYM) in the ratio of 3:1. Tested seeds of *Brassica napus* L. var. Punjabi special used for the study were purchased from local seed store. Untreated effluent samples were collected at regular intervals from M/S Devans Breweries Ltd. (Brewers and Distillers), Talab Tillo, Jammu; analyzed for various physicochemical characteristics according to standard methods (APHA, 1998); and the average values were calculated. Osmotic pressure (Op) was measured by multiplying the value of electrical conductivity with 0.36 (Ayers and Westcot, 1994).

The experimental set up was designed in the form of six treatments; each consisted of three earthen pots (inner diameter 210 mm; height 170 mm) filled with equal quantities (2 kg) of prepared soil. The first treatment was taken as control ($E_0$) in which tap water was used for irrigation of the plants. In remaining five treatments, different concentrations of the effluent viz. 20, 40, 60, 80, and 100% were used for irrigation and designated as $E_{20}$, $E_{40}$, $E_{60}$, $E_{80}$, and $E_{100}$, respectively. In each replicate, two seeds of *Brassica napus* were sown, giving proper spacing. After 40 days (d) of sowing, siliqua were harvested manually over a period of 45 days at 5 d intervals, and the data were used for the estimation of various yield parameters.

Observations were made for the total number of siliqua harvested from each plant and average was worked out for each treatment. The harvested siliqua were then weighed to obtain green as well as dry weights. Economic yield was measured by taking total weight of seeds per plant. Straw/stover yield was measured by subtracting economic yield from total AGB (above ground biomass). Harvest index was calculated by dividing total economic yield by total AGB (above ground biomass) of plant including siliqua (Singh *et al.*, 2002). After harvesting, the plants were uprooted; the root and shoot lengths were measured by using a scale and Root/Shoot ratio (in terms of length) was calculated. Similarly, the dry weight of the root and shoot were measured after drying the plants in an oven at 65°C for 48 hr or till the constant weight was achieved and Root/Shoot ratio (in terms of oven-dried weight) was calculated. The values of mean and standard deviation were computed for all the parameters except harvest index and Root/Shoot ratio by using SPSS 10.0.5 software.

## Results and Discussion

The distillery waste water used for the present study was light brown in colour with unpleasant odour. The average values of various physicochemical characteristics of the 100% effluent exhibited high chemical oxygen demand (COD, 2496 mg $l^{-1}$), chloride concentration ($Cl^-$, 799.7 mg $l^{-1}$), total dissolved solids (TDS, 1408 mg $l^{-1}$) and osmotic pressure (Op, 0.79 atmosphere). The different concentrations of the effluent showed 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 ($E_{20}$), while maximum values were detected in 100% effluent concentration ($E_{100}$) *i.e.* 2.2 mS $cm^{-1}$ EC, 0.79 atmosphere Op and 1408 mg $l^{-1}$ TDS. There was a decreasing trend of pH with increasing concentrations of the effluent with highest pH (6.93) in 20% effluent and lowest (5.53) in 100% effluent concentration.

**Table - 1:** Effect of different effluent concentrations on number of siliqua* of gobi sarson (*B. napus* L.) at regular interval of time

| Treatments** | Time interval (d) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 |
| $E_0$ | - | 4.5 ±2.9 | 8.5 ±0.7 | 14.0 ±1.9 | 23.3 ±2.4 | 41.3 ±3.0 | 54.3 ±2.4 | 56.3 ±2.1 | 58.6 ±2.0 | 59.6 ±1.8 |
| $E_{20}$ | 1.0 ±0 | 9.0 ±0 | 14.0 ±1.8 | 15.0 ±2.2 | 31.6 ±2.3 | 44.6 ±3.1 | 59.0 ±3.0 | 60.6 ±2.5 | 61.3 ±1.8 | 62.0 ±2.3 |
| $E_{40}$ | - | 3.0 ±1.4 | 8.0 ±1.4 | 12.0 ±2.3 | 23.3 ±2.3 | 36.6 ±3.0 | 48.6 ±3.2 | 49.3 ±2.6 | 50.3 ±2.5 | 53.6 ±1.9 |
| $E_{60}$ | - | - | 7.0 ±1.5 | 10.0 ±1.4 | 20.0 ±2.1 | 29.6 ±2.5 | 46.3 ±4.2 | 48.0 ±2.2 | 50.0 ±2.9 | 51.3 ±2.5 |
| $E_{80}$ | - | - | 6.0 ±2.0 | 9.5 ±3.5 | 18.6 ±2.0 | 26.6 ±2.4 | 40.6 ±4.0 | 44.6 ±2.4 | 45.3 ±3.2 | 46.0 ±2.9 |
| $E_{100}$ | - | - | 5.6 ±3.9 | 9.3 ±4.5 | 15.3 ±1.9 | 21.6 ±2.2 | 40.6 ±2.9 | 43.6 ±2.1 | 45.3 ±3.4 | 46.0 ±3.5 |

* = Mean ± standard deviation,

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

**Table - 2:** Effect of distillery effluent on siliqua and seed characteristics* of gobi sarson (*B. napus* L.)

| Treatments** | Siliqua characteristics | | | | Seed characteristics | | | |
|---|---|---|---|---|---|---|---|---|
| | NsP | AsL (cm) | TWs (g) | WTs (g) | NSP | WHS (g) | WSTs (g) | NSTs |
| $E_0$ | 59.60 | 5.90 | 4.80 | 1.14 | 811.6 | 0.38 | 0.66 | 197.0 |
| | ±3.10 | ±0.50 | ±0.60 | ±0.20 | ±2.3 | ±0.30 | ±0.03 | ±0.80 |
| $E_{20}$ | 62.00 | 6.00 | 6.30 | 1.21 | 836.3 | 0.39 | 0.70 | 205.0 |
| | ±3.01 | ±0.90 | ±1.60 | ±0.20 | ±2.9 | ±0.01 | ±0.12 | ±0.90 |
| $E_{40}$ | 53.60 | 5.70 | 4.01 | 1.08 | 715.0 | 0.37 | 0.64 | 192.0 |
| | ±2.70 | ±0.19 | ±0.59 | ±0.20 | ±1.9 | ±0.02 | ±0.13 | ±1.14 |
| $E_{60}$ | 51.60 | 5.50 | 3.70 | 1.01 | 710.0 | 0.37 | 0.59 | 191.0 |
| | ±3.10 | ±0.10 | ±0.60 | ±0.19 | ±3.1 | ±0.0 | ±0.13 | ±1.20 |
| $E_{80}$ | 46.00 | 3.30 | 3.50 | 1.01 | 493.3 | 0.36 | 0.52 | 181.0 |
| | ±2.90 | ±0.40 | ±0.30 | ±0.01 | ±3.5 | ±0.01 | ±0.23 | ±1.21 |
| $E_{100}$ | 46.00 | 5.10 | 3.30 | 0.98 | 143.0 | 0.37 | 0.49 | 164.0 |
| | ±2.40 | ±0.60 | ±0.80 | ±0.02 | ±3.2 | ±0.01 | ±0.04 | ±1.24 |

NsP = Number of siliqua per plant, AsL = Average siliqua length, TWs = Total Weight of siliqua, WTs = Weight of ten siliqua, NSP = number of seeds per plant, WHS = Weight of hundred seeds, WSTs = Weight of seeds per ten siliqua and NSTs = Number of seeds per ten siliqua

* Mean ± standard deviation, ** $E_0$ = Control, $E_{20}$ = 20% effluent, $E_{40}$ = 40% effluent, $E_{60}$ = 60% effluent, $E_{80}$ = 80% effluent, $E_{100}$ = 100% effluent

**Table - 3:** Effect of distillery effluent on yield* (sun-dried basis) of gobi sarson (*B. napus* L.)

| Treatments** | Economic yield (g) | Stover yield (g) | Harvest index |
|---|---|---|---|
| $E_0$ | 2.69±0.02 | 6.41±0.05 | 0.29 |
| $E_{20}$ | 2.85±0.03 | 7.85±0.06 | 0.27 |
| $E_{40}$ | 2.16±0.02 | 6.14±0.06 | 0.26 |
| $E_{60}$ | 1.95±0.01 | 5.95±0.04 | 0.25 |
| $E_{80}$ | 1.88±0.01 | 5.62±0.03 | 0.25 |
| $E_{100}$ | 1.65±0.01 | 5.45±0.03 | 0.23 |

* Mean ± standard deviation, ** $E_0$ = Control, $E_{20}$ = 20% effluent, $E_{40}$ = 40% effluent, $E_{60}$ = 60% effluent, $E_{80}$ = 80% effluent, $E_{100}$ = 100% effluent

Table 1 shows the effect of various concentrations of distillery effluent on siliqua quantity of *B. napus* at regular time intervals. The number of siliqua per plant was found to be maximum in $E_{20}$ and minimum in $E_{100}$. This indicates that there was an increase in siliqua production from control ($E_0$) to $E_{20}$ (20% effluent) and then there was a decrease with further increase in effluent concentration. It has also been observed that there was a delay in siliqua development in $E_{60}$ (60% effluent), $E_{80}$ (80% effluent), and $E_{100}$ (100% effluent) during early periods (i.e. 40th and 45th day) of siliqua formation, whereas in treatment $E_{20}$, siliqua formation started from 40th day (d) of sowing.

Table 2 reveals the effect of different effluent concentrations on siliqua and seed characteristics of *B. napus*. The number of siliqua per plant (NsP), average siliqua length (AsL) and total weight of siliqua (TWs) were found to be maximum in $E_{20}$ which indicates that maximum yield of plant occurred at 20% effluent concentration. Also, the weight of ten siliqua (WTs) was found to be maximum in $E_{20}$ and minimum in $E_{100}$, indicating the better quality of siliqua in the plants irrigated with 20% effluent. Similarly, the number of seeds per plant (NSP), and number of seeds per ten siliqua (NSTs) were also found to be highest in $E_{20}$, followed by $E_0$ and minimum values were found in $E_{100}$. The higher values of the weight of hundred seeds (WHS) and weight of seeds per ten siliqua (WSTs) showed that at 20% effluent concentration, better quality seeds were obtained. This may be attributed to the optimum levels of micro and macro nutrients available to the plants irrigated with 20% effluent. As per literature surveyed, only Kakar *et al*. (2010) using municipal wastewater studied the impact of wastewater on siliqua and seed characteristics of two varieties of *Brassica napus* L. On contrary to the present study, they found significant decrease in all the yield parameters (number of siliqua per plant, seeds per siliqua, seeds per plant, seed weight per plant, weight of 100 seeds) at all concentrations of the wastewater, though the decrease was variable and attributed to sensitivity of varieties to the wastewater. The variation in their findings from the present study can be ascribed to highly toxic nature of municipal wastewater of Quetta city having broad spectrum of toxic compounds coming from variety of sources *e.g.* households, industries and mining (Kakar *et al*., 2010).

Table 3 reveals that economic yield and stover/straw yield (sun-dried basis) were highest in treatment irrigated with lower concentrations of effluent and then it gradually decreased with the increase in effluent concentrations. This may be attributed to the nutritional imbalance (Ramana *et al.*, 2002a) as well as reduction in the availability of essential nutrients to the plants due to increase in the osmotic pressure of soil irrigated with higher concentrations of effluent, which may slow down the uptake of the nutrients. Mitchell (1992) also reported that poor and imbalanced nutrient supply was a major reason for plants not achieving their potential growth and yield capacity. The table also depicts that the value of harvest index was highest in treatment $E_0$ (control), followed by $E_{20}$ and then decreased with the increase in effluent concentration signifying the fact that seed weight was more sensitive to the

**Table - 4:** Effect of distillery effluent on root-shoot ratio (in terms of length and oven-dried biomass) of gobi sarson (*B. napus* L.) after 100th day

| Treatments** | Root length* (cm) | Shoot length (cm) | Root/shoot ratio | Root weight* (g) | Shoot weight (g) | Root/shoot ratio |
|---|---|---|---|---|---|---|
| $E_0$ | 11.00 ±1.25 | 57.30 ±6.12 | 0.19 | 1.90 ±0.02 | 3.71 ±0.11 | 0.51 |
| $E_{20}$ | 12.10 ±1.70 | 58.00 ±5.90 | 0.20 | 2.20 ±0.03 | 3.90 ±0.12 | 0.56 |
| $E_{40}$ | 9.16 ±1.10 | 50.30 ±5.60 | 0.18 | 1.30 ±0.02 | 2.84 ±0.11 | 0.45 |
| $E_{60}$ | 8.90 ±1.15 | 50.00 ±5.85 | 0.17 | 0.88 ±0.01 | 2.10 ±0.08 | 0.41 |
| $E_{80}$ | 8.30 ±0.95 | 49.90 ±4.50 | 0.16 | 0.81 ±0.01 | 2.10 ±0.07 | 0.38 |
| $E_{100}$ | 7.20 ±0.90 | 49.90 ±4.40 | 0.15 | 0.61 ±0.01 | 1.70 ±0.03 | 0.35 |

* Mean ± standard deviation, ** $E_0$ = Control, $E_{20}$ = 20% effluent, $E_{40}$ = 40% effluent, $E_{60}$ = 60% effluent, $E_{80}$ = 80% effluent, $E_{100}$ = 100% effluent

applied effluent stress than straw weight. Singh *et al.* (2002) while studying the effect of pulp and paper mill effluents on growth, yield and nutrient quality of wheat observed an increase in the quality of wheat grains, plant height, shoot and root biomass and harvest index upto 50% concentrations of effluent. This variation in the optimal concentration of effluent with the present study may be attributed to the differences in the physico-chemical characteristics of the effluents.

The effect of distillery effluent on root-shoot ratio (in terms of length) of *B. napus* is demonstrated in Table 4. The values revealed that there was an increase in root-shoot ratio in $E_{20}$ followed by $E_0$ while the minimum value of root-shoot ratio was found in case of $E_{80}$ and $E_{100}$. The decreasing trend of the values of root-shoot ratio at higher concentrations of effluent may be due to the increased toxicity of effluent at higher concentrations. Similar results were obtained while estimating the root-shoot ratio on the basis of biomass. Kumar *et al.* (1990) while studying the effect of chemical factory effluents on germination and growth of Gaur (*Cyamopsis tetragonolobal*), observed that the root and shoot length, dry matter accumulation and crop productivity increased in 5, 10 and 15% of the effluent treated plants. The findings of their study are in conformity with the present study. Likewise, Mahimairaja and Bolan (2004) also found that low doses of distillery effluent remarkably improve growth and yield of dryland crops (ragi, groundnut, sorghum, and green gram).

The present study showed that 20% effluent concentration was the concentration at which almost all the growth parameters showed a maximum value. It may be attributed to the presence of nutrients like N, P, K, and Mg in the effluent at optimum concentration which promoted the growth of plant. On the same line, Ramana *et al.* (2002a) found that distillery effluent significantly increased the seed yield of groundnut over control (no effluent or fertilizer). However, Banerjee *et al.* (1999) while working on the effect of distillery effluents on growth of *Casuarina equisetifolia* L. found 60% of effluent concentration as effective concentration for growth. Similarly, Akbar *et al*. (2007) observed that marble industry effluent causes reduction in shoot length and root dry biomass of *Zea mays* L. at all concentrations. These contradictions with the present study may be attributed to the physicochemical distinctiveness of the effluents and variation in the plant genera.

The above findings lead to the conclusion that lower concentration (20%) of untreated effluent, positively affects the growth and yield attributes of *Brassica napus* L. var. Punjabi Special in comparison to higher concentrations.

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## References

Akbar, F., F. Hadi, Z. Ullah and M.A. Zia: Effect of marble industry effluent on seed germination, post germinative growth and productivity of *Zea mays* L. *Pak. J. Biol. Sci.*, **10**, 4148-4151 (2007).

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

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

Banerjee, A.C., I. Bajwa and K.K. Behal: Effect of distillery effluents on growth of *Casuarina equisetifolia* L. *J. Indus. Pollut. Control,* **20**, 199-204 (1999).

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).

Chandra, R., R.N. Bhargava, S. Yadav and D. Mohan: Accumulation and distribution of toxic metals in wheat (*Triticum aestivum* L.) and Indian mustard (*Brassica campestris* L.) irrigated with distillery and tannery effluents. *J. Hazardous Materials*, **162**, 1514-1521 (2009).

Kakar, S., A. Wahid, R.B. Tareen, S.A. Kakar, M. Tariq and S.A. Kayani: Impact of municipal waste water of Quetta city on biomass, physiology and yield of canola (*Brassica napus* L.). *Pak. J. Bot.*, **42**, 317-328 (2010).

Kannan, A. and R.K. Upreti: Influence of distillery effluent on germination and growth of mung bean (*Vigna radiata*) seeds. *J.Hazardous Materials*, **153**, 609-615 (2008).

Kumar, K.T., P. Kumar, B. Patel and K. Pushpalatha: Effects of chemical factory effluent on germination and growth of Guar (*Cyamopsis tetragonolobal* Taub. var. PNB). *J. Adv. Plant Sci.,* **3**, 34-42 (1990).

Mahimairaja, S and N.S. Bolan: Problems and prospects of agricultural use of distillery spentwash in India. SuperSoil 2004: 3rd Australian New Zealand Soils Conference, 5-9 December, University of Sydney, Australia, 1-6 (2004).

Malaviya, P., R. Kour and N. Sharma: Growth and yield responses of *Capsicum annum* L. to distillery effluent irrigation. *Ind. J. Environ. Ecoplanning*, **14**, 643-646 (2007).

Mitchell, C.P.: Ecophysiology of short rotation forest crops. *Biomass and Bioenergy*, **2**, 25-27 (1992).

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).

Pant, D. and A. Adholeya: Biological approaches for treatment of distillery wastewater: A review. *Biores. Technol.*, **98**, 2321-2334 (2007).

Ramana, S., A.K. Biswas, A.B. Singh and R.B.R. Yadava: Relative efficacy of distillery effluents on growth, nitrogen fixation and yield of ground nut. *Biores. Technol.*, **81**, 117-121 (2002a).

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. *Biores. Technol.*, **82**, 1189-1193 (2002b).

Singh, A., S.B. Aggarwal, J.P.N. Rai and P. Singh: Assessment of pulp and paper mill effluent on growth, yield and nutrient quality of wheat (*Triticum aestivum* L.). *J. Environ. Biol.,* **23**, 283-288 (2002).