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Physico-chemical studies of soil & distillery factory effluent and its irrigational impact on growth of some vegetable crops

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Abstract
Physico-chemical analysis of Rampur distilillery effluent revealed high amount of total suspended and dissolved soild, SO_4^{--2}, PO_4^{--3}, total-N_2 were also present in significant amounts. All higher concentration (above 50%) of effluent the seed germination percentage was retarded. Diluted effluent (upto 50%) favoured seedling growth. Length of roots were increased by low concentration of effluent.

Keywords: Distillery effluent, alcohol, soil, germination, vegetables

Introduction
Rampur distillery is one of the largest and the most efficiently run distilleries in India. It is spread over 100 acres of lush green campus with high level of security system. It manufactures various IMFL brands and country liquor. It has overall alcohol production capacity of 102.46 million liters per annum.
Treated industrial effluents are being used for irrigation in arid areas. These effluents contain nutrients that enhance the growth of crop plants. So it is essential that the implications of the use of industrial effluents for irrigation are assessed properly. In the present study an attempt has been made to assess the effect of distillery factory on germination and growth behavior of four vegetable crops.

Materials and Methods
The effluent samples from Rampur distillery (A unit of Rdico Khaitan Ltd. (U.P.) India, were collected at the point of disposal and analysed for physico-chemical characteristics following the standard procedures [1]. Soil samples were also analysed as per the standard procedures [2, 3]. Seeds from Potato, turnip, sweet Potato and sugar beet were sown in pots (20x12 cm). Before sowing, the seeds were pretreated with acid and soaked in hot water overnight. Different concentrations of the effluent viz., 25, 50, 75 and 100% were applied to the pots at the rate of 100 mL per day. Tap water was used as control. The germination percent and vigour index of the seedling were assessed following the standard procedure [4] at 21 days after sowing. The treatments were replicated thrice in a completely randomized design.

Results and Discussion
The physico-chemical properties of the soil are presented in Table- 1 and those of the effluent in Table-2. Reseults showed that there was low concentration of major inorganic nutrients in the effluent as reported by several workers [5-7].
The results obtained in the germination study are presented in Table-3. The treatment which received 100% effluent had recorded the maximum seed germination of Potato, turnip and sugar beet whereas in sweet potato better germination was observed at lower effluent concentration. In Potato treatment which received 50 % had recorded the highest mean value for the shoot length (5.8 cm) and it was statistically at par with control. No significant deviation in the root length was observed. The treatment which recived 100% had recorded the maximum vigour index (1057), while the minimum was observed in 25% (714).

Table 1: Physico-chemical analysis of the Soil

Clay (%)	-	18.23
Silt (%)	-	7.98
Finesand (%)	-	30.31
Coarsae sand (%)	-	40.23
Water holding capacity (%)	-	49.64
Bulk Density (gmL^{-1})	-	2.27
pH	-	7.90
EC ($mSCm^{-1}$)	-	0.07
Organic Carbon	-	0.40
Available Nitrogen (kg ha^{-1})	-	172
Available Phosphorus (kg ha^{-1})	-	17.10
Available Potassium (kg ha^{-1})	-	24.70

In case of turnip the maximum shoot length was recorded by the control (8.45 cm) and the minimum was recorded at 100 % (6.6 cm). The root length was maximum (12.15 cm) in control and it gradually decreased from 25% (10.78 cm) to 100% (9.7 cm) effluent concentration. The treatment which received 100% had recorded the maximum vigour index (1413) while the minimum (1120) was encountered in 25%. In case of sugar beet also the same trend as that of turnip was observed.

Better growth of seedling was observed even at higher effluent concentration except in sweet potato. This increase in germination and growth parameters might be due to the reduction in level of toxic metabolites by dilution and better utilization of inorganic nutrients present in the effluent by the seeds. Irrigation with distillery effluent had shown encouraging results on the growth of wheat, pea and lady finger [8]. The effluent also contained nutrients like NPK which favour the growth of the seedlings. Irrigation with distillery factory effluent increased the height and collar diameter of *Eucalyptus canaldulensis, Pongamia pinnata, Acacia auriculiformits, Leucaena sp. And Dendrocalmus strictus* [9]. Low concentration of the effluent had no adverse effect on the germination of seeds of some rabi crops [10].

Table 2: Physico-chemical analysis of the effluent

Characteristics		Effluent Concentration	Tap Water
Colour	-	Dark brown	Colourless
Odour	-	Vinegar	-
pH	-	7.5	7.0
Transparency	-	2.9	100
ECe (m SCm^{-1})	-	3.28	1.4
Total solids (mg L^{-1})	-	815	120
Suspended solids (mg L^{-1})	-	168	22
Dissolved solids (mg L^{-1})	-	647	150
D O (mg L^{-1})	-	2.8	12
BOD (mg L^{-1})	-	61.0	3.0
COD (mg L^{-1})	-	780.0	45
Organic carbon (%)	-	0.75	-
Total alkalinity (mg L^{-1})	-	174	40
Ca (mg L^{-1})	-	238	3.9
Mg (mg L^{-1})	-	65	45
Na (mg L^{-1})	-	310	2.0
NH_4^+-N (mg L^{-1})	-	20.0	-
P (mg L^{-1})	-	1.00	0.2
K (mg L^{-1})	-	12.0	2.0

Table 3: Effect of different concentration of distillery factory effluent on germination of Potato, Turnip, Sweet potato and sugar beet (Mean±SE of four replication)

% Concentration Effluent	Potato±SE	% Turnip±SE	%Sweet Potato±SE	%Sugar beet±SE
25	89±0.2	76.2±1.2	68±1. 2	76.2±0.14
50	84±0.3	73.0±0.20	63.4±1.4	71.4±0.12
75	81.2±0.12	70.7±0.10	60.4±0.6	70.6±0.60
100	80±0.14	65.6±0.31	58±0.12	66.2±1.20
Control	86±0.12	72.4±0.02	67.2±0.12	75.2±1.30

Values in %

Table 4: Effect of different concentration of distillery factory effluent on seedling growth of Potato, Turnip, sweet potato and sugar beet in pot culture experiments (Mean±SE of four replication)

%Concentration Effluent	Potato (Cm)		Turnip (Cm)		Sweet Potato (Cm)		Sugar beet (Cm)	
	S. Length	R. Length	S. Length	R. Length	S.Length	R. Length	S. Length	R. Length
25	6.8	7.8	8.55	10.78	7.9	10.78	6.8	7.9
50	5.8	7.0	7.64	10.01	7.4	10.04	5.9	7.1
75	5.6	6.8	7.20	9.94	7.02	10.4	5.9	7.1
100	5.0	5.8	6.6	9.7	6.6	9.7	5.2	5.9
Control	6.5	7.7	8.45	12.5	8.48	12.15	6.8	7.6

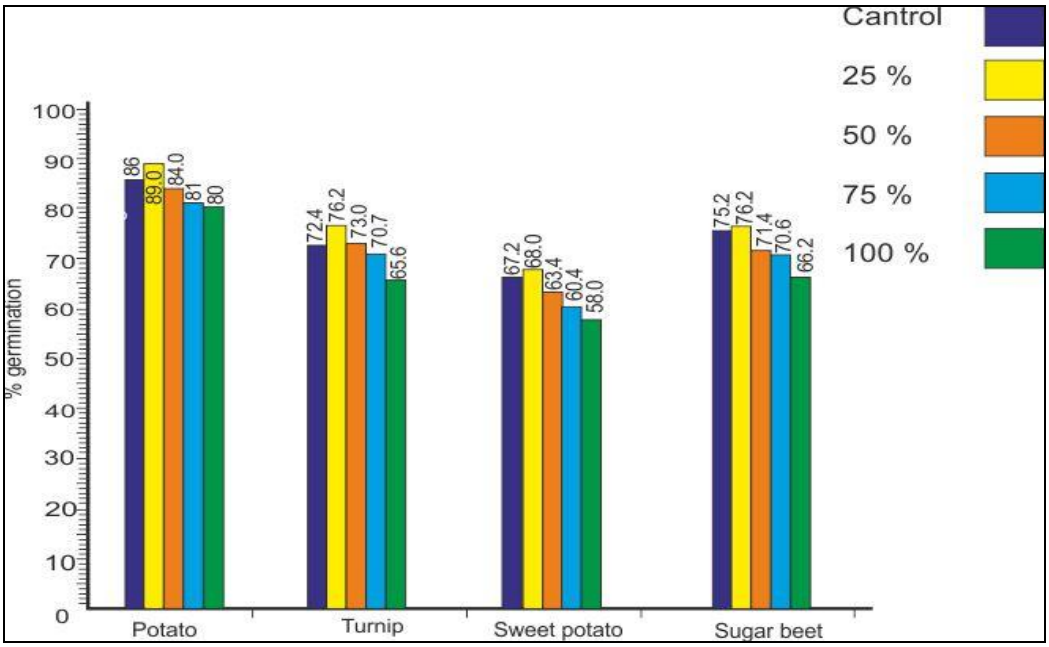

Fig 1: Bar Diagram % germination

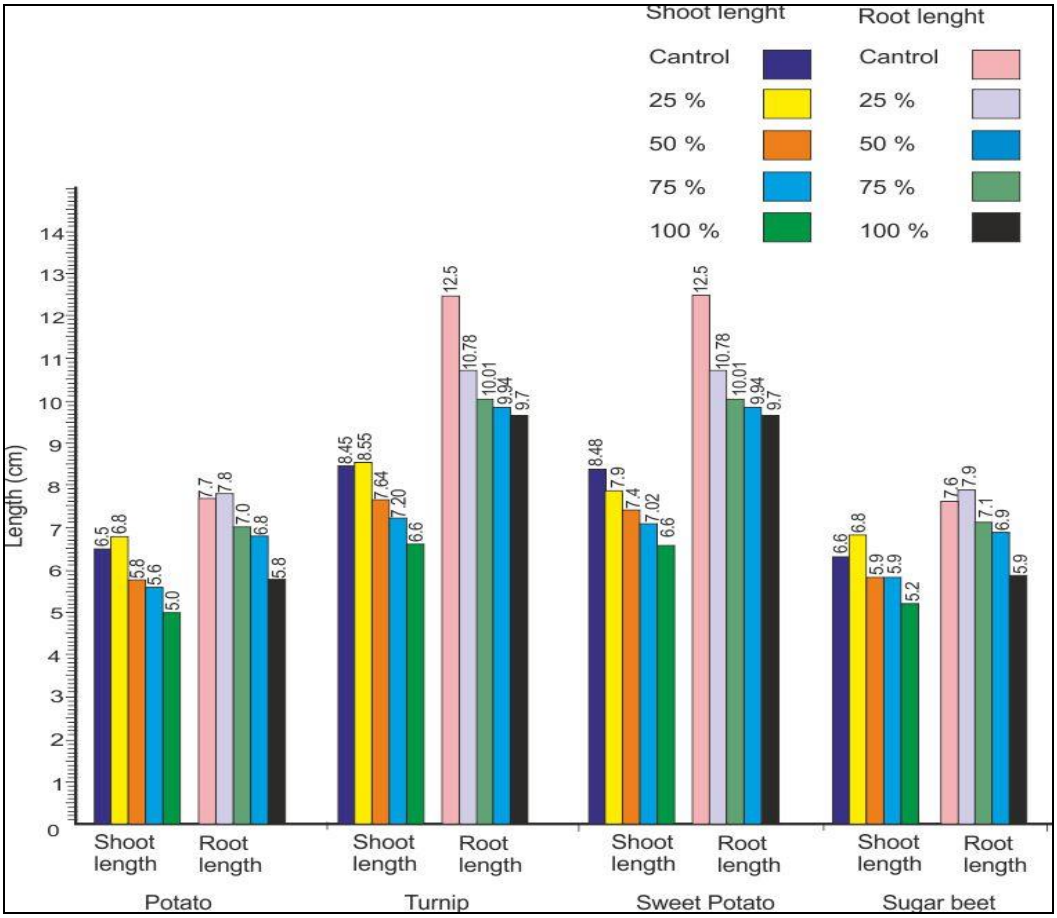

Fig 2: Bar diagram seedling growth

In sweet potato better growth at lower effluent concentration was observed. The reduced performance at higher concentration might be due to excess amount of salts. The excess amount of calcium and magnesium in irrigation water caused injuries to the plant and it might have affected the seedling growth [6, 11].

The results obtained in the present study showed that the treated distillery factory wastewater can be used for irrigation without dilution for potato turnip and sugar beet and after dilution with water for sweet potato.

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