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Study on Changes in Water Quality under Piezometer Experiment with application of graded levels of Treated Sugarcane Distillery Effluent in Sandy Clay Loam soil

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SUMMARY: *In India, there are 290 distilleries producing 2.75 billion litres of alcohol and generate 10 to 15 litres of spent wash per litre of alcohol. Tamil Nadu contributes around 3.6 billion litres of spent wash. The spent wash is used for power generation resulting in the release of treated distillery effluent (TDE) which has nutrient potential for crops grown in normal soils. Thus TDE as an agricultural by-product of sugarcane based distillery effluent is non-harmful, bio-degradable and purely of plant origin. Application of TDE enhances the yield of crops and the TDE in soil tends to move downwards by gravity. This necessitates monitoring of changes in ground water quality. In view of the above, the investigation was undertaken to study the impact of TDE application under piezometer study. TDE was applied @ 0, 10,000, 20,000, 30,000 and 40,000 l ha^{-1}. The water samples were collected at monthly interval from the piezometer and analyzed for pH, Electrical Conductivity (EC), Residual Sodium Carbonate (RSC), Sodium Adsorption Ratio (SAR) Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). The results revealed that the pH of the water had no significant change by the application of TDE. The EC of the ground water get increased at initial stage by the application of TDE. Over a period of time the EC starts decreasing back to the original value and it is due to the dilution and leaching effect of salts. The RSC of the leachate collected from the piezometer reveals that there is no significant effect on ground water by the application of TDE. The SAR of the leachate had no significant change on ground water quality which comes under safe limit. The BOD and COD value of the water samples gets reduced gradually over a period of time. It is due to the reason that, the TDE after application in rice field allowed for natural oxidation for 8 days and there after transplanting were carried out and thus the BOD and COD reduces.*
(Key words: BOD, COD, Distillery effluent, EC, pH, RSC, SAR and Water quality)

INTRODUCTION

The molasses is a by-product of sugar industry used for the production of alcohol. In India, 2.75 billion litres of alcohol are produced every year from 290 distilleries. For every litre of alcohol production, 10 to 15 litres of spent wash is generated. The spent wash is used for power generation resulting in the release of treated distillery effluent (TDE) which is an agricultural by-product of sugarcane based distillery effluent is non-harmful, bio-degradable and purely of plant origin as it contains large quantities of soluble organic matter and plant nutrients that could be used by crops for their growth and yield (Baskar *et al*., 2003 and Balasubramaniam *et al*. 2006). The TDE application in soil tends to move downwards by gravity. Thus, the quality of ground water is of great importance in determining the suitability for irrigation. In view of the above, the investigation was undertaken to study the impact of TDE application on changes in water quality through piezometer study in sandy clay loam texture soil under submerged rice cultivation.

MATERIALS AND METHODS

To assess the quality of ground water, five piezometers were installed at 1m depth in each experimental plot at the rate of one piezometer per plot where rice is to be grown under submerged condition. The initial characteristics of experimental soil were sandy clay loam texture having 47.0, 26.0 and 23.7 per cent of sand, silt and clay, respectively. The soil pH was

7.4 and EC was 0.1 dS m^{-1}. The treatments imposed in each plot were TDE @ 0, 10,000, 20,000, 30,000 and 40,000 l ha^{-1}. The piezometer was installed at the centre of each plot and the bottom of PVC pipe was sealed with end cap without any leakage of the water from the pipe. Leaving the 0.15 m length from the bottom of the pipe for the collection of the leachate, perforation i.e., circular holes or longitudinal slits in a zig - zag fashion to the length of 0.5m were made just above the collection tank. Then, the pipe was marked with marker to the height of 1m from the top of the perforated portion in order to maintain the soil column of 1 m depth from the soil surface to the perforated portion. About 0.30m length pipe was left above the surface layer of the field and the top end of the PVC pipe was fitted with screw cap for easy operation during the collection of the leachate and also to avoid entry of external water sources. The perforated portion of 0.5m length in the pipe was completely covered with 2 mm nylon net and sealed at both end of perforated portion by cello tape. This arrangement of structures facilitated the easy movement of water through the soil column of 1 m depth and easy operation during collection. Piezo water samples were collected at four different intervals *viz*., 30, 60, 90 and 120 days after the application of treated distillery effluent in the experiment plot as pre-sown application. The water samples were analysed for pH, EC, RSC, SAR, BOD and COD. The initial soil pH and EC was determined by using 1:2 soil water suspensions in pH meter and conductivity meter respectively (Jackson, 1973). The soil texture of initial sample was analysed through international pipette method (Piper, 1966). The pH, EC and other chemical constituents in water viz., CO_3, H CO_3, Ca, Mg and Na were analyzed using standard procedures. The BOD of the water sample were determined by iodimetric method (APHA, 1989) and COD by open reflux method (APHA, 1989). The quality parameters viz., Residual Sodium Carbonate (RSC), Sodium Adsorption Ratio (SAR), (Richards, 1954) were assessed to judge the quality of water.

RESULTS AND DISCUSSION

pH and EC :The pH of water collected from the piezometer installed in the different main plots treated with graded levels of TDE viz. 0, 10,000, 20,000, 30,000 and 40,000 l ha^{-1} revealed that the slight changes in pH were noticed with higher dose of TDE (Table 1). Application of graded levels of TDE increased the mean pH from 7.3 to 7.7 irrespective of different intervals. The highest mean pH was revealed by the application of TDE @ 40,000 l ha^{-1} over other treatments. Over a period of time the pH starts to change in declining trend and reaches normal. The EC of the water collected from the piezometer installed in the different main plots treated with graded levels of TDE viz. 0. 10,000, 20,000, 30,000 and 40,000 l ha^{-1} revealed that the changes in EC at higher side were noticed with higher dose of TDE (Table 1). Application of graded levels of TDE increased the mean EC from 0.55 to 0.89 dS m^{-1} irrespective of different intervals. The highest mean EC was recorded by the application of TDE @ 40,000 l ha^{-1} over other treatments. On comparing with different days of intervals, the EC was slightly increased immediately after application i.e. 60 days after application, there after the declining trend was observed. However, the EC was below the critical limit which may not cause any deleterious effect on plant growth. It is due to the dilution and leaching effect of salts. The results obtained from this study were similar to the findings of Balasubramaniam *et al*. (2006) and Anandakrishnan *et al*. (2007).

Residual Sodium Carbonate (RSC) and Sodium Adsorption Ratio (SAR): The RSC is one of the important water quality parameter was assessed in the water samples collected from the piezometer installed in the different plots treated with graded levels of TDE viz. 0, 10,000, 20,000, 30,000 and 40,000 l ha^{-1} (Table 2). The results of RSC in water sample by the application of TDE @ 40,000 l ha^{-1} showed negative values which clearly indicated the excess of Ca, Mg over Na, which may increase the hardness of water as this will make the soil soft. The mean SAR ranged from 0.74 to 0.63 by the application of graded levels of TDE. The SAR gets

increased over a period of time, but it decreases with application of higher dose of TDE. The RSC and SAR fall within the safe limit and they didn't cause any deleterious effect to the plant growth. The results line up with the findings of Balasubramaniam *et al.* (2006) and Anandakrishnan *et al*. (2007).

Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) **:**The BOD of the water collected from the piezometer installed in the different main plots treated with graded levels of TDE viz. 0, 10,000, 20,000, 30,000 and 40,000 l ha^{-1} revealed that the changes in BOD at higher side were noticed with higher dose of TDE (Fig 2). Application of graded levels of TDE increased the mean BOD from 5.1 to 5.5 mg l^{-1} irrespective of different intervals. The highest mean BOD was recorded by the application of TDE @ 40,000 l ha^{-1} over other treatments. On comparing with different days of intervals, the BOD was decreased with increase in days after TDE application (Fig 1). The COD of the water revealed that the changes in COD at higher side were noticed with higher dose of TDE. Application of graded levels of TDE increased the mean COD from 9.5 to 10.5 mg l^{-1} irrespective of different intervals (Fig 4). The highest mean COD was recorded by the application of TDE @ 40,000 l ha^{-1} over other treatments. Irrespective of different treatments the COD decreases from 9.960 to 9.904 mg l^{-1} from 30 to 120 days (Fig 3). The results are corroborated with the findings of Anandakrishnan *et al*. (2007).

CONCLUSIONS

The study conducted reveals that the pH of water showed no significant variation due to TDE application. The EC increases after application of TDE and it starts to return back to its initial value over a period of time. The water samples didn't show considerable change in RSC and the SAR which showed no significant influence on quality of ground water due to application of TDE. Similarly the BOD and COD didn't show any deleterious effect. Hence, the investigation reveals that the application of TDE up to 40,000 l ha^{-1} in soil will not cause any deleterious effect on groundwater quality. However, continuous monitoring of ground water in the TDE applied area is mandatory for assessing the changes occurs over a period of time.

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Table 1. Effect of graded levels of TDE on changes in pH and EC (dS m^{-1}) of water sample collected from piezometer

Treatments	pH					EC (dS m^{-1})				
	Days after application					Days after application				
	30	60	90	120	Mean	30	60	90	120	Mean
Control	7.3	7.3	7.3	7.3	**7.3**	0.55	0.56	0.55	0.55	**0.55**
TDE @ 10,000 l ha^{-1}	7.5	7.5	7.4	7.4	**7.5**	0.62	0.64	0.63	0.63	**0.63**
TDE @ 20,000 l ha^{-1}	7.6	7.6	7.5	7.4	**7.5**	0.74	0.77	0.76	0.75	**0.76**
TDE @ 30,000 l ha^{-1}	7.8	7.8	7.6	7.5	**7.7**	0.81	0.85	0.85	0.83	**0.84**
TDE @ 40,000 l ha^{-1}	7.8	7.8	7.7	7.6	**7.7**	0.89	0.91	0.90	0.89	**0.89**
Mean	**7.6**	**7.6**	**7.5**	**7.4**		**0.72**	**0.75**	**0.74**	**0.73**	
SE d	**0.21**	**3.02**	**0.14**	**3.38**		**0.14**	**0.28**	**0.29**	**0.28**	

Table 2. Effect of graded levels of TDE on changes in RSC (meq l^{-1}) and SAR of water sample collected from piezometer

Treatments	RSC (meq l^{-1})					SAR				
	Days after application					Days after application				
	30	60	90	120	Mean	30	60	90	120	Mean
Control	-7.28	-6.36	-5.64	-5.6	**-6.2**	0.7	0.73	0.75	0.77	**0.74**
TDE @ 10,000 l ha^{-1}	-6.08	-7.76	-7.12	-6.9	**-6.9**	0.65	0.66	0.67	0.68	**0.67**
TDE @ 20,000 l ha^{-1}	-6.88	-8.36	-7.52	-7.4	**-7.5**	0.63	0.64	0.66	0.69	**0.66**
TDE @ 30,000 l ha^{-1}	-7.44	-9.12	-8.32	-8.1	**-8.2**	0.62	0.63	0.64	0.65	**0.64**
TDE @ 40,000 l ha^{-1}	-7.92	-9.06	-8.56	-8.3	**-8.5**	0.61	0.62	0.64	0.65	**0.63**
Mean	-7.12	-8.132	-7.432	-7.26		0.64	0.66	0.67	0.69	
SE d	**8.56**	**6.87**	**7.47**	**6.90**		**0.19**	**0.19**	**0.23**	**0.25**	

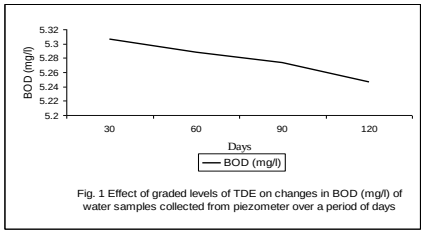

Fig. 1 Effect of graded levels of TDE on changes in BOD (mg/l) of water samples collected from piezometer over a period of days

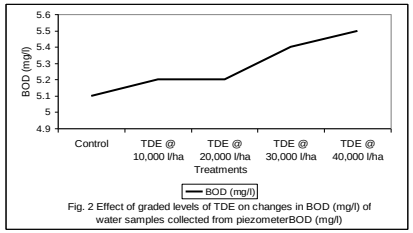

Fig. 2 Effect of graded levels of TDE on changes in BOD (mg/l) of water samples collected from piezometerBOD (mg/l)

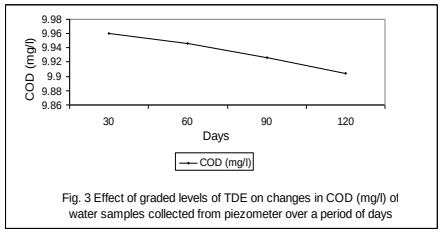

Fig. 3 Effect of graded levels of TDE on changes in COD (mg/l) ol water samples collected from piezometer over a period of days

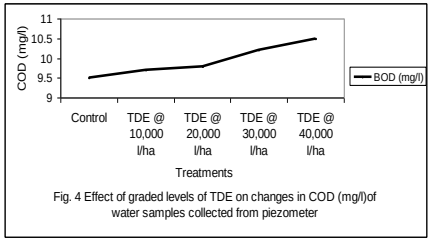

Fig. 4 Effect of graded levels of TDE on changes in COD (mg/l)of water samples collected from piezometer