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Short Note

Monitoring Distillery Effluent Effect on Water Quality using Piezometer

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To monitor the downward movement of distillery effluent and possible ground water contamination, piezometers were installed at 1 metre depth in the Cumbu Napier hybrid grass field at Research and Development Farm of M/s. Bannari Amman Sugars Ltd., Ealur, Erode district, Tamil Nadu, during August 2009 to July 2010. Treatments involved are distillery spentwash @ 37.5 and 50 kilo litres per ha at full and split dose along with recommended dose of fertilizers. Leachate was collected from piezometers at 4th week after planting and subsequent collections at the time of harvesting from 12th week after planting to 52nd week after planting and leachate samples were analyzed for various parameters. The results indicated that there was an increase in pH, EC, COD, anions and cations content due to the application of BDS over the recommended dose and were within the critical limits and have not influenced the ground water and there is no possibility of pollution by BDS application.

Key words: BDS, CN Hybrid grass, Leachate and Sodium Adsorption Ratio.

The disposal of wastes from industrial sources is becoming a serious problem throughout the world. Distilleries, one of the most important agro-based industry in India, produce alcohol from molasses. They generate large volume of foul smelling, coloured wastewater known as spentwash. For production of each litre of alcohol, 12-15 l of spentwash is produced. Approximately 40 billion litres of wastewater is generated per annum from 319 distilleries in the country (Kanimozhi and Vasudevan, 2010). Most of the distilleries are concentrated in the states of Maharashtra, Uttar Pradesh, Andra Pradesh, Madhya Pradesh, Tamil Nadu and Karnataka. Indiscriminate disposal of BDS has resulted in adverse impact on soil and environmental health in various areas. Ground water contamination by effluent with high BOD and salt content near the lagoon in most of the distilleries has been reported widely. Farmers in the adjoining areas of molasses based distilleries often use the effluent for irrigating crops without considering its impact on the ground water. Monitoring of ground water beneath the effluent irrigation site is important to maintain its quality because of the risk due to leaching of organic and inorganic ions from effluent irrigated fields have been made to assess the risk of groundwater pollution arising due to such practice. The objective of the present study was to assess the impact of BDS application on groundwater quality.

Materials and Methods

The BDS collected from the distillery unit of M/s. Bannari Amman Sugars Ltd., Periyapuliyur, Erode district, Tamil Nadu was analyzed for its physico-chemical properties following standard procedures (APHA, 1998). The important characteristics of spentwash are presented in Table 1. Field experiment was conducted during 2009 to 2010, at Research and Development Farm, M/s. Bannari Amman Sugars Distillery Division Ltd., Ealur, Erode, Tamil Nadu. To study the potentiality of BDS contaminating the ground water due to its high salt content, BOD and COD, piezometers at 1 metre depth of soil were installed at different treatments *viz.,* T_1- Recommended dose of fertilizers (without BDS application), T_2- BDS @ 37.5 kilo litres per ha at full dose, T_3- BDS @ 37.5 kilo litres per ha at split dose (basal 40 % and 10 % after each cutting), T_4-BDS @ 50 kilo litres per ha at full dose, T_5- BDS @ 50 kilo litres per ha at split dose in cumbu napier hybrid grass field experiment. The experiment was laid out in randomized block design with three replications.

Structure and installation of piezometers

The PVC pipe of 50 mm diameter with a total length of 1.95 m was taken.

The bottom of PVC pipe was sealed with end cap without any leakage of water from the pipe. Leaving 0.15 m length from the bottom of the pipe for collection of leachate, perforation of circular holes or longitudinal slits in a zig zag fashion to the length of 0.5 m were made just above the collection tank. Then, the pipe was marked with marker to a 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 0.30 m

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length pipe was left above the surface layer of the field and top end of the PVC pipe was fitted with a screw cap for easy operation during the collection of the leachate and also to avoid entry of external water sources. The perforated portion of 0.5 m length in the pipe was completely covered with 2 mm nylon net and sealed at both the ends of perforated portion by a cellophane tape (Fig. 1). This arrangement of structures would facilitate for the easy movement of water through the soil column of 1m depth and also for the easy operation during collection. Before installation of piezometer, a soil core of more than 50 mm diameter to a depth of 1.65 m was completely removed by employing mechanical driller or soil auger. Then, the piezometer of above structure was vertically placed in the empty soil column. The quartz

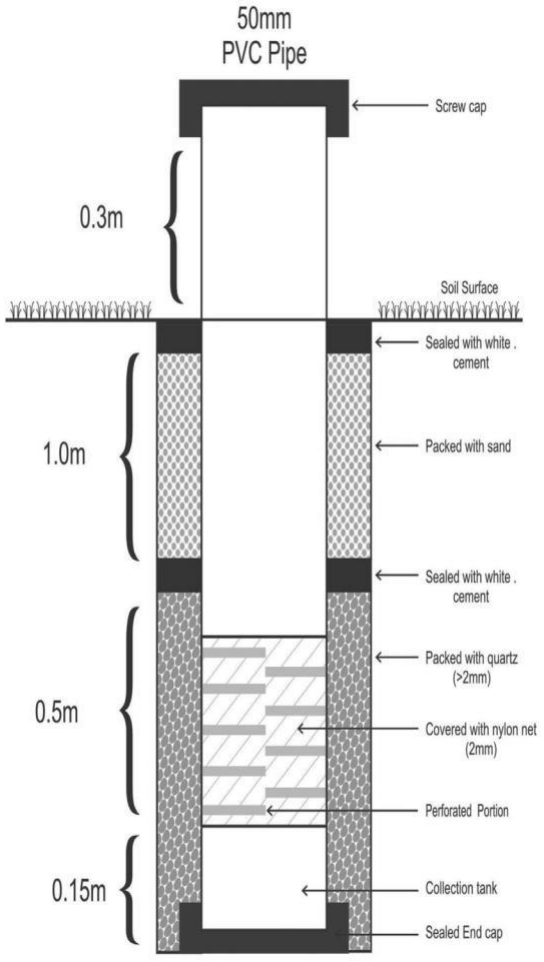

Fig. 1. Schematic diagram of piezometer

particles with more than 2 mm size was packed along the sides of the empty column up to a height of just above the top of perforated portion and then a small portion was sealed with wetted white cement. After few minutes, while the white cement sets, river sand was packed up to a height of just below the soil surface. Again, the unfilled portion just below the soil surface was sealed with wetted white cement. After the installation of piezometer in individual plot, the treatments already fixed were imposed as per the method described earlier. Leachate was periodically collected from piezometers at 4th WAP and subsequent collection at the time of each harvesting from 12th WAP to 52nd WAP of the crop (8 collections totally) and analysed for various parameters by following standard procedures (APHA, 1998).

Results and Discussion

Influence of BDS on pH and EC

The quantum of spentwash application had a marked influence on the pH and EC of the leachate. The pH of the leachate collected from spentwash applied soil was relatively high compared to RD plot and the moderately alkaline pH was observed in plots applied with spentwash @ 50 kilo litres ha^{-1} and 37.5 kilo litres ha^{-1} at full dose. The increase in the pH upto 7.99 might be due to addition of salts by spentwash which favours alkalinity and continuous release of exchangeable bases *viz.,* Ca, Mg, Na and K in the soil solution (Sridharan, 2007) (Fig. 2). The EC, an index of salt loading of leachate was increased markedly as the rate of spentwash application increased. Moreover, EC of the leachate varied from 0.52 to 1.08 dS m^{-1} and significantly decreased with the increasing number of leaching

Table 1. Characteristics of Biomethanated Distillery Spentwash (BDS)

S. No	Parameters	Values*
1.	Colour	Dark brown
2.	Odour	Unpleasant burnt sugar
3.	Total suspended solids	12,908
4.	Total dissolved solids	32,730
5.	pH	7.42
6.	EC (dS m^{-1})	32.5
7.	Biological oxygen demand	6,545
8.	Chemical oxygen demand	34,476
9.	Organic carbon	13,110
10.	Total Nitrogen	2,116
11.	Total Phosphorus	52.8
12.	Total Potassium	8,376

*Mean of triplicate samples; (Values are in mg L^{-1} unless otherwise stated)

(Fig. 2). Increase in EC was very well correlated with the increase in the levels of spentwash application. The results indicated that application of spentwash at higher rates might lead to build up of salts in the soil as claimed by Ashok Kumar *et al.* (2011).

Influence of BDS on BOD and COD

The mean BOD and COD ranged from 4.69 to 11.99 mg L^{-1} and 17.7 to 43.8 mg L^{-1} respectively for the treatments T_1 to T_5, respectively. The maximum BOD (11.99 mg L^{-1}) and COD (43.8 mg L^{-1}) was registered by BDS @ 50 kilo litres ha^{-1} at full dose which was significantly different from other treatments. The content was decreased with the increasing number of leaching. The result of the BOD and COD of the leachate collected from BDS treated soil indicated that though the level was high

Table 2. Effect of BDS on COD (mg L^{-1}) at various periods of leachate collected in piezometer

Treatment	Leachate collection periods								
	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	Mean
T_1- Recommended dose of fertilizers (without BDS application)	32.9	26.7	22.6	18.9	14.6	9.9	8.6	7.3	17.7
T_2- BDS @ 37.5 kilo litres per ha at full dose	61.2	52.5	45.2	39.6	32.3	27.6	24.6	22.4	38.2
T_3- BDS @ 37.5 kilo litres per ha at split dose	42.8	31.2	24.6	21.5	17.7	14.0	12.5	9.1	21.6
T_4- BDS @ 50 kilo litres per ha at full dose	68.0	58.2	51.9	46.6	38.8	31.9	28.4	26.7	43.8
T_5- BDS @ 50 kilo litres per ha at split dose	50.9	42.6	36.7	27.8	21.8	17.7	16.5	14.2	28.5
		SEd				CD (p=0.05)			
T		0.76					1.52		
L		0.90					1.80		
TxL		2.02					4.02		

T_1- Recommended dose of fertilizers (without BDS application), T_2- BDS @ 37.5 kilo litres per ha at full dose, T_3- BDS @ 37.5 kilo litres per ha at split dose, T_4- BDS @ 50 kilo litres per ha at full dose, T_5- BDS @ 50 kilo litres per ha at split dose

in the leachate compared to RD plot, they are within the critical limits of Indian standard norms (<30 and 250 mg $^{-1}$ respectively) (Table 2). The high organic loading in the leachate of spentwash applied soil might be due to buildup of organic matter and salt content in soil. The results suggested that if sufficient time is allowed for planting the crop after the spentwash application, this will facilitate the decomposition of organic matter resulting in the considerable reduction of BOD and COD of the ground water. Similar results were reported by Jain *et al*. (2005).

Influence of BDS on cations

The mean Ca content ranged from 3.03 to 5.02 m.e. L^{-1} for the treatments T_1 to T_5, respectively. With regard to the various treatments, BDS @ 50 kilo litres ha^{-1} at full dose significantly recorded the

Table 3. Effect of BDS on Ca (mg L^{-1}) at various periods of leachate collected in piezometer

Treatment	Leachate collection periods								
	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	Mean
T_1- Recommended dose of fertilizers (without BDS application)	4.12	3.86	3.45	3.14	2.73	2.46	2.34	2.14	3.03
T_2- BDS @ 37.5 kilo litres per ha at full dose	5.82	5.63	5.05	4.65	4.32	4.22	4.17	4.04	4.74
T_3- BDS @ 37.5 kilo litres per ha at split dose	4.76	4.64	4.38	4.04	3.85	3.62	3.55	3.38	4.03
T_4- BDS @ 50 kilo litres per ha at full dose	6.17	6.08	5.48	4.82	4.54	4.48	4.34	4.21	5.02
T_5- BDS @ 50 kilo litres per ha at split dose	5.02	4.86	4.59	4.22	4.02	3.85	3.76	3.69	4.25
		SEd				CD (p=0.05)			
T		0.08					0.16		
L		0.09					0.19		
TxL		0.21					0.42		

T_1- Recommended dose of fertilizers (without BDS application), T_2- BDS @ 37.5 kilo litres per ha at full dose, T_3- BDS @ 37.5 kilo litres per ha at split dose, T_4- BDS @ 50 kilo litres per ha at full dose, T_5- BDS @ 50 kilo litres per ha at split dose

maximum and a significant minimum value recorded by RD. The content was decreased with the increasing number of leaching. Higher amounts of cations *viz.,* Ca^{2+} was found in the leachates due to the application of spentwash. Increase in the level of spentwash markedly increased the total amount of cations leached from the soil (Table 3). At all leaching events, higher amounts of salts expulsion were associated with the higher rate of spentwash application and there was a decrease in value of cations with the increase in number of leachings. This is in close agreement with the findings of Saliha *et al.,* (2005).

Influence of BDS on anions

The influence on Cl^- content at various stages of leachate collection was significantly different from each other. The mean Cl^- for the treatments ranged from 2.80 to 5.23 m.e. L^{-1}. The treatment T_4 (BDS @ 50 kilo litres ha^{-1} at full dose) significantly recorded the highest and lowest was recorded by RD. In general, the Cl^- contents of the leachate collected from the piezometer increased with application of distillery spentwash to the crop. As the spentwash contained high concentration of Cl^- (8,120 mg L^{-1}) which might have enriched the soil solution with soluble Cl^- resulted in greater concentration of this ion in the leachate (Table 4). In most of the soil amended with spentwash, large accumulation of salts followed by greater amount of leaching were reported by Rajukkannu *et al.* (1996).

Conclusion

The possible pollution of ground water due to one time land application of BDS @ 50 kilo litres per ha at full doses was not at significant level. There was an increase in pH, EC, BOD, COD, anions and cations content, SAR and RSC of soil due to the application of BDS over the recommended dose of fertilizers and were within the critical limits. However, the level of application should be within the prescribed limit to avoid development of soil salinity

Table 4. Effect of BDS on Cl^- (m.e. L^{-1}) at various periods of leachate collected in piezometer

Treatment	Leachate collection periods								
	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	Mean
T_1- Recommended dose of fertilizers (without BDS application)	4.15	3.75	3.32	2.86	2.45	2.04	1.99	1.83	2.80
T_2- BDS @ 37.5 kilo litres per ha at full dose	6.32	5.87	5.43	5.15	4.66	3.86	3.65	3.46	4.80
T_3- BDS @ 37.5 kilo litres per ha at split dose	5.04	4.64	4.36	4.18	3.24	3.12	2.94	2.78	3.79
T_4- BDS @ 50 kilo litres per ha at full dose	6.85	6.35	5.92	5.68	4.84	4.28	4.07	3.84	5.23
T_5- BDS @ 50 kilo litres per ha at split dose	5.46	5.03	4.84	4.35	3.52	3.37	3.26	3.15	4.12
		SEd					CD (p=0.05)		
T		0.05					0.11		
L		0.06					0.13		
TxL		0.14					0.29		

T_1- Recommended dose of fertilizers (without BDS application), T_2- BDS @ 37.5 kilo litres per ha at full dose, T_3- BDS @ 37.5 kilo litres per ha at split dose, T_4- BDS @ 50 kilo litres per ha at full dose, T_5- BDS @ 50 kilo litres per ha at split dose

in the long run and not to affect the ground water quality.

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References

American Public Health Association (APHA). 1998. Standard Methods for the Examination of Water and Waste water. Ed. Clesceri, A.D., Rice, L.S. and Greenberg, A.E., American water works association, Washington, pp. 1368.

Anandakrishnan, B., Soundarajan, M., Sheik Dawood, M., Jebaraj, S. and Pushpavalli, R. 2007. Studies on the long term effect of distillery effluent on sugarcane yield and soil properties. **In:** *Abstracts of National Conference on eco -friendly utilization of recyclable organic resources from the sugar and distillery industries for sustainable agriculture*, Tamil Nadu Agricultural University, Tiruchirappalli, Tamil Nadu, March 6-7, p. 42.

Ashok Kumar, U.P. Shahi, B.P. Dhyani, R.K. Naresh, B. Singh, Yogesh Kumar and Suhel Sardar. 2011. Quality assessment of ground water in PMDE treated farm land for drinking purpose. *Plant Archives,* **11:** 187-191.

Jain, N., Bhatia, A., Kaushik, R., Sanjeev Kumar, H. and Joshi. C. 2005. Impact of Post-Methanation Distillery effluent irrigation on groundwater quality. *Environ. Monit. Asses.,* **110:** 243-255.

Kanimozhi, R. and N. Vasudevan. 2010. An overview of wastewater treatment in distillery industry. *Int. J. Environ. Engg.*, **2:** 159-184.

Rajukkannu, K., Manickam, T.S., Shanmugam, K., Chandrasekharan, A. and Gladis. R. 1996. Distillery spentwash-Development of technology for using it as an amendment for reclamation of sodic soils. In: *Proceedings of National Symposium on use of distillery and sugar industry wastes in agriculture*, Tamil Nadu Agricultural University, Tiruchirapalli, pp. 30-39.

Saliha, B.B., Krishnakumar, S. and Natarajan. S.K. 2005. Response of rice crop to organic manuring in high pH soil. *Asian J. Environ. Sci.*, **4:** 524-526.

Sridharan, B. 2007. Recycling of post methanated distillery spentwash in the soils of Vasudevanallur for maize crop. M.Sc. (Env. Sci.) Thesis, Tamil Nadu Agricultural University, Coimbatore.

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