International Archive of Applied Sciences and Technology
Int. Arch. App. Sci. Technol; Vol 5 [2]June 2014: 06-12
© 2014 Society of Education, India
[ISO9001: 2008 Certified Organization]
www.soeagra.co/iaast.html

IAAST
ONLINE ISSN 2277- 1565
PRINT ISSN 0976 - 4828

CODEN: IAASCA **ORIGINAL ARTICLE**

Effect of Sugar Mill Effluent on Physico-chemical Properties of Soil at Panipat City, India

Renu Daulta[1], Jyoti Rani[1] and Anoop Yadav[2*]
[1]Department of Energy Studies & Environmental Management,
Deenbandhu Chhotu Ram University of Science and Technology, Murthal (Sonipat), Haryana, INDIA.
[2]Department of Environmental Science and Engineering,
Guru Jambheshwar University of Science and Technology, Hisar-125001, Haryana, INDIA.
E-mail: yadavanoop@rediffmail.com*; renu.daulta@gmail.com

ABSTRACT
India is agriculture based country and there is a great demand in water for irrigation. Use of industrial effluent for agricultural and discharge of industrial effluent in the land of irrigation have become common practice in India as a result of which these toxic metals get accumulated in soil. The present study was aimed to investigate the impact of sugar industry on soil quality of area around the sugar industry. Soil sampling was done from January to May from 10 different locations around a sugar industry. The various physico-chemical parameters were determined including pH, Electrical Conductivity, Organic carbon, Potassium, Phosphorus and Sulphur. Results indicate that sugar mill effluent affected various soil parameters such as Organic carbon, Electrical conductivity, Sulphur and Potassium. Addition of nutrients by effluent improves the soil properties but the addition of too much nutrient like sulphur and potassium content in soil become toxic, decline the soil property.
Keywords: Sugar industry; Soil properties; effluent; pH; Sulphur; potassium

Received 13/03/2013 Revised 01/05/2014 Accepted 20/05/2014

INTRODUCTION

India is agriculture based country and there is an excessive demand of water for irrigation while large quantity of effluent is discharged into water source as untreated (1). Use of industrial effluent for agricultural have become common practice in India, as a result of which these toxic metals get accumulated into plant tissue from the polluted soil (2). Disposal of industrial waste has created dual problem that has degraded the soil fertility and contaminated the food-chain (3). Sugar mill play a major role in polluting the water bodies and land by discharging a huge amount of wastewater as effluent. Several chemicals are used during the sugar manufacturing process mainly for coagulation of impurities and refining of the end products. Large amount of effluent generated during the manufacture of sugar contains a high amount of pollution load particularly suspended solids, organic matters, press-mud, bagasse and air pollution (4-5). Discharge of sugar industry effluent to the land of irrigation influences the physico-chemical properties of soil (6-7). Chopra and Pathak have showed that the sugar mill effluent can be a source of contamination to the soil as some toxic metals may also be transfer to roots and then to leaves (8). Baskaran et al have also identified the polluted soil by sugar industry becomes unsuitable for further cultivation of crops (9).

Presently, India has more than 650 sugar mills that produce about 15 million tons of sugar and 13 million tons of molasses (10). These mills discharge huge amount of effluent per day without any treatment or partial treatment during the crushing season. It has also been reported that sugar mill effluent contains a high magnitude of pollution load and causes antagonistic effects on soil (10, 11). The continuous use of these effluents harmfully affects the crops when used for irrigation. As a result, a higher amount of various elements get deposited in the soil and make them polluted. However, some time effluents containing various metallic and non-metallic elements which act as nutrients, but at the higher concentration they show toxic effects on seed germination and seedling growth, ultimately adversely affecting plant growth and yield in cultivated land (12). Most crops give higher potential yields with wastewater irrigation which reduce the need for chemical fertilizers, resulting in net cost savings to farmers. This is due to organic waste that may contribute to maintain or increase the organic matter and

nutrient content in the soil (13). Present study is conducted to identify the possible impact of sugar industry effluent on the soil by analysis of various physico-chemical parameter of soil.

MATERIALS AND METHODS

Present study was conducted to analyse the effect of Sugar Industry on the soil quality of nearby area around sugar industry. For study 'The Panipat Sugar Mill', located in Panipat City Haryana India was selected. Soil sample were collected in triplicate from agricultural land from 10 different locations cover 10 km area around the Sugar mill. Sampling location along with their distance from sugar mill is shown in Table 1. Before to testing, the soils samples were air-dried, grounded, passed through a 2 mm sieve and stored at 4^0C. Different physico-chemical parameter of soil were analysed by different method, pH is determined by Electrometric method instrument used is pH meter, Electrical conductivity is determined by E.C meter, Soil organic carbon is analysed by Walkley-Black chromic acid wet oxidation method, Potassium is analysed by Flame Photometer, Phosphorus and Sulphur is analysed by Spectrophotometer.

Table- 1: Details of sampling with distance from sugar mill

Sample No.	Area name	Distance in Km from sugar mill
S1	Insar	1
S2	Jatal	2
S3	Risalu	3
S4	Binjol	4
S5	Maharana	5
S6	Dahar	6
S7	Raja Kheri	7
S8	Noltha	8
S9	Babail	9
S10	Nimbri	10

RESULTS AND DISCUSSION

pH: pH of soil sample determined for different sapling locations and it was in the range of 6.7 - 8.3, which satisfied the range of soil productivity limit established by Agriculture Department of Haryana (Fig. 1). Thus, the pH of wastewater-affected soils was optimum for sustainable soil fertility and crop productivity. The pH level in the soil is a measure of its relative acidity or alkalinity. This is important when considering soil fertility because pH can affect the availability of soil nutrients. Sulfate ($S0_4^{2-}$) sulfur, the plant available form of Sulfur, is little affected by soil pH. The availability of the micronutrients manganese (Mn), iron (Fe), copper (Cu), zinc (Zn), and boron (B) tend to decrease as soil pH increase. Most essential plant nutrients are soluble at pH levels of 6.5 to 6.8. If soil pH is much higher or lower than this range, the soil nutrients can become chemically bound and unavailable for uptake by plants. Results of this study were also supported by other researcher who had reported pH of industrial waste water treated soil was ranged from 7.6 to 7.9 (14-15).

Electrical conductivity (EC): In present investigation EC content of soil samples were in the range of 0.31 to 0.59 mmhos (Fig. 2). Values of EC content were very much less than the standard value given by Agricultural Department of Haryana, but electrical conductivity of polluted soil is high when compared to electrical conductivity of unpolluted soil. The wastewater contained various dissolved organic and inorganic substances, which elevated the electrolyte content of the soils with a consequent increase in their electrical conductivity. Low EC resulted in a significant loss of hydraulic conductivity for fine textured soils. As the soil electrical conductivity decrease the water holding capacity of soil decrease which affect the crop yield. Samuel et al (16) also report the similar result in his study they reported EC 0.43 mmhos in effluent treated soil. Similarly Baskaran (9) also analyzed the EC content and reported 0.43 mmhos in sugar mill effluent affected soil.

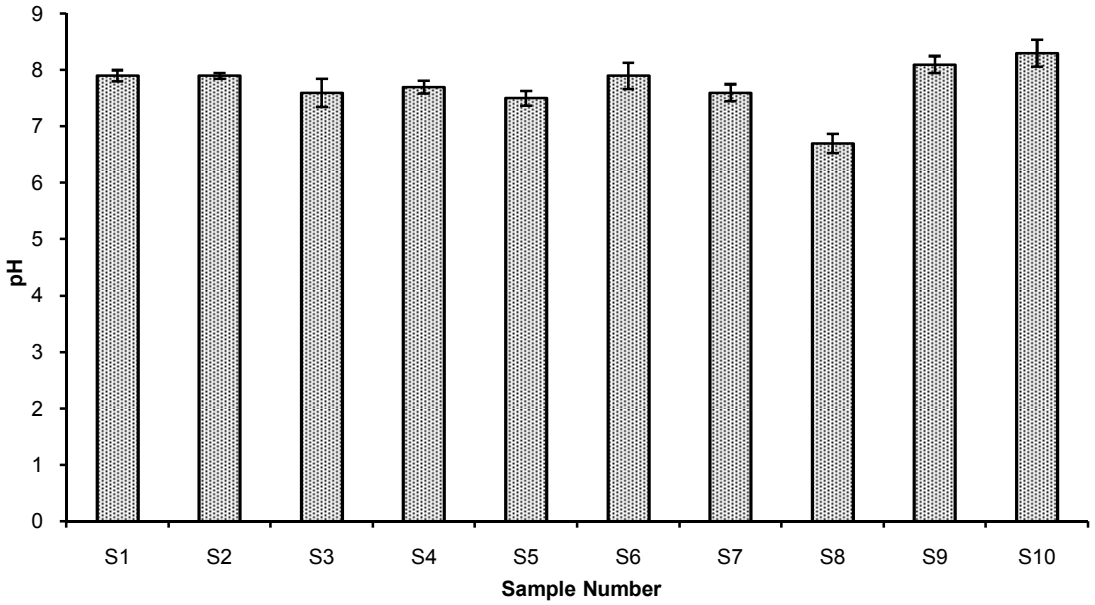

Figure 1:- pH value in soil samples collected from different locations

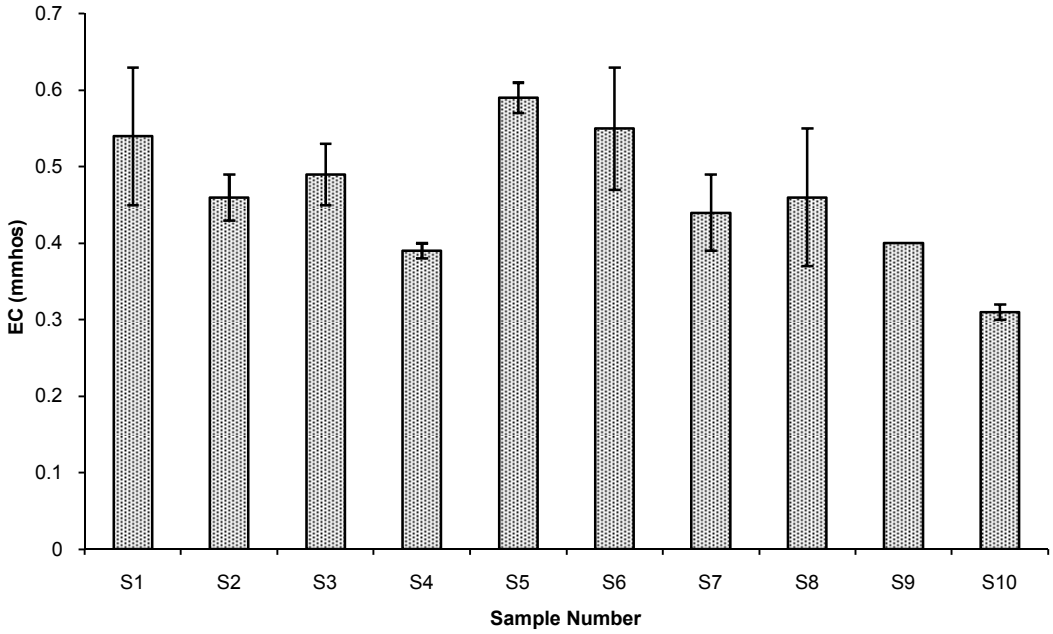

Figure 2:- EC content in soil samples collected from different locations

Organic Carbon: In present investigation percentage of organic carbon content in soil samples comes in the range of 1.42 to 2.39 %, which fairly good for soil fertility (Fig. 3). For good soil fertility organic carbon percentage must be comes in range of 0.41 to 0.75%. High percentage of organic carbon find in the sugar mill waste water affected soil. This is because the sugar mill effluent contains high level of organic waste. When this water is used for irrigation it increases the organic carbon in the soil. Tabriz et al (17) support our results as he study the sugar mill effluent and its effect on soil property and find that the organic carbon in the wastewater affected soils was 2.14%. Similarly Chopra and Pathak (8) also analysed the sugar mill effluent affected soil and found Organic carbon 1.37%. Organic matter, which is calculated as 1.73 times of OC influences physical, chemical and biological properties of soils. So, the use of sugar mill's wastewater for irrigation would increase soil fertility by increasing organic matter content. Soil

carbon improves the physical properties of soil. It increases the cation exchange capacity (CEC) and water-holding capacity of sandy soil and it contributes to the structural stability of clay soils by helping to bind particles into aggregates. Soil organic matter, of which carbon is a major part, holds a great proportion of nutrients, cations and trace elements that are of importance to plant growth. It prevents nutrient leaching and is integral to the organic acids that make minerals available to plants. It also buffers soil from strong changes in pH. It is widely accepted that the carbon content of soil is a major factor in its overall health.

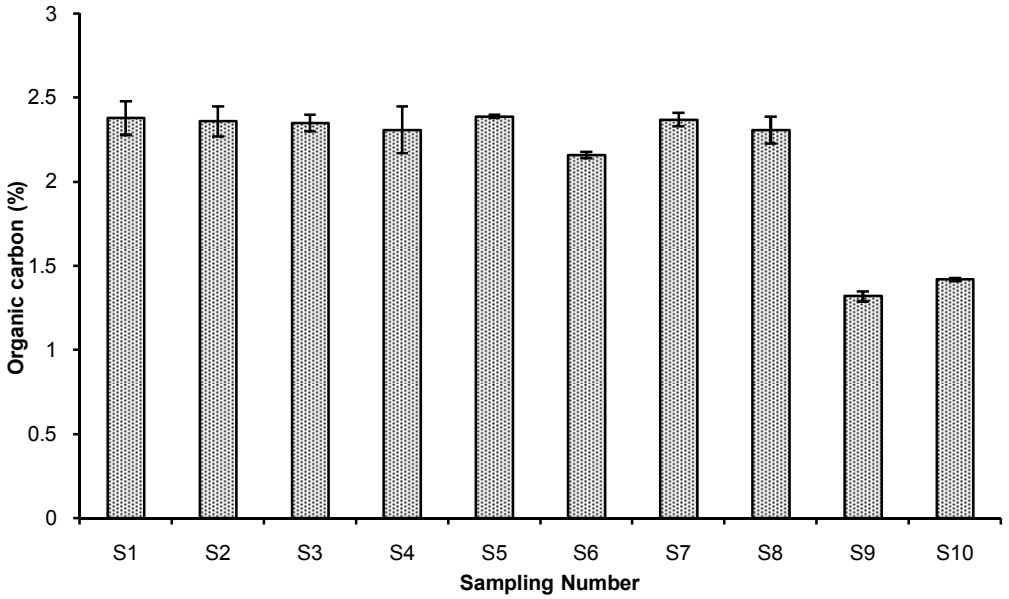

Figure 3:- OC content (%) in soil samples collected from different locations

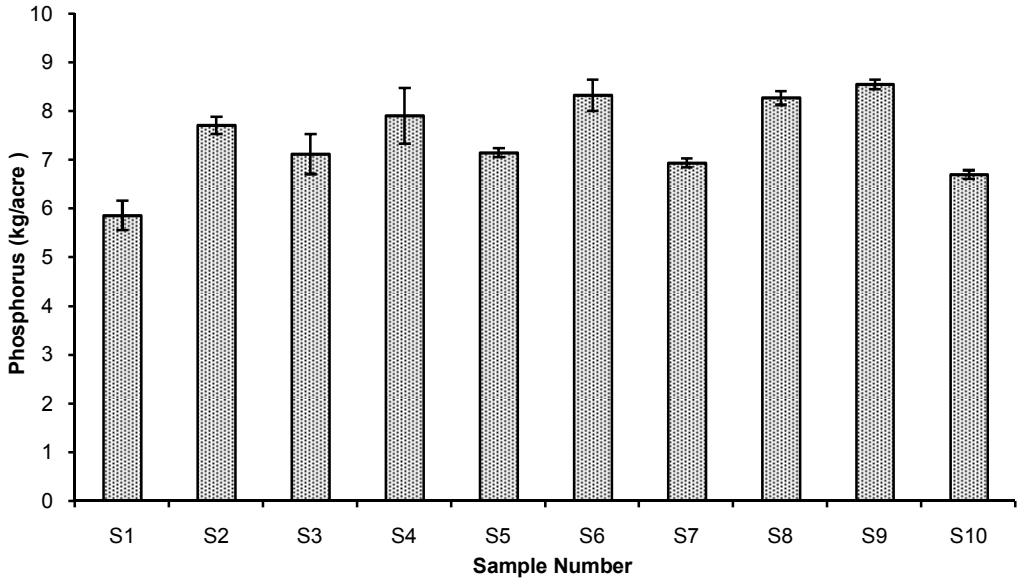

Figure 4:- Phosphorus content in soil samples collected from different locations

Phosphorus: In present investigation the content of phosphorus present in soil samples are range from 5.86 to 6.70 kg/acre (Fig. 4). The concentration of phosphate is not enough for the better crop production. For good fertility the concentration of phosphate must be in range from 10-20 kg/acre. Bama et al. (18) analysed the physico chemical properties of sugar mill effluent polluted soil and find that study sites were deficient in phosphorus. Dhagar and Lohar (19) analysed sugar mill effluent affected soil and recorded the phosphorus content come in range 42-52 kg/ ha. Similarly Shenbagavalli et al. (20) also analysed the sugar mill effluent affected soil and reported phosphorus content was ranged from 16 - 35 kg/ha. The study indicates high content of phosphorus in soil because phosphoric acid was used in sugar processing.

A fraction of this acid was released to wastewater through washing and other processes with an ensuing increase in P in the effluent of sugar mill, but in our study sugar mill effluent polluted soil had low level of phosphate. This may be because phosphate can potentially be lost through soil erosion and to a lesser extent to water running over or through the soil. There is considerable concern about P being lost from soils and transported to nearby streams.

Potassium: In present investigation the content of potassium present in soil samples was very much high it ranged from 135 to 250 kg/acre (Fig. 5). Potassium must be come in range 55-135 kg/acre for good soil fertility. The wastewater contained large quantity of fly ash, which accumulated in the soil and consequently raised its K content. Too much potassium is not directly toxic to plants but can have adverse effects. Over fertilization with potassium can induce a magnesium deficiency. In apples, too much potassium in relation to calcium will increase the severity of bitter pit. When there is too much potassium in soil, it can lead to big trouble like salt damage and acid fixation of root system as well as too much potassium causes a calcium deficiency. Due to a molecular imbalance potassium toxicity can cause a reduced uptake and lead to the deficiencies of Mg, and in some case calcium. Also leads to lots of other deficiency such as magnesium, manganese, zinc and iron and can cause problem with calcium as well. So in this investigation potassium exceed the limit. It is toxic for soil due to the reason mention above. This high potassium content in soil may be due to the sugar mill effluent discharge on soil. Bama and Ramakrishna (18) analysed the sugar mill effluent affected soil and estimate potassium content comes in range 156-232 kg/acre. Similar study was contected by Bakkialakashmi et al (21) estimates the potassium content 20-125 kg/ ha in sugar mill effluent affected soil.

Sulphur: In present investigation the sulphur content in the soil samples found in range from 29.46 to 53.27 kg/acre which is very much high for soil productivity (Fig. 6). Optimum sulphur content for better soil productivity is 10 kg/acre according to the Agriculture Department of Haryana. Saleh et al. (22) and Friedel et al. (23) also reported increased sulphur content of soil due to the effect of wastewater from sugar mill. Sulphur was used for refining juice in the sugar mill and a part of it entered the wastewater that elevated S content in the waste water affected soil. Too much sulfur can actually detrimentally affect the pH level of the soil in which crops are grown, and poor pH can cause many plants to wither and die. Additionally, over-irrigation can actually cause the sulfur already present in the soil not to be absorbed by plants thus leading to deficiency of Sulphur. Excess intake if sulphur leads to accumulation of sulphate in root zone of the plants and being toxic for plants. Phosphoric acid and sulphur were used in the sugar mill during sugar production. Sugar mill effluent contains high level of sulphur content which is accumulated in the cultivated when sugar mill effluent infected water is used for irrigation, so sugar mill effluent is one of the reasons behind the high content of sulphur in soil.

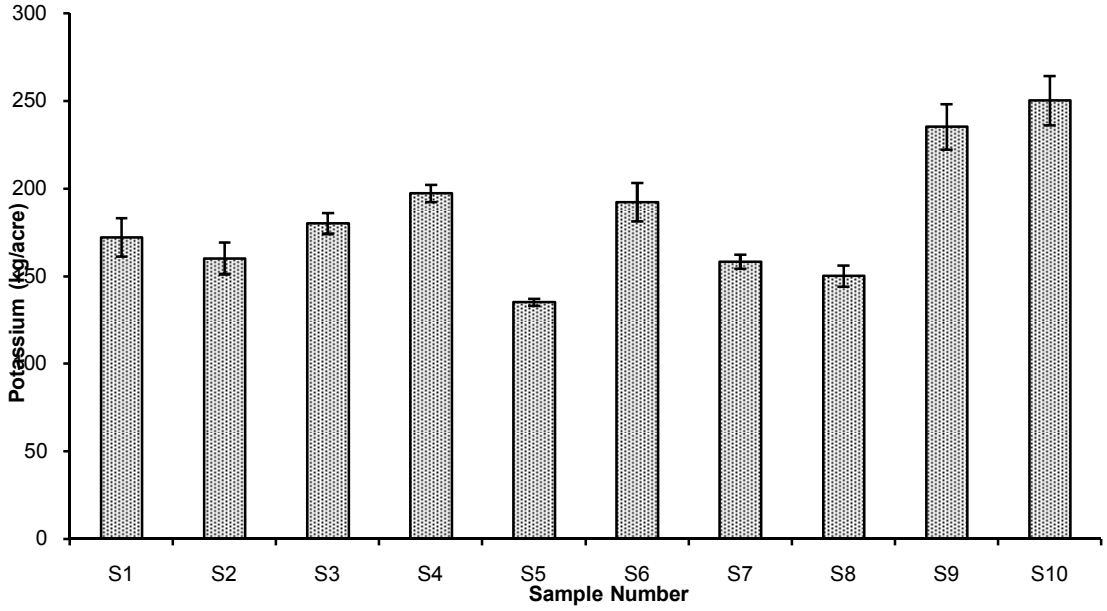

Figure 5:- Potassium content in soil samples collected from different locations

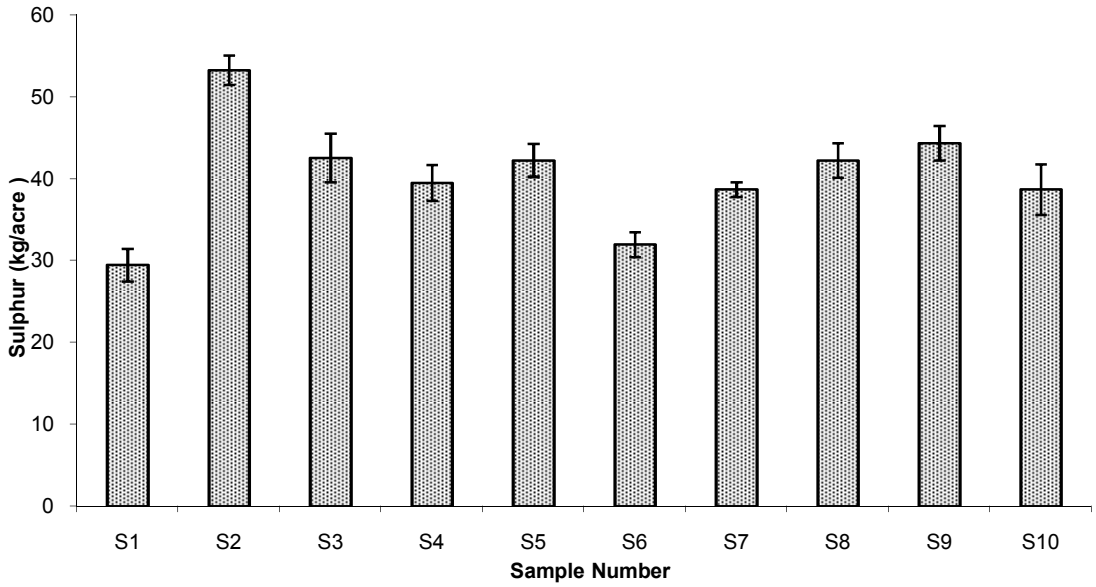

Figure 6:- Sulphur content in soil samples collected from different locations

CONCLUSION

The result of present study indicates that sugar mill effluent which is discharged to nearby land and used by the farmer for irrigation purposes, may affects the soil properties. Sugar mill effluent contains high level of organic waste which increase the organic carbon in soil when this water use for irrigation. Disposal of sugar mill effluent also improves the EC of soil. Sugar mill effluent has high concentration of sulphur because sulphur is used for refining the juice during sugar manufacturing process which also increases the S content in soil. Sugar mill effluent affected soil also has high content of K. The reason behind the high K content in soil is wastewater contains large quantity of fly ash, which accumulates in soil and consequently raised its K content. Phosphoric acid was used in sugar processing and a fraction of this acid was released to wastewater through washing and other processes with an ensuing increase in P in the effluent of sugar mill, still sugar mill effluent polluted soil had low level of phosphate. This may be because phosphate can potentially be lost through soil erosion and to a lesser extent to water running over or through the soil. There is considerable concern about P being lost from soils and transported to nearby streams. So by the perusal of result we conclude that at one side it improve the soil quality by increasing the Electrical conductivity and percentage of organic carbon. But on other side sugar mill effluent affected soil have high concentration of potassium and sulphur which may be harmful for soil.

REFERENCES

1. Saranraj, P. & Stella, D. (2014). Impact of Sugar mill effluent to environment and bioremediation: A Review. World Applied Sc. J., 30(3): 299- 306.
2. Mahavi, R. (2005). Biotechnology application to environmental remediation in resource exploitation. Current Sci., 97: 6-25.
3. Sinha, S., Singh, S. & Mallick, S. (2008). Comparative growth response of two varieties of *Vigna radiata* L. (var. PDM 54 and var. NM 1) grown on different tannery sludge applications: effects of treated wastewater and ground water used for irrigation. Environ. Geochem. & Health, 30: 407–422.
4. Muthusamy, P., Murugan, S. & Manothi, S. (2012). Removal of Nickel ion from industrial wastewater using maize cob. J. of Biol. Sci., 1(2): 7-11.
5. Thambavani, S. D. & Sabitha. M. A. (2012). Multivariate statistical analysis between COD and BOD of sugar mill effluent. Scholarly J. of Maths and Computer Sci., 1(1): 6-12.
6. Nagaraju, G. N. & Rangaswami, V. (2007). Impact of effluents of sugar cane industry on soil physico-chemical and biological properties. J. Ind. Pollut. Cont., 23: 73-76.
7. Narasimha, G., Babu, G.V.A.K. & Reddy, R. B., (1999). Physicochemical and biological properties of soil samples collected from soil contaminated with effluents of cotton ginning industry. J. of Environ. Biol., 20: 235–239.
8. Chopra, A. K. & Pathak, C. (2013). Enrichment and translocation of heavy metals in soil and *Spinaceaoleracea* grown in sugar mill Effluent irrigated soil. Sugar Tech., 15(1): 77–83.

9. Baskaran, L., Sankar, K., Ganesh, Chidambaram A.L.A. & Sundaramoorthy, P. (2009): Amelioration of sugar mill effluent polluted soil and its effect of green gram (*Vigna radiata* L.) -Botany Research International., 2 (2): 131-135
10. Kumar, V. & Chopra, A. K. (2010). Influence of sugar mill effluent on physico-chemical characteristics of soil at Haridwar (Uttarakhand), India. J.of Appl. and Nat. Sci., 2(2): 269–279.
11. Ayyasamy, P. M. Yasodha, R., Rajakumar, S., Lakshmanaperumalsamy, P.K.S.M. Rahman, P. & Sanghoon, L. (2008). Impact of sugar factory effluent on the growth and biochemical characteristics of terrestrial and aquatic plants. Bull. of Environ. Contam. and Toxicol., 81: 449–454.
12. Avasn, Y. M. & Rao, S.R. (2000). Effect of sugar mill effluent on organic reserves of fish. Pollut. Res., 19(6): 391-393.
13. Bollag, J.M., Berthelin, J., Adriano, D. & Huang, P.M., (2002). Impact of soil minerals organic component – microorganisms interactions on restoration of terrestrial ecosystems. In: Oral Presentation at the 47th Symposium, 17th World Congress of Soil Science, Thailand, 14–21.
14. Balkhande, J. V., Jalander, V. & Balkhande, S. V. (2013). The influence of Hingoli and Nanded districts sugarcane industry effluent on physicochemical properties and mycoflora of soil. Research in Biotechnol., 4(3): 01-06.
15. Nagaraju, M., Narasimha, G. & Rangaswamy, V. (2009) Impact of sugar industry effluents on soil cellulase activity. Internat. Biodeteriorat. & Biodegrad., 63: 1088–1092.
16. Samuel, S. & Muthukkaruppan, S.M., (2011). Physico-chemical analysis of sugar mill effluent, contaminated soil and its effect on seed germination of paddy (*Oryza sativa* L.). Internat. J. of Pharm . & Biolog. Arch., 2(5): 1469-1472.
17. Tabriz, S.S., Mojid, M.A. & Wyseure, G.C.L. (2011). Irrigation suitability of north Bengal sugar mill's effluent and its impact on soil properties . J. Bangladesh Agri. Univ., 9(2): 283-290.
18. Bama, M. E. & Ramakrishnan, K. (2010). Studies on the occurrence and distribution of fungi in sugar mill effluent polluted soils in Nellikuppam region of Cuddalore District. J. of Phytology., 2(1): 91-95.
19. Dhangar, S.D. & Lohar, P. S. (2013). Effect of sugar factory effluent on physico-chemical properties and cellulase activity of soil - A case study. Internat. Multidiscip. Res. J., 3(1): 18-22.
20. Shenbagavalli, S. Mahimairaja, S. & Kalaiselvi, P. (2011). Impact of biomethanated distillery spentwash application on soil and water quality: A field appraisal. Internat. J. of Environ. Sci., 1(7): 1753-1759.
21. Bakkialakshmi, B.S. Barkavi, S., Chitra, V.P. & Jarletjeyaseeli, A. (2011). Spectro-chemical study of Thiru. Aruran sugar factory waste affected soil in A Sithoor, Cuddalore District, Tamilnadu, India. Schol. Res. Lib. Arch. of Phy. Res., 2 (2): 142-148.
22. Saleh, A.S., Salam, A. & Khalil, J. (2009). Effect of irrigation with reclaimed wastewater on soil properties and olive oil quality. Jordan J. Agril. Sci., 5: 128–141.
23. Friedel, J.K., Langer, T., Siebe, C. & Stahr, K. (2000). Effects of long-term wastewater irrigation on soil organic matter, soil microbial biomass and its activities in central Mexico. Biol. Fertile Soils, 3: 414–421.

Ciation of this article

Renu D, Jyoti R and Anoop Y. Effect of Sugar Mill Effluent on Physico-chemical Properties of Soil at Panipat City, India. Int. Arch. App. Sci. Technol; Vol 5 [2] June 2014: 06-12. http://dx.doi.org/10.15515/iaast.0976-4828.5.2.612