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RESEARCH ARTICLE

IMPACT OF PAPER MILL EFFLUENT ON THE QUALITY OF RECEIVING SOIL

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ABSTRACT

Maintaining good soil quality and minimizing soil pollution and degradation is of fundamental importance to preserve quality of ground water, surface water, to give us clean air bountiful crop and forest, productive grazing lands, divers wild life and beautiful landscape. Soil has both inherent and dynamic properties. In India a tropical country, drought conditions and depletion of ground water source necessitate alternate irrigation source. The various water irrigation source can be augmented by using the effluent from pulp and paper industry. In the present study we analysed the soil quality in term of salient physicochemical properties of the soil, receiving paper mill effluent. Among the physical properties Bulk density slightly improved, no change in pH, slight changes in percent total solid, percent ash content, among nutritional parameter phosphorous increase,. Actinomycetes units were strongly enhanced in receiving effluent as compare to control soil. The fungi population also increase in all the samples irrigated with effluent. Consequently these changes suggested some favourable amendment in soil.

INTRODUCTION

The soil is thin covering over the land consisting of mix minerals, organic material, living organism and water that together support the growth of plant life. Maintaining good soil quality and its chemical composition is necessary to protect our food from toxic substance which can be accumulated in the soil and can be transfer to ground water or enter into food chain. The pulp and paper industry is one of the major industry in the world and rank fifth among the industries contributing water pollution (Srivastava, 1986 and spinger, 1993). A small paper mill consume280m^3 water per ton of paper and discharge waste water in the range of 200 m^3 per ton and then pollute huge amount of water resources. The paper mill waste water is the liquid byproduct contain large amount of slowly biodegradable lignin derived from wood used for making paper lignin and its derivative impact high COD and also a source of several trace elements and m *et al* loids As, Se, Sb etc.. Many researcher have established that this waste water have a high fertilizer value when applied to soil. The utilization of waste water for irrigation has increasingly gained importance in various countries for the arid and semi arid region as water is becoming a scare commodity (Oved *et al.,*2001). Various workers reported that diluted paper mill effluent has drastically affected germination of rice, black gram and tomato seed.

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Naiwal *et al.,* 2005 reported that paper mill effluent increased Na and K cationic balance in plant. But if the nutrients like N, K, P, SO_4 and Mg are at optimum level may promote the growth through enhance cell division "Expansion and differentiation." The effluent contains numerous organic and inorganic chemical which exerts remarkable influents on soil characteristic and thereby on ground water quality and plant growth. The Taragram Paper Mill is a small Paper industry. The temperature, turbidity, pH, EC, TDS, Alkalinity are within the permissible range of CPCB effluent (Srivastava *et al.,* 2014). The waste contain an enormous supply of organic matter COD-630ppm & BOD-92.1 ppm, so it can serve as a source of nutrient and organic fertilizers. In present study we analyse the soil quality in term of salient physicochemical properties of the soil receiving paper mill effluent.

MATERIALS AND METHODS

Study area

Taragram paper mill is one of the registered paper mill in the Jhansi city. It is located between Jhansi Orchha road. It is widely sphere paper mill and its production annually about 120 tonnes. The effluents of 'Taragram' paper mill meet to the Betwa River through a small stream 'Bebdie nala'. This nala discharge the sludge into the Betwa River at Orchha.

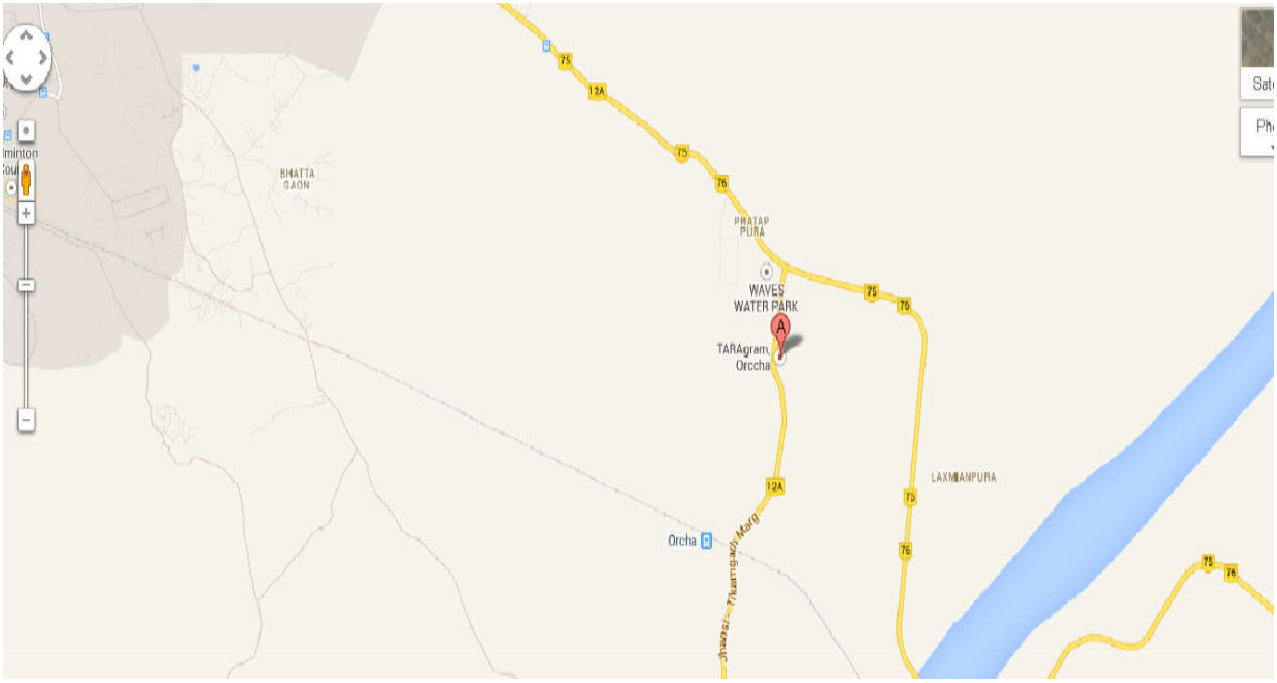

Fig. 1.

Sampling Scheme

The soil sample were collected in may 2014 to find out the impact of effluents on irrigated soil.

Sample Site

Four sites have been selected for sampling in the present study to evaluate the physico-chemical and biological studies of effluent on surrounding soil. The physico-chemical variation helps to evaluate the quality of soil while biological studies (population status) help to establish a relationship between paper mill effluent and soil quality. The soil samples were collected in summer from all the selected sites. The location of sample sites are given below:

S_1 Sample site – 1 Control soil.
S_2 Sample site – 2 Soil from field 0 km away from paper mill.
S_3 Sample Site – 3 Soil from field located 3 km away from paper mill.
S_4 Sample Site – 4 Soil from field located 5 km away from paper mill

Collection of soil sample

Four soil samples were collected from all the selected sites in triplicate for analysis. The soil samples were collected by variables distance from the effluent surrounding field by using zigzag sampling and collected in the zip lock polythene bag.

Experimental

The physical chemical and microbial parameter such as bulk density, pH, % moisture, % Ash, % Total Solids, % organic matters, % organic Carbon, N, P, K, etc. are analysed by the standard method as prescribed by Jackson 1973, Trivedi & Raj, 1992, Page *et al*, 1982 and Black, 1965.

RESULTS AND DISCUSSION

The effect of Paper mill effluent on soil quality is presented in Table-1. The effluent significantly reduced the bulk density at station 3 and 4 and hence improve permeability, infilteration and total porosity. The range of this bulk density is suitable for movement for nutrient (shrivastava *et al.,*2014). There was no significant difference among the pH of the soil of station 1 to 4, because difference between Ph of effluent and that of soil was not much wide. many crops grow best if pH is close to (6 to 7.5) and good for survival and function for micro-organism (Karlen *et al.,*2008). Percent moisture concentration suddenly decrease from station 1to2 might be due to increase in percent ash content and in bulk density. Percent ash content of soil is define as the wt of sample after treatment of muffle furnace and is expresses as percent of the received wt of sample. On the basis of our result obtained in the present study it could be found that the higher % Ash content were found sample- 3, while lower ash content were found in sample - 1. During investigation it was found that the % total solid values of all samples are almost same. The % total solid and % moisture content of soil are co-related with each other. Both are inversely proportional to each other and dependent upon the water holding capacity of soil. Organic matter is an essential fraction of soil composed of anything that was once alive which include plant and animal remaining in various stage of decomposition cells and tissues of soil organism and other organic substance. The data indicate that percent organic matter in well water irrigated soil is within range (1.45) as prescribed by Eugene (2000),but it's value decrease suddenly in effluent irrigating soil at sample station $S_2$and S_3However the organic matter were reobtained in sample-4. In the nutrients status the nitrogen value was found to be 224-240 kg/hact in all the samples. And no change were observed in N value by effluent. Phosphorous concentration increase the soil quality as the value increase up to 11.79 in sample-3 irrigated with effluent as compare to 5.89 kg/hac in sample-1 (control soil).

Table 1. Parameters of paper mill effluents surrounding soil

S.No.	Properties	S_1	S_2	S_3	S_4
1	Bulk Density (g/cm^3)	1.18	1.13	0.9	0.9
2	Ph	7.4	7.9	7.4	7.8
3	Percent Moisture	3.05	1.636	2.645	1.706
4	Percent Total Solid	96.95	98.36	97.35	98.29
5	Percent Ash Content	97.5002	99.7932	99.8794	98.501
6	Percent Organic Matter	2.4998	0.2068	0.1206	1.499
7	Percent Organic Carbon	1.45	0.12	0.07	0.87
8	Total Nitrogen (Kg/hac)	240	232	224	228
9	Total Phosphorus (Kg/hac)	5.89	9.82	11.79	9.825
10	Total Potassium (Kg/hac)	426	363	242	215
11	Fungi (No./gm)	41800	46500	55000	62000
12	Actinomycetes (No./gm)	5×10^4	9×10^4	11×10^4	13×10^4
13	Azotobactor (No./gm)	10×10^5	14×10^5	12×10^5	7×10^5
14	Rhizobium (No./gm)	10×10^5	12×10^5	9×10^5	8×10^5

Although less than 23 kg/hact phosphorous indicates poor level of soil. (Ladwani *et al* 2012).The increase in available Phosphorous concentration in effluent irrigated soil could be due to high microbial activity induced by addition of organic residue which speed up Phosphorous cycle.(Melero *et al.,*2007). Potassium in sample-1 suggested fertile soil but irrigation decrease the potassium concentration of soil up to 215 kg/hact, but enough from critical value (Rakkar *et al* 2015). Actinomycetes and spore forming bacteria play a significant role in the organic matter cycle in nature by virtue of their considerable powers and ability to break down complex organic molecule (Atalas *et al* 1991).Actinomycetes counts were strongly enhanced by using effluents from 5×10^4 to 13×10^4 from station 1 to 4.During investigation it has been observed that effluent surrounding soil support growth of Fungi as compare to normal well water irrigated soil. Fungi are most important organism decomposing lignin and polyphenols, thus helpful to control ground water quality and plant growth. The number of rizobial cell and azotobactor is least effected but still change is positive on irrigation by effluent.

Conclusion

The selected physico-chemical properties are the indicator which are measurable properties of effluent and soil and provide clues about how well the soil can function if irrigated by paper mill effluent. Physical properties of soil such as bulk density were improved. Fertility status of the irrigated soil in terms of organic carbon, organic matter available phosphorus, potassium and nitrogen were improved due to the effluent irrigation.

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