

# Effect of Industrial Effluent on Soil Characteristics

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**ABSTRACT:** Soil is an essential natural resource like water and air. In India the main source of soil pollution is the effluent discharge from industries. Generally, industries discharge huge amount of effluent to the open land or to the nearby water resources. The composition of effluent differs according to the source of production. The macro and micro nutrients present in the effluent increases the soil fertility; along with it the heavy metals and toxic substance present in the soil also can be increased in concentration. In this study, the industrial effluent was collected and the soil sample sets were treated with 10%, 20%, 30%, 40% and 50% of effluents and some important soil parameters were analysed along with the control (effluent free soil). The result showed that the treatment of soil with the effluent led to noticeable changes in the soil characters such as the pH, electrical conductivity, organic carbon, iron, copper, manganese, potash, phosphorous and zinc. The 10% treatment set showed the highest pH value of 6.9 and the lowest pH was recorded in the 50% treatment soil set (4.1). The highest electrical conductivity was given by the 50% sample (1.09ds/m) and the lowest was in the control set (0.23ds/m). The amount of organic carbon was recorded highest in the 50% set (0.88%) and the lowest in the control sample set (0.16%). The highest amount of available phosphorous was in the 50% set (186.27ppm) and the lowest was recorded in the control (123.02ppm), available potash was recorded highest in the 50% sample (429ppm) and the lowest in the control (143ppm). The value of available iron was recorded highest in the 50% set (89.3ppm) and the lowest value in the 10% (27.9ppm). Available manganese was highest in the 50% (20.2ppm) and lowest in the 10% treatment set. The concentration of available zinc was recorded highest in the 50% (2ppm) and the lowest value was recorded in the 10% (0.4ppm). The concentration of available copper was highest in the 50% (2.7ppm) and the lowest was recorded in the 10% (0.8ppm). So, the addition of effluent is capable to make noticeable changes in the soil parameters. Except the pH, all the parameters showed an increase in their values with the increase in the concentration of the effluent (10% to 50%).

**KEYWORDS:** Industrial effluent, Soil parameters, pH, Electrical conductivity, Organic carbon, Soil nitrogen.

## I. INTRODUCTION

Late 20<sup>th</sup> century is the period which changed the entire manufacturing processes through the use of machinery and other innovations. The changes lead to arise of new and class work for the upper class in the factories for relatively low payment. The industrial revolution plays an important role in the development of many countries around the world. But the main issue that India faced was the high cost industrial waste disposal in limited land area. Generally, most of the industrial wastes are disposed untreated to the nearby water bodies, open land or directly emitted to the air. Even at certain companies which are provided with these treatment facilities are not being operated properly. Due to this direct emission of untreated waste water to the nearby water bodies or land ultimately results in the pollution of water resources and agriculture land. The industries release the toxic substance as suspended solids, hazardous chemicals, oils, dyes, thermal pollutants etc. Discharge of highly toxic wastes to the open land' results in undesirable changes to the soil physico-chemical changes. This change in the soil parameters makes it unsuitable for irrigation. The usage of industrial effluents for irrigation leads to reduction in the plant growth, yield and soil fertility. The industries like

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pesticide industry, leather industry, pharmaceuticals, mines and quarry industry release a huge amount of toxic heavy metals through their effluent. It leads to the natural processes such as bioaccumulation, biomagnifications etc. The accumulation of heavy metals makes physiological and biochemical changes in plants and animals. From the production to the marketing process of an industry, a huge amount of solid as well as liquid wastes are generated. Most of which contains a large amount of toxic organic and inorganic pollutants which is capable to cause negative impact on soil and associated life. Effluent discharge to the soil destroys the soil productivity and also affects the crop yield cultivating in the surrounding land area. It is very necessary to do on site effluent treatment in order to minimise the harm to the environment. The pressure facing by the environment due to the release of effluent is too high. This is a globally important issue; very few are aware about the effects of effluent discharge and how important is the treatment process before discharge. Our soil ecosystem has been destroyed completely by the action of environment and now it is capable to make health hazards through food chain. This study aimed at examining the effect of industrial effluent on some of the important soil parameters.

## II. MATERIALS AND METHODS

### Estimation of soil pH using pH meter

Weighed 20 gm of 2.0 mm air dried soil into a beaker and added 50 ml of distilled water and stirred with a glass rod thoroughly for about 5 minutes and kept it for half an hour. Calibrating the pH meter, pH was recorded.

### Estimation of electrical conductivity

The soil water suspension of 20 gm: 50 ml ratio was prepared. Allowed the soil water suspension in the beaker to settle for additional half an hour (the total intermittently shaking period is 1 hr.) After the calibration conductivity was recorded.

### Estimation of organic carbon

Weighed 1 gm of 0.5 mm sieved soil into dry 500 ml conical flask and added 10 ml of  $K_2Cr_2O_7$  into the flask with pipette. 20 ml conc.  $H_2SO_4$  is added with a burette and swirled gently until soil and reagents are mixed then more vigorously for one minute. Allowed the reaction to proceed for 30 min. Added 200 ml of distilled water, 10 ml of concentrated orthophosphoric acid and about 0.2 gm NaF (one small teaspoon) and allowed the sample to stand for 1.5 hrs. The titration end point was clear in a cooled solution. Just before titration 1 ml ferroin indicator was added into the conical flask. Titrated the excess  $K_2Cr_2O_7$  with 0.5 N ferrous ammonium sulphate till the colour flashed from yellowish green to greenish and finally brownish red at the end point. Simultaneously blank test was run without soil.

### Determination of phosphorous in soil (Olsen's method)

Weighted 2.5 gm of soil sample in 150 ml plastic conical flask, added a pinch (0.3 gm) of phosphate free activated charcoal AR grade. 50 ml of Olsen reagent was added and shaken for 20 minutes. Filtered the content out and 5ml of aliquot was transferred into 25 ml volumetric flask and 5 ml of filtrate was pipette out into 25 ml volumetric flask. 4 ml of the freshly prepared ascorbic acid and ammonium molybdate solutions were added to it. Shaken well and kept it for 30 minutes then made up to the volume. Prepared the standard curve using 0, 1, 2, 3, 4 & 5 ml of 5 ppm standard phosphorous solution into 25 ml volumetric flask and developed the colour using the same procedure as above. The corresponding phosphorous concentration was 0, 0.2, 0.4, 0.6, 0.8 & 1ppm. The absorbance and colour intensity at 882 nm were observed.

### Determination of available potassium

25 ml of  $NH_4$  extracting solution was added to the conical flask containing 5 gm air dry soil sample. Shake the mixture for 5 min and filter. Determine potassium as indicated in preparation of standard curve, dilute if necessary.

### Determination of available iron, manganese, zinc and copper

Weighed 12.5g of soil sample in 100ml iodine value flasks. 25 ml DTPA solution is added to each. Shaked the mixture for two hours on the shaker at 70-80 oscillation per minute filtered out the mixture through Whatman No. 1 filter paper and the filtrate is collected. The micronutrients are determined on atomic absorption spectrophotometer.

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## III. EXPERIMENTAL RESULTS AND DISCUSSION

The industrial effluents are the main soil pollutants releasing from various industries. The continuous addition of effluent in different concentrations made substantial changes to soil parameters, which was capable to make negative impacts on sensitive plant varieties. As part of the project work, the soil samples were treated with the industrial effluent once in a week for 40 days at the concentrations of 10%, 20%, 30%, 40% and 50%, after the treatment time the samples from each treatment sets were collected and tested. The changes observed were listed out in the table 1.

**Table 1: Soil parameters in control and samples.**

| Soil Parameters                | Treatment concentrations |        |        |        |       |        |
|--------------------------------|--------------------------|--------|--------|--------|-------|--------|
|                                | Control                  | 10%    | 20%    | 30%    | 40%   | 50%    |
| pH                             | 6.7                      | 6.9    | 6.8    | 6.2    | 4.5   | 4.1    |
| Electrical conductivity (ds/m) | 0.23                     | 0.81   | 0.84   | 0.87   | 0.91  | 1.09   |
| Organic carbon (%)             | 0.16                     | 0.29   | 0.43   | 0.45   | 0.64  | 0.88   |
| Available phosphorus (ppm)     | 123.02                   | 145.57 | 159.32 | 160.23 | 168.3 | 186.27 |
| Available potassium (ppm)      | 143                      | 242    | 275    | 275    | 356   | 429    |
| Available iron(ppm)            | 31.5                     | 27.9   | 28.3   | 30.2   | 66    | 89.3   |
| Available manganese (ppm)      | 4.9                      | 4.8    | 5.2    | 8.5    | 11.3  | 20.2   |
| Available zinc(ppm)            | 0.6                      | 0.4    | 0.5    | 1.2    | 1.8   | 2      |
| Available copper(ppm)          | 1.1                      | 0.8    | 0.9    | 1.3    | 2.1   | 2.7    |

As per the test results, various soil parameters showed fluctuations from the normal range. The pH of soil showed changes in their values. The pH value of the control was 6.7 and in case of the soli treated with 10% effluent, the pH showed an increase in value, 6.9. After that, it showed a gradual decrease in pH values- 6.8, 6.2, 4.5, and 4.1 as the effluent concentration increased. The data revealed that the soil pH is affected due to application of effluent. The highest pH value was showed by the 10% (6.9) and the lowest pH value was for 50% (4.1). There are studies which also observed that the pH decreases with the increase in effluent concentration (Vimaldeep *et al.*, 2014, Kansal *et al.*, 1999; Yadav *et al.*, 2002) [3] [8]. Mir Tariq Ahmad *et al.*, 2012[6] also observed that the pH of effluent irrigated soil ranged from 7.76 to 8.7 while pH of uncontaminated soil was ranged from 6.90 to 7.31. In sample Site 1 and 2, the contaminated soil pH increased with the application of effluent as compared to uncontaminated soil. The increase of soil pH is due to addition of various soluble salts in industrial effluent also reported.

The electrical conductivity of the control was found to be 0. 23 and it's got increased by 0.81, 0.84, 0.87, 0.91 and 1.09 as the effluent concentration increased (10%, 20%, 30%, 40% and 50%). The highest electrical conductivity is to 50% (1.09) and lowest for the control (0.23). This change of electrical conductivity from normal to marginal range is harmful for the survival of sensitive crops. The high rate of electrical conductivity indicates the presence of excess nitrogen or high range of exchangeable sodium (Mir Tariq Ahmad *et al.*, 2012) [6]. The excess accumulation of sodium in soil results poor tilt and low permeability making them unfavourable for plant growth. The electrical conductivity of

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soil also affects the crop yield, top soil depth, pH, salt concentration and increases water holding capacity. Mir Tariq Ahmad *et al.*, (2012) [6] also studied the effect of effluent on the physico chemical properties of soil. He observed that the EC increased with the application of effluent as irrigation water having high concentration of salts, particularly  $\text{Na}^+$  and  $\text{Cl}^-$  has significantly increased the salinity as compared to the uncontaminated soil. He also observed that the higher concentration of cations such as Na and K in waste water led to an increase in EC and exchangeable Na and K in soil irrigated with waste water.

As the treatment concentration increases the amount of organic carbon present in the soil got decreased. The amount of organic carbon present in the soil was 0.16% and as the treatment concentration increases from 10%, 20%, 30%, 40%, and 50% the amount of organic carbon also changes from 0.29, 0.43, 0.45, 0.64 and 0.88% respectively. The highest amount of organic carbon was present in 50% set (0.88%) and the lowest was recorded in the control set (0.16%). In the study of Dr. Deepti Sahare *et al.*, (2014) [1] also identified that the value of organic carbon increases with the addition of effluent. It is being also reported that increase in organic carbon facilitates the accumulation of available nutrients and metals in the soil.

The effluent treatment also showed slight fluctuations in the amount of soil potash, copper, zinc, manganese, potassium and iron. The amount of available phosphorous in the soil getting increased by 123.02, 145.57, 159.32, 160.23, 168.3 and 186.27ppm as the effluent concentration got increased, likely the amount of potash present in the soil had been increased from the control, 143ppm by 242, 275, 275, 356 and 429ppm as the treatment concentration increased. The available manganese in the control set was 4.9ppm as the treatment concentration increased from 10% to 50 %, the amount of manganese also changed as 4.8, 5.2, 8.5, 11.3 and 20.2ppm. The presence of zinc in the soil is essential for the growth of plants and it has a vital role in the metabolism of human body but the increased presence of heavy metal in the soil results to bio-magnification.

The amount of zinc in the control set or the effluent free set was 0.6ppm, as the treatment concentration increased the amount of zinc showed slight increase in the rate as 0.4, 0.5, 1.2, 1.8, and 2ppm. The amount of iron had been decreased from control value 31.5ppm to 27.9ppm and 28.3ppm as the treatment concentration increased by 10% and 20% respectively. While at the concentrations 30%, 40% and 50%, the amount of iron showed an increase in values as 30.2, 66, and 89.3ppm respectively. The amount of copper also showed a gradual decrease in values from the control (1.1ppm) to 0.8ppm and 0.9ppm as the concentration increased by 10% and 20% respectively. But as the concentrations increases again as 30%, 40% and 50% the value got increased by 1.3, 2.1 and 2.7ppm respectively.

The highest concentration of available phosphorous was in the 50% set (186.27ppm) and the lowest was recorded in the control (123.02ppm). Available potash was recorded highest in the 50% (429ppm) and the lowest in the control set (143ppm). The value of available iron was recorded highest in the 50% set (89.3ppm) and the lowest value in the 10% (27.9ppm). Available manganese was highest in the 50% (20.2ppm) and lowest in the 10% treatment set. The concentration of available zinc was recorded highest in the 50% (2ppm) and the lowest value was recorded in the 10% (0.4ppm).

The concentration of available copper was highest in the 50% (2.7ppm) and the lowest was recorded in the 10% (0.8ppm). Dr. Deepti Sahare *et al.*, (2014)[1] also studied the impact of irrigation of industrial effluents on soil-plant health, in that the study, the soil samples were collected under three categories, first which comprised of those soil samples which are continuously receiving industrial effluent discharges and second, which had those soil samples which are totally unaffected from industrial effluent discharges but are still in the nearby area and third which comprised of those soil samples which are very far. Again different parameters of these soil samples were studied namely pH, EC (electrical conductivity), OC(organic carbon), N, P, K,  $\text{Na}^+$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ , Zn, Cu, Fe, Mn and Pb and it was found that many of these parameters were considerably higher in case of first set of samples. So, from the study it is very clear that the effluent treatment is capable to cause noticeable changes in the soil parameters. Except the pH, all the parameters got increased with the increase in treatment concentrations.

## IV. CONCLUSION

Increased pollution of soil due to continuous use of heavy metal contaminated industrial effluents is critical to crop production globally and a great environmental threat. These metals accumulate in soils and plants in excess and enter the food chain (Kashem and Singh, 1999; Stolt *et al.*, 2006) [4] [5]. Soil quality cannot be judged directly; it must be determined from the changes of its parameters (Danica Fazekašová *et al.*, 2012) [2]. From the present study the conclusion is that the regular and periodic addition of industrial effluent makes undesirable changes to the soil

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parameters. Even a small concentration for a short period of time is capable to cause a great change from the normal parameter value, which indicates the toxicity of the effluent. So the pre-treatment of industrial effluents are very necessary before their discharge into the environment.

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