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Impact of industrial effluents on soil and plant health from Ambernath MIDC, Maharashtra

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Abstract
Environment plays a key role in regulating the different life processes of all living beings. Environment is a complex of both living as well as non- living things, which surrounds an organism. Any external force or substance, which surrounds and affects in any way the life of an organism, becomes a factor of its environment. It is also called an environmental factor. Environment must be suitable for the sustainable development of all living beings. Environmental factors influence and determine the presence or absence and relative success or failure of various living organisms in a particular habitat. The present study was conducted in in Ambernath MIDC area where small to medium sized industries are not equipped with pollution control measures so they discharge untreated effluent to nearby sources. The industrial effluents contain various toxic chemicals, dyes and heavy metals such as mercury (Hg), Cadmium (Cd), Chromium (Cr) and Zinc (Zn) and their impact on plant growth of the surrounding areas.

Keywords: Environment, living beings, life processes, environmental factors

Introduction

Pollution is an undesirable change in the physical, chemical or biological characteristics of air, water and soil that may harmfully affect the life create a potential health hazard of any living organism. Pollution is a man-made problem and at present it is a great problem of all the countries. Industrialization, progress in agriculture and unlimited exploitation of nature are the main causes of pollution. On the basis of the type of medium being polluted, it can be divided into many different types such as air pollution, water pollution, soil or land pollution, noise pollution etc. Nowadays, it is growing realization and concern about the pollution throughout the world. There are various means by which fresh water (river and natural resources) is getting polluted. Industries are one of the major sources of environmental pollutants. During the processing, and manufacturing of intermediate chemicals and end products, industries generate waste materials and useless byproducts to certain extent and magnitude. Industrial wastes and effluents contain various levels of organic and inorganic pollutants including acids, alkalis, inorganic ions, phenols, heavy metals etc.

Industrialization plays a very important role for developing nations. But the disposal of wastewater has become a global concern as the industries are associated with the generation of high of effluents, limited space for land needed for the treatment including high cost of treatment technologies. In India, wastewaters from almost all the industries are being discharged untreated either on land or into the watercourse. Even at the place where some treatment facilities exist, these are not being operated properly. Resultantly these waste waters pollute the water resources and ultimately the land. The soil factor influences the growth and distribution of plants. The toxicants present in the industrial effluents when come in contact with biological environment may create serious long-term toxicity effect to the living organism. However, the degree of toxicity depends upon their concentration and length of exposure to the susceptible site.

Among the various changes that are brought about in the soil as a result of effluent irrigation include leaching, removal or accumulation of toxic chemicals, alteration in the soil pH, suppression of pore spaces and a consequent reduction of permeability. The chemical changes affect not only the nutritional characteristics of the soil but also the physical characteristics of soil. Both physical and chemical changes have their effects on productivity of soil. The effluent from the industries contains large number of bacteria and fungi. Some of these microorganisms are beneficial to the plants. These organisms help to breakdown the complex organic matter into the simple form and consequently increase the fertility of the land. But some micro- organisms are pathogenic to the plants. These organisms cause different diseases to the plants. The effluent also contains different chemicals in high amount. These chemicals in high amount serve as toxic to the plants. The industries utilize many poisonous substances, which are very harmful to the plants and soil microorganisms.

Ambernath is a city in India state of Maharashtra which is also a part of Mumbai Metropolitan region. Ambernath comes under the Thane district of Maharashtra. This is also well known for its industrial zones especially the Anand nagar MIDC which hosts more than 150 large scale industries including textile, chemicals, edible goods and electrical hardware. The study area is 4 kms or 2.5 miles is from Ambernath station (East). The soil samples were collected from the surrounding areas of Anand Nagar MIDC, Ambernath.

Material and Methods

Sampling of The Plant and Soil From Industrial Area

Plant Sample Collection

The plant samples from study area and the area 100 m away from study area were collected in labeled clean polythene bags, washed thoroughly with tap water, rinsed with distilled water and blotted with clean sterilized blotting paper to avoid surface contamination. Harvested samples were stored in refrigerator.

Soil sample collection

Soil Sample was Collected From two Different Location

1. Area that continuously receives industrial effluent discharges.
2. Area which is 100 meters away from the studied industries soil collected from industrial area and the area 100 meters away from industry was collected in seal pack polythene bags, removed the pebbles and large lumps from the soil sample. The collected soil was passed through a course sieve to remove small lumps and dead decaying leaves and twigs. The plant analysis was done for chlorophyll content and leaf relative water content.

Soil Sample Analysis

The following techniques were conducted like ph, electrical conductivity, water holding capacity of soil, heavy metal analysis and nitric acid digestion for the soil sample analysis. The digested samples were further analyzed at WRIC, University of Mumbai, Kalina campus, Santacruz (E), Mumbai.

Results and Discussion

Plant Sample Analysis

1. Chlorophyll Content

Table 1: Chlorophyll content analysis of the plants

Sr no.	Plants Names	Industrial Area		Total chl. Content	Unpolluted area		Total chl. Content
		Chl. a	Chl. b		Chl. a	Chl. b	
1	*Mangifera indica* L.	12.61	22.87	24.17	16.09	29.17	30.09
2	*Ficus religiosa* L.	7.20	13.00	5.86	8.02	14.50	9.00
3	*Terminalia catappa* L.	13.01	23.63	28.36	14.86	26.94	26.90
4	*Eugenia jambolana* Lam.	13.12	23.81	27.56	16.03	29.07	31.58
5	*Polyalthia longifolia* (Sonn.) Thwaites	7.39	8.38	14.74	11.26	20.41	19.81

Result of the present study have given in table no.1. in *Mangifera indica* L. leaves the industrial plant leaves have Chl. a and Chl b contents were 12.61 mg and 22.87 mg, respectively. The unpolluted leaves contained Chl a=16.09 mg and Chl b= 29.17 mg. In *Mangifera indica* L. the unpolluted area leaves contained higher amount of chlorophyll than industrial area leaves.

Similarly, in *Ficus religiosa* L. the chlorophyll content in industrial area plant leaves were Chl a=7.20 mg and Chl b=13.00 mg while in unpolluted area leaves the Chl. a and Chl. b content were 8.02 mg and 14.50 mg respectively indicating that, the unpolluted leaves of *Ficus religiosa* L. the contained higher amount of Chlorophyll content than the industrial leaves.

In *Terminalia catappa* L. the chlorophyll content in industrial area leaves were Chl. a =13.01 mg and Chl. b =23.63 mg, while in unpolluted area Chl. a =14.86 mg and Chl. b=26.94 mg. The chlorophyll content as higher in unpolluted area than industrial area plants leave.

In *Eugenia jambolana* Lam. the chlorophyll content in industrial area plant leaves were Chl. a =13.02 mg and Chl. b =23.81 mg, while in unpolluted area plants leaves were Chl. a =16.02 mg and Chl. b=29.07 mg indicating higher chlorophyll content in unpolluted area plant leaves than industrial area.

In *Polyalthia longifolia* (Sonn.) Thwaites the chlorophyll content in industrial area plant leaves were Chl. a =7.39 mg and Chl. b =8.38 mg, while in unpolluted area plants leaves were Chl. a =11.26 mg and Chl. b=20.41 mg indicating higher chlorophyll content in unpolluted area plant leaves than industrial area.

In case of total chlorophyll content, higher chlorophyll content has been observed in *Eugenia jambolana* Lam. while the lowest chlorophyll content was observed in *Polyalthia longifolia* (Sonn.) Thwaites.

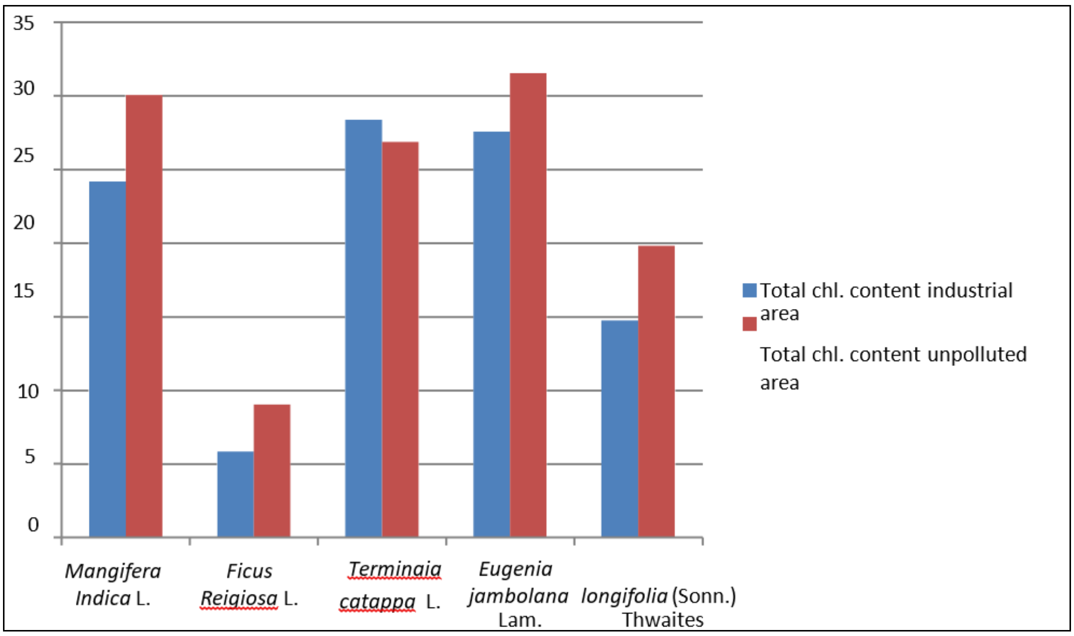


Fig 1: Total Chlorophyll content in industrial and unpolluted areas plant leaves of different plant species

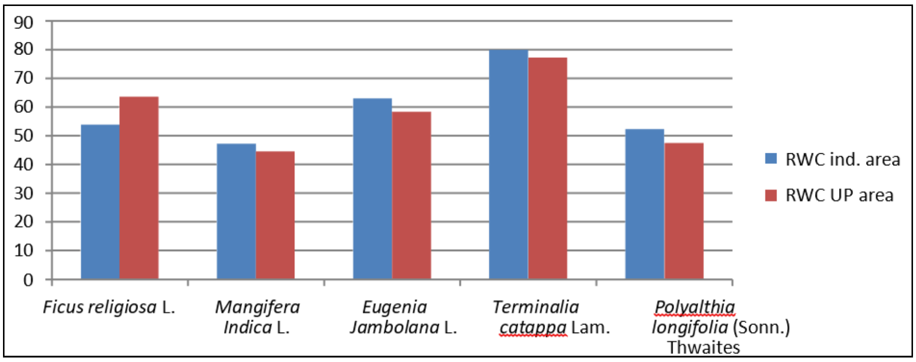
In almost all the selected plants, the chlorophyll content was high in unpolluted area plant leaves in comparison to industrial area plant leaves.

The possible explanation could be that in the industrial area the continuously releasing of gases and effluents in the surrounding environment, the effluents from soil could affect the photosynthetic activity of plants. Micronutrient deficiency in soil e.g. Fe deficiency or less penetration of sunlight can be the cause of low chlorophyll content.

Water Content of Plants by Fresh and Dry Weight

The main functions of plant roots are the absorption of water and inorganic nutrients, supporting the plant body and anchoring it to the ground, storage of food and nutrients, and vegetative reproduction.

Sr No	Plant Name	Industrial Area			Leaf	Unpolluted Area			Leaf
		FW	TW	DW	RWC %	FW	TW	DW	RWC %
1	*Ficus religiosa* L.	0.665	0.985	0.292	53.8	0.721	0.962	0.301	63.54
2	*Mangifera indica* L.	0.809	1.322	0.350	47.2	0.841	1.433	0.367	44.46
3	*Eugenia jambolana* Lam.	0.811	1.086	0.345	62.9	0.814	1.109	0.402	58.27
4	*Terminalia catappa* L.	0.884	1.004	0.410	79.79	0.921	1.271	0.520	77.11
5	*Polyalthia longifolia* (Sonn.) Thwaites	0.562	0.864	0.232	52.21	0.569	0.883	0.286	47.40



Result of relative water content of plants from both the study area indicated that the water content of the *Ficus religiosa* L. is more in unpolluted area (63.54%) than that of industrial area (53.8%). Rest of other plant species leaves reported from unpolluted area is less than industrial area shown in Table number 2.

An excess of metal ions in tissues may affect water absorption from the soil, and in turn decrease water content in the root. If soils are high in soluble salts (including heavy metal salts), the osmotic potential in the soil solution might be lower than the potential of the cell sap in root. Under these circumstances, the soil solution would several restrict the rate of water uptake by plants and lead to osmotic stress.

pH and Electrical Conductivity of soil

Soil pH is measure of the acidity or alkalinity of soil. Soil pH as considered a master variable in soils as it affects many chemical processes. It specifically affects plant nutrient availability by controlling the chemical forms of the different nutrients they undergo. The optimum pH range for most plants is between 5.5 and 7.5.

pH and electrical conductivity of both the study area

Table 2: pH and electrical conductivity of study area

Area	pH	EC
Industrial area	8.9	0.106 dS
Unpolluted area	8.4	0.100 dS

The collected samples have been analyzed to determine their physicochemical characteristics of the effluent soil showed alkaline pH 8.9 and 8.4 for industrial and unpolluted area respectively. The electrical conductivity which represents total ions concentration ranged 0.106 and 0.100 ds. There is no significant difference in EC from both the study area. The data revealed that the soil pH is affected due to application of different industrial waste. In sample collected from industrial area the increase in soil pH may be due to the discharge of effluent as compared to uncontaminated soil. The increase of soil pH is due to addition of various soluble salts in industrial effluent. Electrical conductivity is commonly used as measure of salinity of soil. In both the industrial and unpolluted area shows high EC. In the contaminated soil, EC increased with the application of effluent has high concentration of salts, particularly Na+ and Cl- has significantly increased in both the areas soil.

Water Holding Capacity

Water holding capacity of the soil is the amount of water retained in the capillary spaces of the soil after the percolation of gravitational water into the deeper layers. Water holding capacity depends upon the capillary pore spaces in the soil. Sandy soil has very low water holding capacity, whereas clay soil has very high-water holding capacity.

Table 3: Water holding capacity of soil samples from industrial and unpolluted areas

Area	Wt of crucible (W1)	Wt. of crucible + dry soil (W2)	Wt. of crucible + wet soil (W3)	Wt. of dry soil W2-W1	Wt. of wet soil W3-W1	WHC %
Industrial area	33.96 g	70.70	83.43	36.74	49.47	34.64
Unpolluted area	31.57 g	54.97	71.89	23.4	40.32	72.30

The present study shows water holding capacity of unpolluted area (72.30%) to be more compared to industrial area (34.64%). More water holding capacity shows the good physical condition of soil. Increased water holding capacity of area in unpolluted area may be due to the accumulation of organic waste such as amino acid residues.

Heavy Metal Analysis

Heavy metals as a general collective term refer to metals and metalloids with an atomic number above 20 and a relatively high density greater than water. Heavy metals include Lead (Pb), Cadmium (Cd), Nickel (Ni), Cobalt (Co), Copper (Cu), Zinc (Zn), Chromium (Cr) and many more. An excess of both essential and non-essential metals induces ion stress in plans and causes multiple direct or indirect effects, which concern practically all physiological functions.

Table 4: Solution Result – Lead

Sample ID	Signal Abs	Rsd %	Conc. mg/l	Corrected Conc. mg/l
Lead Blank	0.000	>99	0.0000	
Lead Standard 1	0.006	28.8	0.2500	
Lead Standard 2	0.015	5.9	0.5000 X	
Lead Standard 3	0.035	4.7	1.0000 X	
Lead Industrial area	0.031	7.8	0.9062 X	0.9062 X
Lead unpolluted area	0.095	3.2	2.4663 CX	2.4663 CX

Table 5: Solution Result – Copper

Sample ID	Signal Abs	Rsd %	Conc mg/l	Corrected Conc mg/l
Cu Blank	0.001	6.4	0.0000	
Cu Standard 1	0.031	0.8	0.2500	
Cu standard 2	0.057	0.2	0.5000	
Cu standard 3	0.104	0.4	1.0000	
Cu Industrial area	0.663	0.2	6.8680C	6.8680C
Cu Unpolluted area	0.436	0.8	4.4885C	4.4885C

The result shows that the lead concentration is higher in unpolluted area (2.4663) as compared to industrial area (0.9062). Where concentration of copper is higher in industrial area (6.8680) than that of unpolluted area (4.4885). The concentration of lead is seen more in unpolluted area from industrial area is high it might be due leaching of this salts by water source, irrigation and slope.

Conclusion

Ambernath MIDC which is located in Thane district of Maharashtra from which most of the industries discharges its untreated effluent into streams or directly into surrounding environment, was chosen for this study. This industry discharges its effluents directly into surrounding environment where the vegetation was continuously irrigated with these effluents. This study analyzes the physico-chemical characters of plants and soil from both the areas. The industrial area and unpolluted area 100 m away and its impact on soil. Different parameters analyzed were pH, electrical conductivity and water holding capacity of soil. There was no significant difference in the parameters of industrial and unpolluted sites studied.

In plant analysis the chlorophyll content was more in unpolluted area then that of industrial area this might be due to release of untreated effluents in soil. This might lower the chlorophyll content in industrial area than unpolluted area. The relative water content of plants from industrial area and unpolluted area was studied there was no significant difference in both the areas.

The heavy metals analyzed were Lead and Copper in the soil samples from Unpolluted and Industrial area. The amount of Lead was more in unpolluted area as compare to industrial soil sample. The amount of Copper was more from the soil sample collected from industrial area.

Following points are recommended on the basis of present research work:

- These industries should establish the effective effluent treatment plant and it should be properly treated before discharge.
- Awareness program should be launch to the industries and local people about the impact of effluents and its proper utilization.
- For heavy metal the phytoremediation technique should be carry out to reduce the level of pollution.

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