

A Comparative Analysis for Phyto-Remediation Using *Allium cepa* and *Brassica juncea* For Treatment of Sewage Water of RIICO Industrial Area, Jaipur

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ABSTRACT

Removal of pollutant and heavy metals from the waste water collected from the effluent is one of the burning problems. In the industrial area of jaipur Rajasthan State Industrial Development and Investment Corporation Limited RIICO, several industries are mushrooming day by day. These industries are one of the major sources of toxic chemicals and heavy metals along with their effluents. Several approaches have been taken for the treatment of these waste water. Among the numerous approaches phytoremediation is one of the alternative methods for the removal of heavy metal from the waste water collected over there.

The present study is to determine which plant species is more significant in the industrial area RIICO of Jaipur for the removal of heavy metals and other pollutants from the effluent generated in this locality. A comparative analysis of the waste water treatment using two common plant as mustard plant *Brassica juncea* of family brassicaceae and onion plant *Allium cepa* of family Amaryllidaceous.

Qualitative parameters like pH, Electrical Conductivity, Total Solid (TS), Total Dissolved Solid (TDS), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) are analyzed for two samples from different locations sample 1 from sitapura and sample 2 from sanganer After the treatment using the process of phytoremediation. Before treatment average pH of the samples was found in the average range of 7.6 for sample 1 and 8.6 for sample 2 and after treatment with onion and mustard plant was 6.5 and 5.6 for sample 1 and 5.6 treatment that enhances its transparency also affects aesthetic value. Electrical Conductivity reduces from the average range of 2800 to 1450 and 1400 S/cm as well as for sample 2 it reduces from 3800 to 1850 and 1800 S/cm. The average value of total solid for sample 1 changes from 5250 to 3600 and 3900 mg/l and for sample 2 it changes from 3800 to 1850 and 1800 mg/l. After the treatment the average value of Total Dissolved Solid reduces from 2200 to 1350 and 1300 mg/l for sample 1 and for sample 2 value reduces from average range of 2900 to 1700 and 1600 mg/l. The value of BOD changes from the average range of 265 to 145 and 135 for sample 1 and for sample 2 it reduces from 295 to 155 and 140 mg/l. The range of COD changes from 1100 to 750 and 700 mg/l for sample 1 and for sample 2 it changes from 1350 to 750 and 700 mg/l. The lead content for sample 1 reduces from 0.053 to 0.03 and 0.029 $\mu\text{g/l}$ as well as for sample 2 it reduces from 0.104 to 0.073 and 0.064 $\mu\text{g/l}$. The content of cadmium in average changes from 0.017 to 0.009 and 0.0088 $\mu\text{g/l}$ for sample 1 and for sample 2 the value changes from 0.023 to 0.012 and 0.009 $\mu\text{g/l}$. On the basis of these result there is comparative analysis of treatment of waste water collected from two different locations of Jaipur by using two different plants by the mechanism of phytoremediation. Overall conclusion reveals that waste water discharge from Sanganer industrial area, Jaipur can be used efficiently for the cultivation of mustard plant. So that it can be treated and will not cause poisoning. This work shows a comparative approach by different plants using same mechanism and signifies which plant will be more beneficial for which particular location in jaipur in the way of sustainable development.

Keywords: Phytoremediation, Turbidity, Biochemical Oxygen Demand, Electrical Conductance, onion plant, mustard plant.

INTRODUCTION

A. Need of study

India is having 2.45% of land area and 4 % of water resources of world along with 16% of world population. As the industrial growth is increasing rapidly day by day, rate of generation of waste water is also enhancing simultaneously. Several research and analysis have shown that availability of fresh water is reducing on one side and generation of waste water is increasing on another side. Effluent generated by various industries contributes several toxic and heavy metals to the environment. In the industrial area RIICO, Jaipur several chemical and textile industries are implanted. For the treatment of waste water collected over there different conventional method of treatment is also regulated, but some of the heavy metal cannot be destroyed by this degradation method [1]. Since the method of Phytoremediation is considered as alternative approach for their removal, it is an effective and technological solution for the removal of heavy metal and toxic metal from contaminated water. This method has been proposed first 300 years ago for the treatment of waste water [6]

In my present work, following topics should be discussed before initiating it.

1. Waste water characteristics
2. Phytoremediation

B Objectives

The objectives of this paper are as follows:

1. To find an alternative method of waste water treatment
2. To identify the best plant source for Phytoremediation in RIICO, Industrial area.
3. To analyze and characterize the waste water of the effluent generated from various industries of Sitapura, Jaipur.
- 4 To emphasize the method of artificial recharging after waste water treatment.

C. History of wastewater

Most ancient waste water management system was in Mohenjo-Daro at about 1500 BC. Wastewater are collected through canals and grooves and then exposed to the river Indus. At about 500 BC cloaca maxima in Rome act as waste water collector. A simple sewer system was first constructed in the year 1864. Extension of pipe system and conduits are established simultaneously in the year 1883 and 1933. Water supply system improved in the mid of 19th century with the development of water toilet and construction of open and closed waste water ditches. In this period waste water generated from various industries discharged directly in to river and canal as well as in to the soil below the toilet at courtyard. A large number of wastewater channels were added to the system, few are laid underground and few are open channeled directly near the sidewalk. In the 20th century public concern arises about water pollution and public health. In the year 1952 primary treatment facilities started in operation for the healthier future of city and progressively the system was modernized with time and capacity

was enhanced. As the time passes pump stations and different type of clarifiers are added to the treatment system as shown in fig.1.



Fig .1 Water Treatment System with Clarifiers

With the expansion of treatment system with digesters in the year 2011 and the use of chemically enhanced primary treatment system was introduced in the year 2012. The systems like optimized plug flow control and air diffuser system enhances sludge holding capacity as well as its efficiency.

D. Sources of wastewater

As the development of city is enhancing rapidly the amount of wastewater discharge is also increasing in same proportion. Industrial development contributes huge amount of pollutants in different forms as well as different ways.. Beside industrial waste water other sources of waste water are washing water from houses, human faeces, sewage treatment plant discharge, septic tank leakage, rainfall collected from roof yards etc. water used for industrial processing as well as cooling system in industries generate large amount of waste water. Industries relevant to pharmaceutical by products, pesticides, chemical, textile manufacturing, paper and pulp, food packaging carries heavy metals as well as toxic metals along with their effluent. In the industrial area of Jaipur RIICO several industries has been established.

E. Characterization of wastewater

Due to industrial development and change in manufacturing processes, characteristics of waste water also changes accordingly and significantly. The amounts of heavy metal and synthesized organic compounds generated by industrial activities have increased and new compounds are also added. Their characteristics vary according to the function of particular industry. Waste water collected from combined system .contain several organic, inorganic as well as heavy metals. Various methods have been used for the removal of these constituent from the waste water collected from various sources.

F. Phytoremediation

Phytoremediation can be defined as the use of plant techniques to remove or degrade organic and inorganic metal constituent present in soil and water. It is processed by different mechanism namely rhizofiltration, phytostabilization, phytodegradation and phytoextraction. Phytoremediation is one of the emerging techniques over other conventional techniques for the removal of pollutants from waste water. Several techniques have been earlier used but this is one of the cost effective as well as environment friendly method to clean it. This method comprises operation like plant metal uptake, trans location, accumulation, and degradation.

G. Mechanism of Phytoremediation

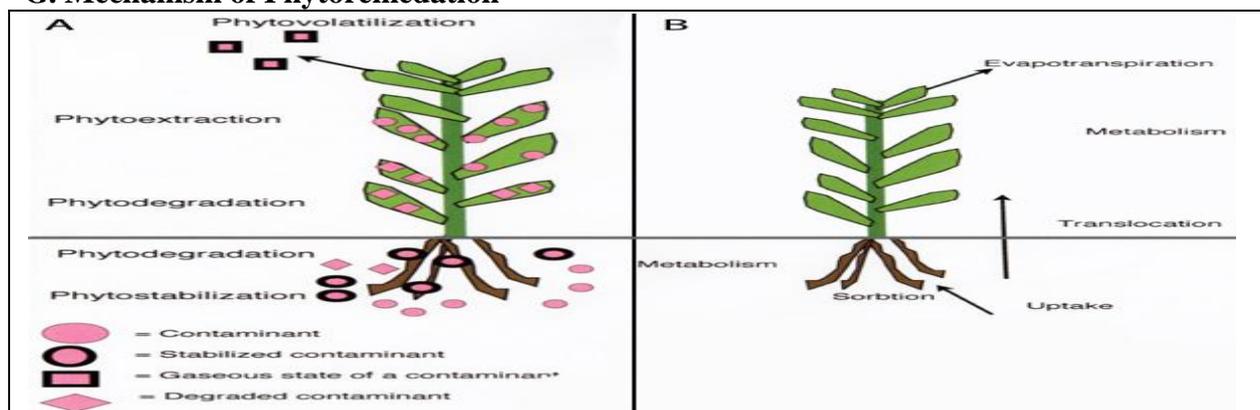


Fig.2 Mechanism of Phytoremediation

H. Plant Used

a) Mustard Plant (*Brassica juncea*)

These are the one of the hyper accumulator plant of plant family Brassicaceae that are capable to accumulate Pb, Cr, Cd, Cu, Ni, Zn, Sr, B and Se. The species is capable to accumulate > 1.8% lead in their shoot and 0.82 to 10.9 % Pb in their roots.



Fig. 3 Mustard plant

b) Onion plant (*Allium Cepa*)

Uptake and accumulation of plant species belongs to this family involves the mechanism of hyper accumulation for the removal of cadmium. A recent agricultural study in Israel shows that Cd was accumulated in root and leaves of plant.



Fig. 4 onion plant

METHODOLOGY

A. Physical and chemical characterization

Samples are collected from two different locations of proper volume so that physical and chemical characteristics are analyzed in proper manner. Characteristics like pH, Electrical conductivity, TS, TDS, BOD, COD are analyzed using guidelines given in Central Pollution Control Board waste water analysis manual. Heavy metal test for analysis of lead and cadmium concentration in waste water is determined in Rajasthan state pollution Control Board.

B. Steps involved in phytoremediation

a) Implantation of plant

- 1) First the seed of mustard and onion is taken and seeded in different pots on 15th of August, after certain duration of around 10-15 day a developed plant is chosen and implanted in a two separate pots on 1st September.
- 2) Pots are prepared by filling clayey soil.
- 3) Both the plants should be developed to appropriate level so that they are capable for treating the waste water.

The following tools and materials are needed for planting the Plant:

- a) Flower pots
- b) Onion Seeds
- c) Mustard seeds
- d) Water spray

Sample collection

Samples are carefully collected from two different sources of effluent so that it does not deteriorate or become contaminated before analyzed.

Table 1 : Sample information at the time of sampling

Sr.no	Sam Sample information	Sample 1	Sample 2
1	Sample identification number	1	2
2	Location	Sitapura industrial area	Sanganer industrial area
3	Date and hour	15 sept. 30 sept. 15 oct,9am	15 sept. 30 sept. 15 oct,10 am
4	Water temperature in ° C	24 °C	26 °C

b) Filtration of wastewater

- 1) After 15 days, on 15th September 2 L of sample water is poured in the flower pot containing mustard plant and onion plant separately.
- 2) Water is retained in the pot for 4 hour, and after this water is collected by opening the inlet of pot.
- 3) Treated water is collected in tray by keeping the pot over it. Some of the constituent present in the water sample get absorbed by the plant

c) Collection of filtered water

- 1) The flower pot was placed in a tray after pouring of water in to it. After few hour of duration water get collected over in the tray.
- 2) The method of filtration and collection of sample water is repeated after 15 days of interval. Characterization of filtered water was done successfully according to the manual of waste water guided by central pollution control board and heavy metal test were performed in Pollution Control Board, Jaipur.

RESULT

Sample 1 & 2 were characterized using various physiochemical parameters and result has been analyzed using two different plants for Phytoremediation. A comparative analysis is explained by graphical representation for each and every characteristic.

A. pH

The mechanism of chemical and biochemical reactions depends upon the pH; after treating the water by the method of phytoremediation pH reduces. In both the sample more reduction was observed in case of using mustard plant, whereas in case of using onion plant slight variation was observed. There is reduction in the alkaline characteristic of sewage water in both of the cases. It shows the capability of these plant to remove metals like cadmium and other positive ions.

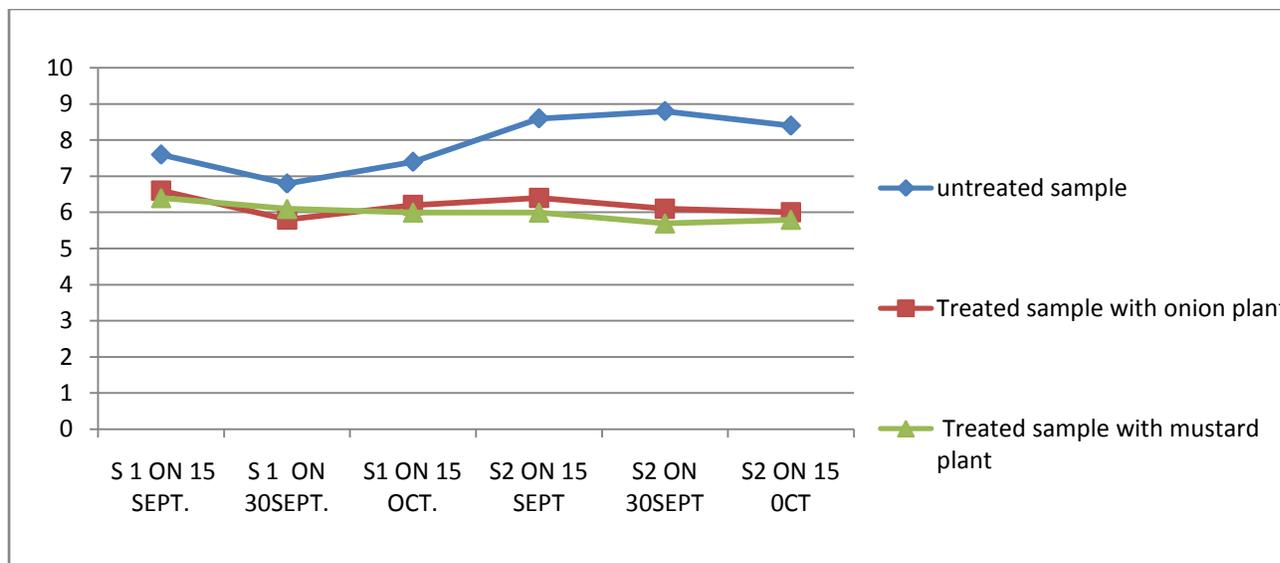


Fig. 5 Variation in pH

B. ELECTRICAL CONDUCTANCE

Conductivity reflects the presence of ionized salts in wastewater as well as its ionic strength. There is huge reduction of electrical conductivity after treating it with onion and mustard plant. For sample 1 mustard plant have shown better result where as for sample 2 onion plant have shown better result. But overall in both cases more than 50% reduction is observed in case of electrical conductivity. This reduction is basically due to removal of phosphate.

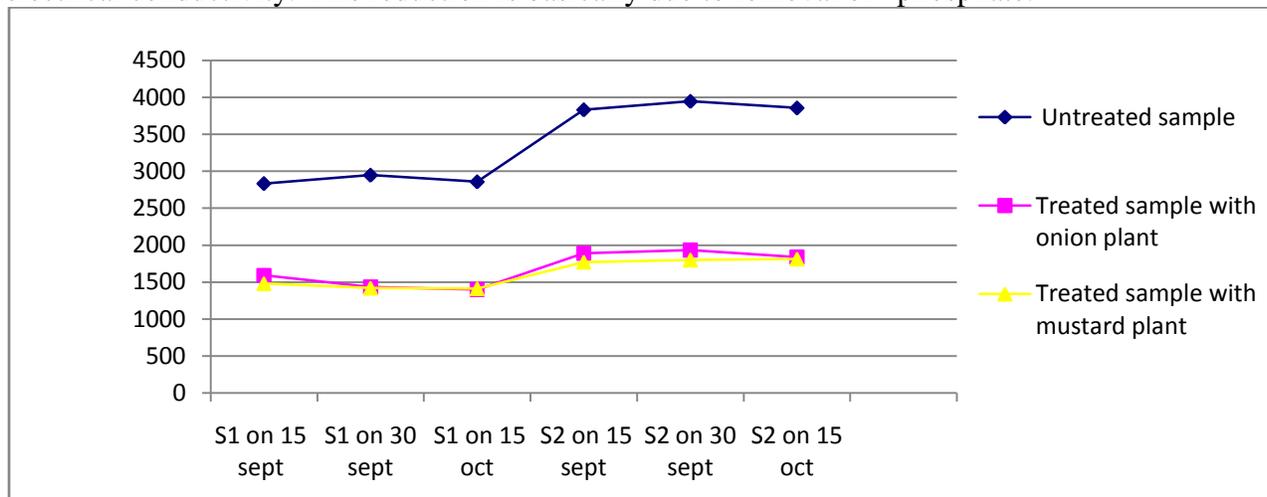


Fig. 6 Variation in Electrical Conductivity in s/cm

C. TOTAL SOLIDS

Significant change in value of total solid has been observed after treatment using the method of phytoremediation. Approximately 50% reduction is observed in both the case using both the sample. This is due to the removal of heavy metals like Pb, Cd, Cu; Zn. Presence of solid content in water creates anesthetic condition

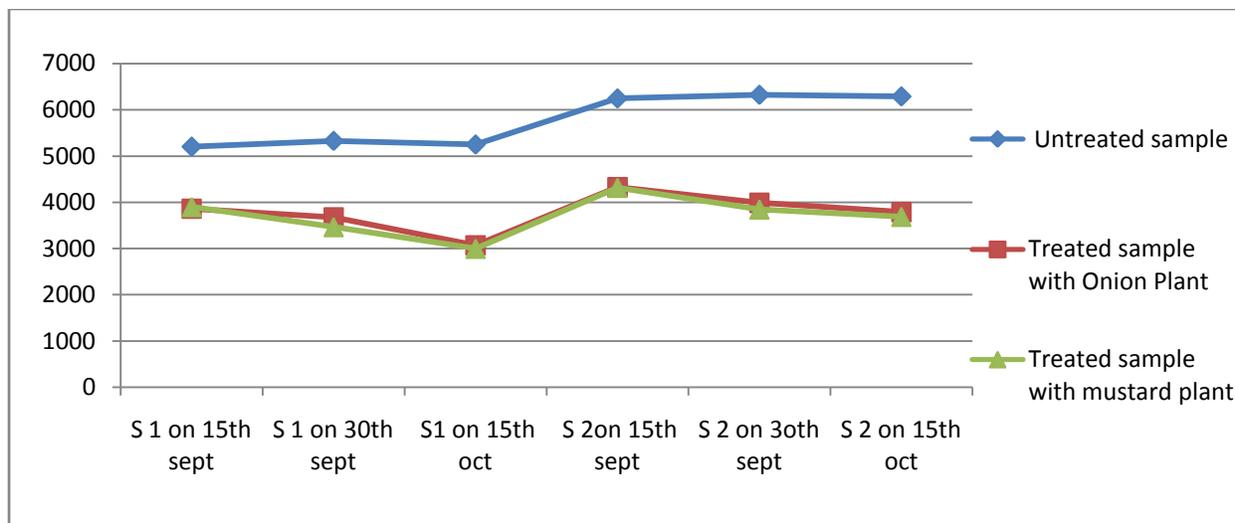


Fig. 7 Variation in Total Solid in mg/l

D. TOTAL DISSOLVED SOLID

Amount of Total Dissolved Solid has been reduced to approx 50% after treating the industrial wastewater using the method of phytoremediation. On comparing the result of treating both the sample by *Allium cepa* and *Brassica juncea*, *Brassica juncea* has found to be more efficient in Sanganer area, whereas in case of Sitapura both plants shows similar efficiency in reduction.

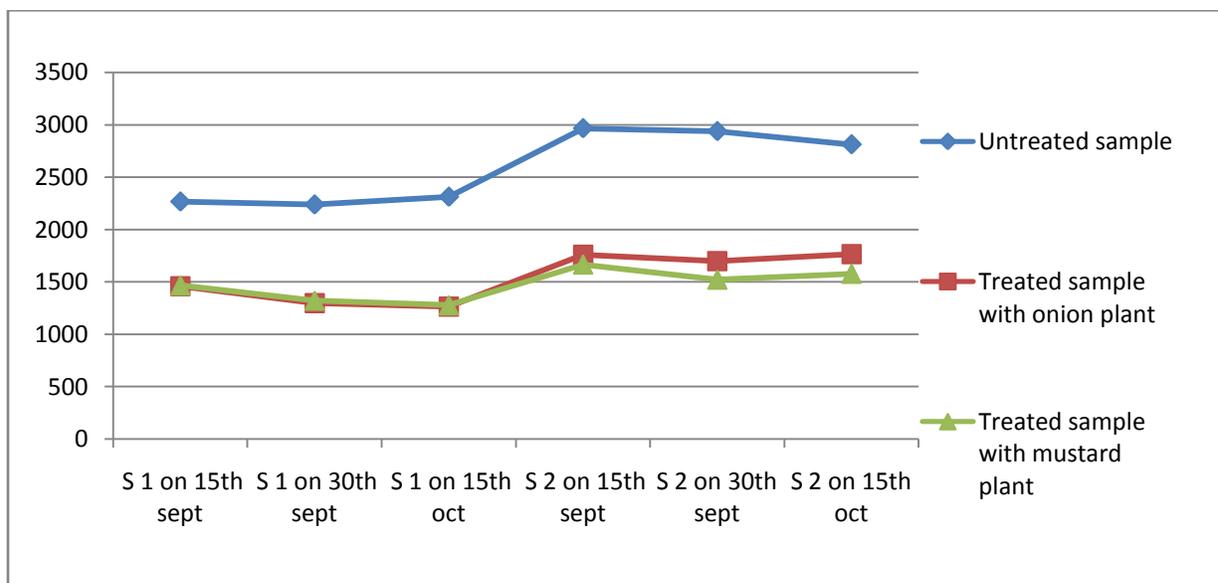


Fig. 8 Variation in Total dissolved solid in mg/l

E. BIOCHEMICAL OXYGEN DEMAND

It signifies the amount of organic material in present in water that is required by the micro organism. In both the sample the amount of reduction of BOD is found to be more while using *Allium cepa*. Mustard plant also shows significant reduction in amount of BOD. More than 50%

of reduction is observed in case of mustard plant. While using onion plant it shows less efficiency in the case of sample 2.

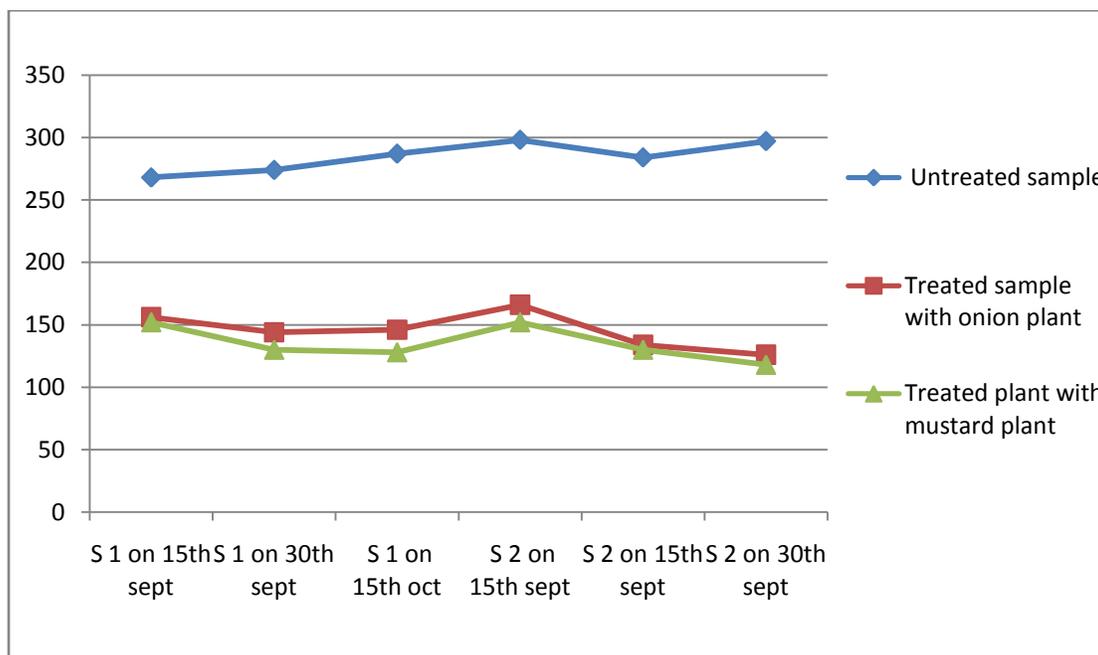


Fig. 9 Variation in BOD mg/l

F. CHEMICAL OXYGEN DEMAND

It determines the equivalent amount of oxygen equivalent of organic matter susceptible to oxidation by using oxidant. 52 % of reduction was observed after treatment using mustard plant in case of sample 2, while in case of treatment with onion plant for sample 1 30 % reduction was observed.

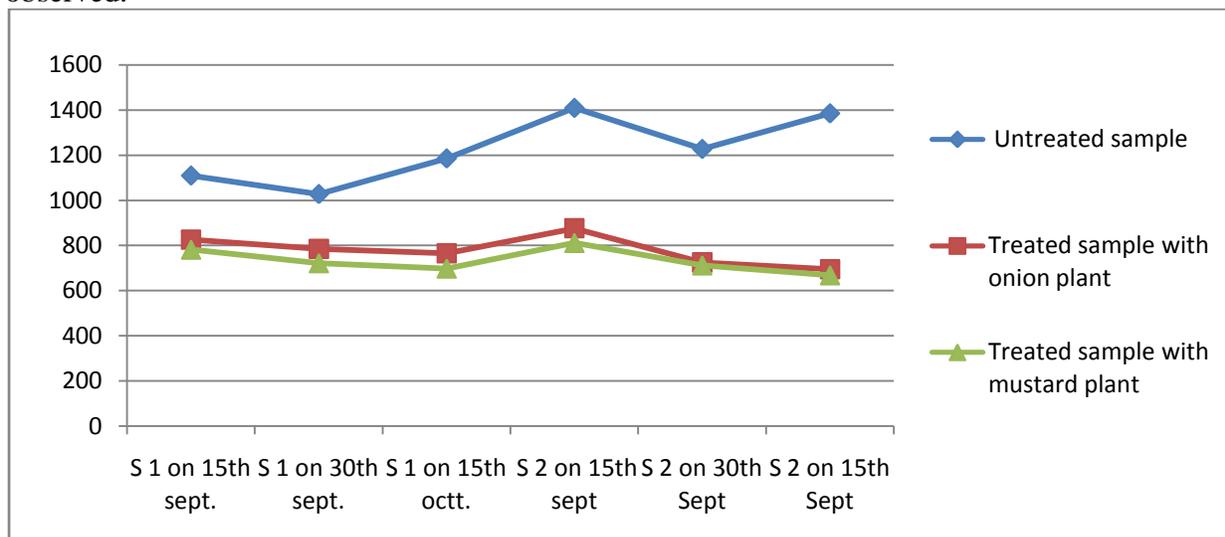


Fig. 10 Variation in COD in mg/l

HEAVY METAL TEST G. LEAD

Industrial discharge commonly contains lead in the form of smelter discharge or from the dissolution of plumbing discharge. After treatment of water using onion plant reduction was found to be 30-32% reduction while in case of mustard plant more reduction was observed approximately 35-40 %. This occurs due to the more percentage of accumulation of lead content in Sanganer by mustard plant

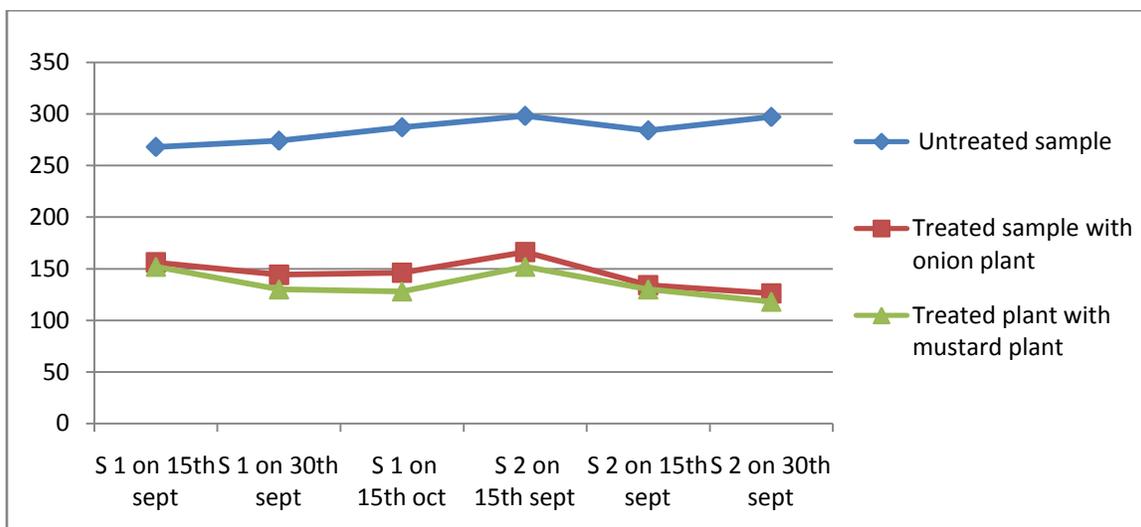


Fig. 11 Variation in lead in µg/l

H. CADMIUM

Cadmium presence is responsible for toxicity in food, sometime which leads to poisoning also. The result after treatment with onion plant was found to be average of 45 % reduction in both the cases. In sample 2 more reduction was observed in case of mustard plant with respect to onion plant. This reveals the fact that more amount of cadmium was observed in case of treatment with mustard plant.

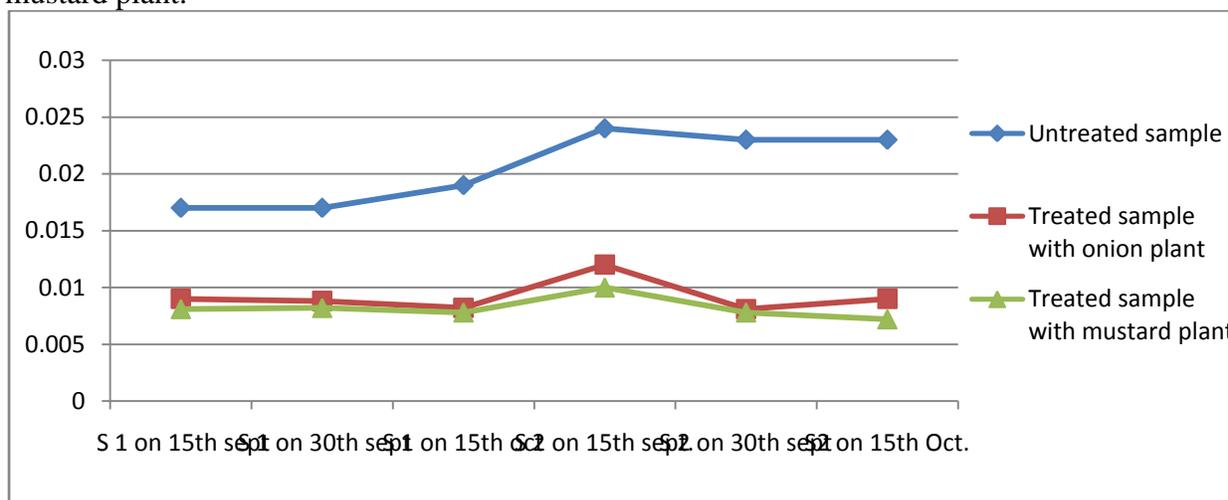


Fig. 12 Variation in Cadmium µg/l

CONCLUSION

Phytoremediation is one of the environment friendly method for the treatment of wastewater. For the implication of this method in two different sector of Jaipur. The samples were collected from two industrial regions one is sitapura and another is sanganer. Physiochemical analysis like pH, total solid, total dissolved solid, Biochemical Oxygen Demand, Chemical Oxygen Demand and heavy metal test of lead and cadmium were analyzed after treating them using two different plant species i.e *Allium cepa* and *Brassica juncea*. The comparative analysis reveals that method of treatment is more effective in case of sample 2 that was from sanganer industrial zone. In case of plant analysis, overall conclusion is made in favour of *Brassica juncea*. After treatment with *Brassica juncea* the percentage deduction in case of total solid, total dissolved solid, Biochemical Oxygen Demand, Chemical Oxygen Demand, Heavy metal Pb and Cd is more with respect to other. After treatment there is slight reduction in pH and temperature. Appearance of the waste water changes effectively after treatment. Approximately 50 % reduction observed in case of electrical conductance and more than 50% reduction is estimated in case of TDS , BOD, COD for both the samples. In case of lead and cadmium content approx 35-40% reduction is estimated.

Overall conclusion reveals that waste water discharge from sanganer industrial area can be used efficient for the cultivation of mustard plant. So that it can be treated and will not cause poisoning. Best result is observed on the second date when the plant growth is at optimum level. On this stage root of plant are well developed and able to extract more amount of heavy metal and other ions. Another fact is that it will not effect the water table characteristics.

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