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Potential of Eichhorniacrassipes and Lemna minor for degrading Pulp and Paper Mill Effluent using Phytoremediation technique along with enhancers

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ABSTRACT

We want to compare the potential of Eichhorniacrassipes and Lemna minor for degrading Pulp and Paper Mill Effluent using Phytoremediation technique along with enhancers.Experiment was performed in 8sets:Set 1and set 5was control, and sets 2-4 were treated with plants, plants with EDTA and plants with Citric Acid in 20% effluent concentration and 6-8 were treated with plants, plants with EDTA and plants with Citric Acid in 40% effluent concentration.The Phytoremediation of Pulp and Paper Mill Effluent using E.crassipes and Lemna minor along with enhancers has been assessed in terms of reduction in pH, EC,BOD, COD, TSS, TDS. A significant reduction in all the selected parameters of Pulp and Paper Mill Effluent over zero day value has been observed. All parameters exhibited exponential decrease from the start up to 45 days and thereafter showed negligible decrease till the termination of the experiment.The proposed phytoremediation technique along with enhancers can be profitably employed for the abatement of pollution from industrial waste water.

Keywords: Phytoremediation, Pulp and Paper Mill Effluent,Eichhorniacrassipes(Water hyacinth), Lemna minor(Duckweed), EDTA, Citric Acid.

I. INTRODUCTION

Water pollution is one of the most serious problems of world. The water consumption is increasing day by day due to increasing population. Hence, to overcome the water problems in future,waste water recycling was adopted. Therefore, it is necessary to treat this wastewater .Now-a-days, treated wastewater is considered as a potential water resource because it contains considerable amount of nutrients, which may prove beneficial for plants growth [1, 2]and hence the use of wastewater in agriculture is gaining importance rapidly.. Generally, the quality of discharged effluent differs from industry to industry, which may or may not be suitable for the irrigation of crop. So, the effluent should be assessed properly prior to its application for irrigation. The industrial waste water discharged to the river in downstream [3].Thus, theindiscriminate use of industrial effluent may reduce crop growth and contaminants may interfere with natural characteristics of soil.

The paper industry is one of the largest industries in India,consuming large amount of water[4]. Nearly 75 to 95% of the water was discharged by the industries as effluent containing organic, inorganic pollutants and

colouring materials.Presence of these chemicals may affect soil and in turn the growth and development of plants[5]. Studies on the effect of paper mill effluent on various crops have been carried out by various investigators[6-10]. Baruah and Das [11] reported that there is delay, retard and decline of germination of rice seeds and seedling growth with paper mill effluent treatment in comparison to control. Rajannan and Oblismai[12]reported that paper mill effluent had drastically affected the germination of rice, black gram and tomato seeds, however, the diluted form of effluent (25 and 50%) enhance the growth. Karande and Ghanvat[13] observed that dilute effluent show negligible effect on the overall growth characteristic in pigeon pea seedling treated with paper mill effluent. Mishra et al. [14] conducted the studyof physiotoxicity of the paper mill effluents on Elusinecoracana and Oryza sativa crops. Further, Mishra and Behera [15] studied the same effect on rice seedlings. Narwal et al. [16] reported that paper mill effluent increased sodium and potassium contents and disturbed the anionic-cationic balance in plants, thereby reducing the yield and quality of crops. Similarly, textile waste water was also treated by phytoremediators[17]. Several comprehensive reviews summarizing important aspects of phytoremediation are available[18-23].Study for removal of metals have already done by phytoremediator plants[24-25].

Literature survey indicated that diluted form of paper mill effluent could be used for irrigation purpose to enhance production of agricultural crops (the yield and quality of crops).The concentration of dilution is varied depending upon the crops. On the other hand, after application of paper mill effluent in different concentrations, the physico-chemical properties of the soil may be changed or it may be toxic to the plants. So, before going to apply the effluent in the agricultural field, the physicochemical characteristics of the effluent have to be characterised.

The present study was carried out withan objective to analyse the physico-chemical properties of the effluentfrom the paper mill industry and to study further impact of paper mill effluent on the environment. In the present paper, attempt has been made to compare the potential of Eichhorniacrassipes and Lemna minor for degrading Pulp and Paper Mill Effluent using Phytoremediation technique along with enhancers. Phytoremediation of metals is the most effective plant-based method to remove pollutants from contaminated areas [26].

II.MATERIALS & METHODS

Pulp and Paper Mill Effluentwas collected from the exit point of Ballarpur Paper Mill Unit, Yamuna Nagar (Haryana). The effluent collected in clean plastic containers from effluent drain was stored.

Plant samples were collected from a natural pond along the road side and washed thoroughly with running tap water followed by distilled water to avoid any surface contamination.

Experiment was performed in plastic tubs (capacity 10 litre). Each tub was filled with 10 litres of Pulp and Paper Mill Effluent. Equal number of uniform size Eichhorniacrassipes plants were immersed in four tubs.Lemna minor after drying on filter paper is transferredinto four tubs.The plants were allowed to grow and analyzed for different pollution load parameters at intervals of 15 days each between 0 to 60 days. 50ml of the samples were withdrawn from each tub at the specified interval and analysed for various physico-chemical

parameters. The lost effluent on account of its analysis was made good by adding as amount of distilled water equal to the amount withdrawn from each tub.

Analysis of the chosen pollution parameters of the effluent drawn after experimental treatment was carried at 0, 15, 30, 45, 60 days of the start of the experiment using standard methods outlined in APHA[27].

Phytoremediation Experimental set up of Pulp & Paper Mill Effluent

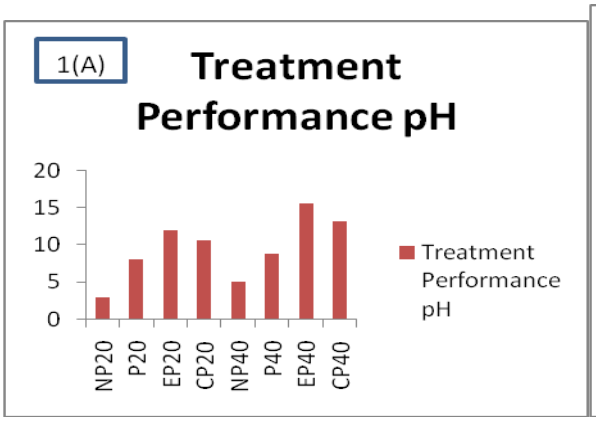
Experimental Set Up (10L)	Abbreviation	Pulp & Paper Mill Effluent Concentration (PE) (With Distilled Water)
Set 1	NP20	20% PE (Control 1)
Set 2	P20	20% PE + Plant
Set 3	EP20	20% PE + Plant + EDTA
Set 4	CP20	20% PE + Plant + Citric Acid
Set 5	NP40	40% PE(Control 2)
Set 6	P40	40% PE + Plant
Set 7	EP40	40% PE + Plant + EDTA
Set8	CP40	40% PE + Plant + Citric Acid

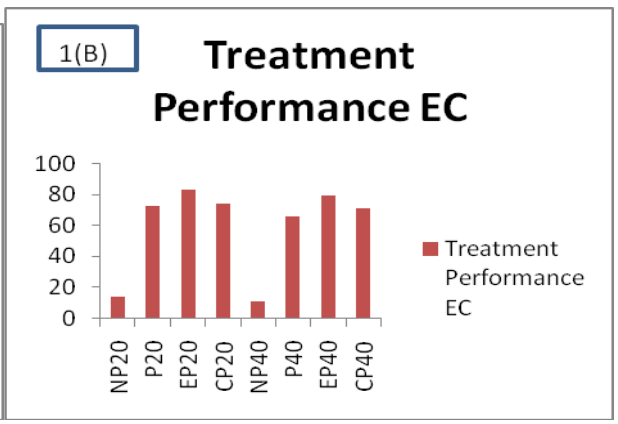
III. RESULTS

The effluent of pulp and paper mill industry contains heavy load of organic and inorganic compounds. Due to this, they show high concentration of all physico-chemical parameters. The Phytoremediation of Pulp and Paper Mill Effluent employing Eichhorniacrassipesand Lemna minorhas been assessed in terms of reduction in pH, EC,BOD, COD, TSS, TDS .

The effect of Eichhorniacrassipesand Lemna minor withon physico-chemical characteristics of Pulp and Paper Mill Effluent phytoremediated for different durations in respect of observed parameters have been summed up in Fig. I and Fig. II.

Fig 1(A-G) and Fig 2(A-G)shows the reduction of various parameters i.e. pH, BOD, COD, TS, TDS, TSS of paper mill effluent after pytoremediation with E.Crassipes and Lemna minor along with EDTA and Citric Acid respectively.





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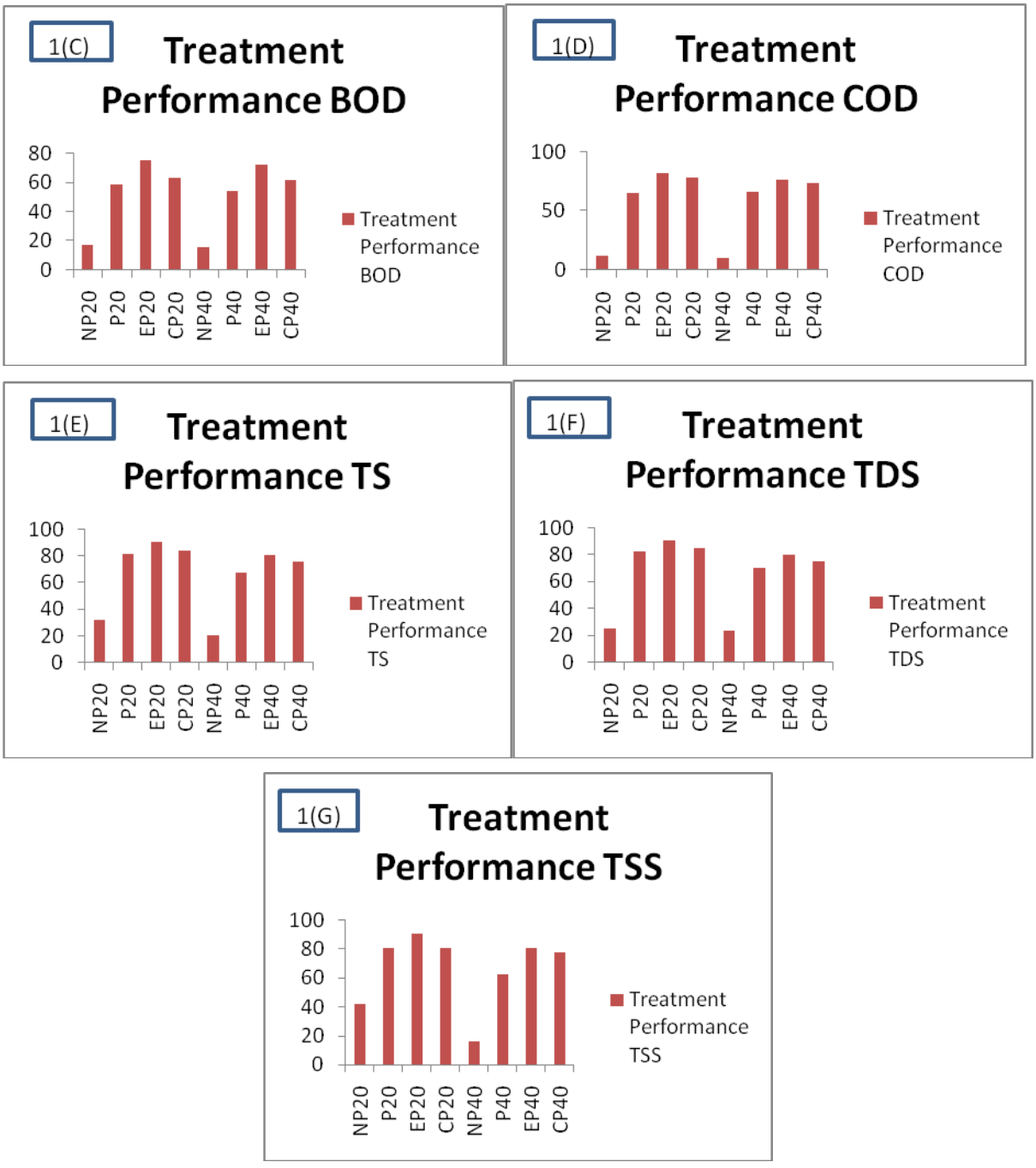

Fig 1.Effect of E.crassipes , EDTA & Citric Acid on the physico-chemical characteristics of Ballarpur paper mill effluent (A)pH (B)EC (C)BOD (D)COD (E)TS (F)TDS (G)TSS

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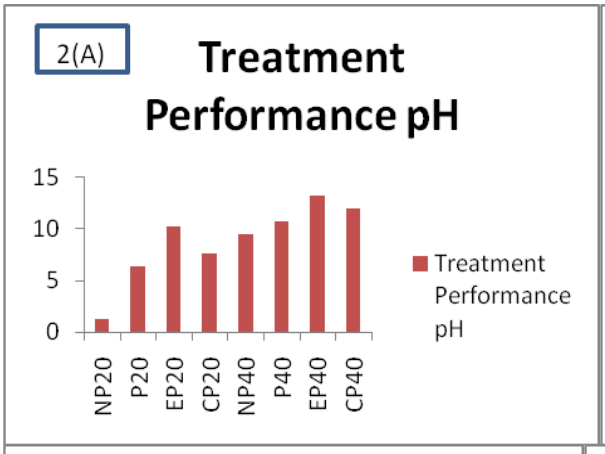

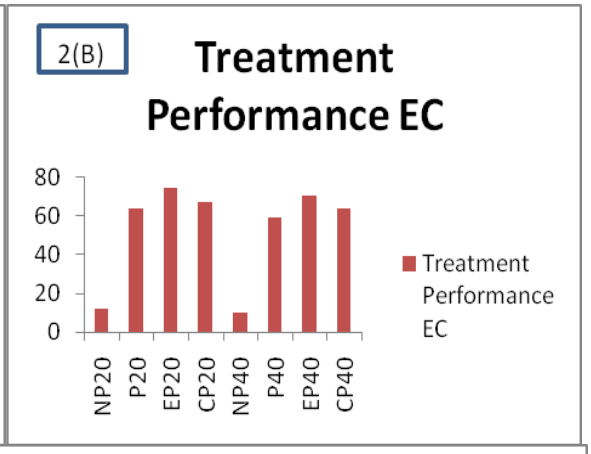

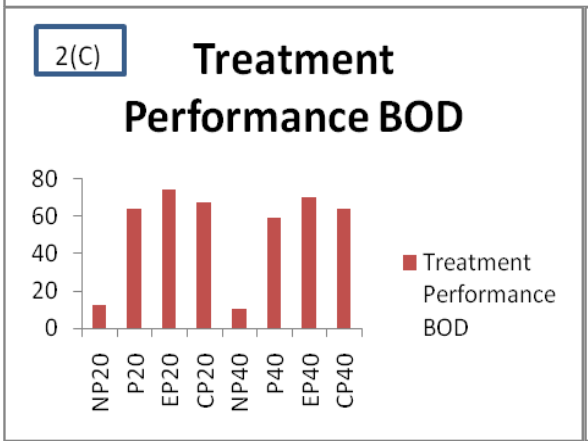

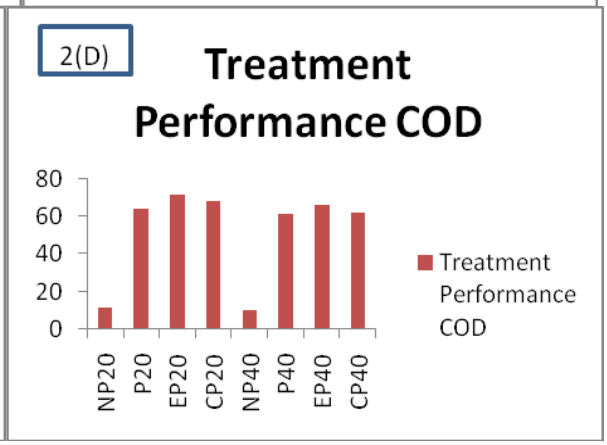

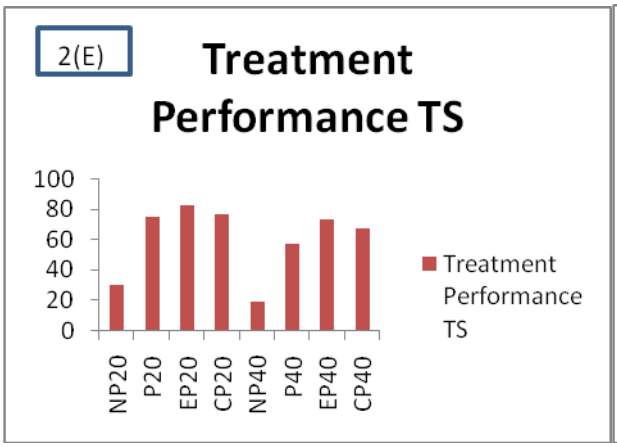

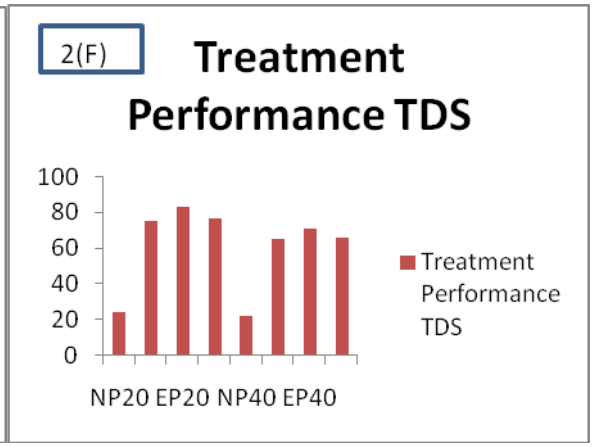

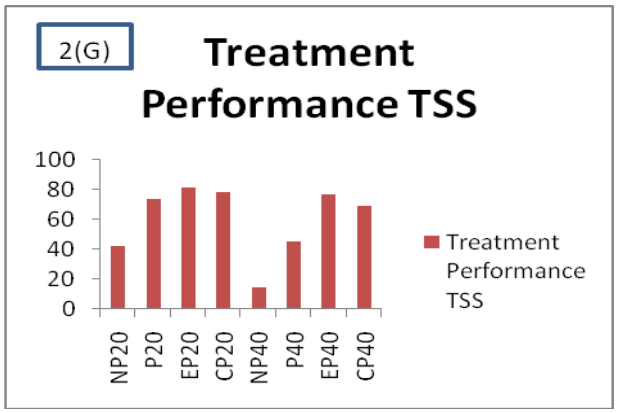

Fig 2.Effect of Lemna minor, EDTA & Citric Acid on the physico-chemical characteristics of Ballarpur paper mill effluent (A)pH (B)EC (C)BOD (D)COD (E)TS (F)TDS (G)TSS

IV. DISCUSSION

Redution in various pollutants after phytoremediation

pH: According to *WHO*, the range of desirable pH of water is 6 to 9[28]. But in above study, the pH value ofsamples is slightlyalkaline. It was observed that whenphytoremediation and enhancers are used, the pH was decreased.

Electrical conductivity: Itis a useful indicator to show the salinity or total salt content of the effluents. Water having high EC values can makes it more difficult for a plant to absorb water for growth. Increase in EC values indicates the presence of higher concentration of ions [29]. Thus increased EC in irrigation water leads to lower crops production [30]. EC itself is not a human or aquatic health concern but it canserve as an indicator of otherwater quality problems[31]. The EC value of effluent samples was recorded as 1043 before experiment. Similarly electrical conductivity was also decreased, when phytoremediation and enhancers are applied on it.

BOD: Biological Oxygen Demand is the measure of the oxygen required by microorganisms whilst breaking down organic matter. The high BOD levels are indications of the pollution strength of the waste waters. According to *WHO*, The range of desirable BOD of water is 50mg/l. If the BOD level is too high, the water could be at risk for further contamination interfering with the treatment process and affecting the end product[32]. In the present study, BOD of the effluent was 360 mg/l, which were extremely higher than the permissible limit. The greater the *BOD*, the more rapidly oxygen is depleted in the water. This means less oxygen is available to higher forms of aquatic life. When phytoremediation and enhancer s are applied, BOD decreases.

COD: Chemical Oxygen Demand is the measure of amount of oxygen required to breakdown both organic and inorganic matters. High COD levels indicate toxic state of the waste water along with the presence of biologically resistant organic substances[33]. Like BOD, higher COD is also harmful to all aquatic life[34]. According to *Department of Environment*, the maximum range of desirable COD of water is upto 200 mg/l. The

COD value of the sample was recorded as 920.0 mg/l. Again by phytoremediation and enhancers, COD value decreases.

TDS:*TDS* content in water is a measure for salinity. A large number of salts are found dissolved in natural waters, the common ones are carbonates, bicarbonates, chlorides, phosphates, and nitrates of calcium, magnesium, sodium, potassium, iron, and manganese, etc. Waters can be classified based on the concentration of *TDS*, as desirable for drinking (up to 500 mg/L), permissible for drinking (up to 1,000 mg/L), useful for irrigation (up to 2,000 mg/L), not useful for drinking and irrigation (above 3,000 mg/L). Thus increased TDS in irrigation water leads to lower cropsproduction[35].The TDS value decreases by using Phytoremediation and enhancers.

TSS: High TSS reduces light penetration and hence decreases photosynthetic rates of green aquatic macrophytes, algae and cells which are served as food sources for many invertebrates[36]. According to *Department of Environment,* the maximum range of desirable TSS of water is upto 150 mg/l.In the present study, TSS of the effluent was 420 mg/l, which were extremely higher than the permissible limit.By phytoremediation and enhancers, TSS decreases.

It is clear from the above studies that all parameters exhibited potential decrease in pollution parameters from the start of the experiment upto 45 days, and thereafter showed negligible decrease. This pattern of take up of nutrients from industrial waste could be attributed to carrying capacity of phytoremediator plants as has been reported earlier [37]. It is clear that with increasing time, the concentration of the pollutants is decreased. However beyond attainment of equilibrium, plants ceases to contribute towards pollution removal. The variation in parameters caused by phytoremediation of industrial effluents cannot exceed beyond finite limit and is maximum at the first day of experiment. Phytoremediator plant almost stopped functioning after 45 days of phytoremediation.

V. CONCLUSION

The phytoremediation potential of Eichhorniacrassipes and Lemna minorcan be used for abatement of pollution parameters from Pulp and Paper Mill Effluent at any time interval. When enhancers like EDTA and Citric Acid are incorporated in phytoremediation, parameters are decreased more effectively.It is observed that EDTA incorporated phtoremediation shows maximum reduction in all the parameters. It establishes the fact that Phytoremediation is a cost effective, eco-friendly technique which can be profitably employed for the abatement of pollution from industrial waste water.This study can be used on large scale at industrial levels.

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