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# Effect of industrial effluent on the growth parameters of *Eichhornia crassipes*, *Vallisneria spiralis* and *Lemna minor*

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## Abstract

The effect of organic and inorganic pollutants of effluent is expressed in terms of growth parameters like leaf number/plant, leaf area/plant, and chlorophyll content of the phytoremediators. It has been observed that with the increase in phytoremediation period, there is increase in leaf number and leaf area but a negative effect on chlorophyll a, chlorophyll b and total chlorophyll. The maximum change in growth parameters was observed when plants were grown in 20% concentration of the effluent followed by 40 % concentration of the effluent and pure water. Among three phytoremediators, *E. crassipes* exhibited more growth than *V. spiralis* and *L. minor*.

**Keywords:** Effluent, phytoremediators, growth parameters

## Introduction

Phytoremediation with aquatic plants is an aesthetically pleasant, ecofriendly, cost effective, solar driven, passive technique that is useful for cleaning up environmental pollutants with low to moderate levels of contaminants [1]. The aquatic plants covering the wetland areas plays an important role in sequestering large quantities of nutrients [2-4] and metals [5-8] from the environment by storing them in their roots and shoots. The plants have ability to absorb these pollutants from wastewater due to their sophisticated metabolism and detoxification mechanism. The wetland plants take up the heavy metals from the environment but tend mainly to accumulate them in the below ground tissues [9-10]. However, the capacity to accumulate heavy metals in the above ground plant

tissues represents the suitability of plants for phytoextraction [11]. It has been observed that accumulation of organic and inorganic pollutants result in increase in leaf number and leaf area per plant. The heavy metals accumulation is responsible for decrease in total chlorophyll and negatively affects the Chl a/Chl b ratio [12,13]. Extent of increase and decrease in growth parameters was in proportion to the concentration of the effluent and duration of exposure.

## Materials and Methods

### Leaf Number

The leaf number per plant was counted on each observation date.

### Leaf area/plant

Average leaf area/leaf was calculated by drawing the area of 10 leaves representing different size on graph paper. An average leaf area per plant was calculated by multiplying the number of leaves/plant with average leaf area/leaf.

### Determination of Chlorophyll

500 mg of finely cut and well-mixed sample of plant was weighed into a clean mortar and pestle. Ground the tissue to a fine pulp with the addition of 20 ml of 80% acetone centrifugated for 5 minutes and supernatant was transferred to a conical flask. This procedure was repeated until the residue was colourless. The mortar and pestle was washed thoroughly with 80 % acetone and clear washings were collected in the volumetric flask. The volume was made to 50 ml with 80 % acetone. The absorbance of the solution was read at 645 and 663 nm against the 80% acetone (solvent) [14,15].

## Results and Discussion

### Initial growth parameters of *E. crassipes*, *V. spiralis* and *L. minor*

Initial growth parameters like leaf number per plant, leaf area per plant, chlorophyll a, chlorophyll b and total

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chlorophyll of *E. crassipes*, *V. spiralis* and *L. minor* were recorded and represented in table 1. It was found that leaf number per plant was more in *Vallisneria* (12.75). *Eichhornia* has more leaf area per plant (135.27 cm<sup>2</sup>). Total chlorophyll content is more in *Vallisneria* followed by *Lemna* and *Eichhornia*. Conc. of chlorophyll a is more in *E. crassipes* and *V. spiralis* as compared to chlorophyll b but in *L. minor* the conc. of chlorophyll b is more in comparison to chlorophyll a.

**Effect of different concentrations of pulp and paper mill effluent on the growth parameters of *Eichhornia crassipes***

The growth parameters of *Eichhornia crassipes*, like leaf number, leaf area, chlorophyll a, chlorophyll b and total chlorophyll were analyzed in 0% conc., 20% conc. and

40% conc. of pulp and paper mill effluent for a period of 50 days. The data is represented in table 2. The data showed that maximum increase in leaf number /plant and leaf area /plant and and maximum decrease in chlorophyll content was observed in P20 treatment among 20% and 40% of nonphytoremediated and 20% and 40% phytoremediated treatments.

Per plant number of leaves and leaf area increased up to 76.9% and 64.3% in P20 treatment and 61.5 and 46.2% in P40 treatment under a phytoremediation period of 50 days. Chlorophyll a, chlorophyll b and total chlorophyll were decreased by 34.7%, 34.8% and 34.7% in P20 treatment and 46.7, 45.7 and 46.3% in P40 treatment respectively for pulp and paper mill effluent after 50 days of phytoremediation.

**Table 1. Initial growth parameters of *E. crassipes*, *V. spiralis* and *L. minor***

Growth parameters	<i>E. crassipes</i>	<i>V. spiralis</i>	<i>L. minor</i>
Leaf number/plant	6.50	12.75	2.5
Leaf area/plant	135.27cm <sup>2</sup>	123.15 cm <sup>2</sup>	50.4 mm <sup>2</sup>
Chlorophyll a	0.75	0.89	0.43
Chlorophyll b	0.46	0.68	0.66
Total chlorophyll	1.21	1.57	1.09

**Table 2. Effect of pulp and paper mill effluent on the growth parameters of *E. crassipes***

Days	10 Days			20 Days			30 Days			40 Days			50 Days		
	P0	P20	P40	P0	P20	P40	P0	P20	P40	P0	P20	P40	P0	P20	P40
Leaf No. /Plant	6.50	8.75	7.50	6.25	9.50	8.25	5.75	10.75	9.50	5.25	11.50	10.25	5.25	11.50	10.50
Leaf area (cm <sup>2</sup> /plant)	132.6	168.2	149.1	120.5	196.5	178.3	121.4	204.6	189.8	120.7	220.1	196.8	119.5	222.3	197.7
Chlorophyll a	0.57	0.67	0.59	0.49	0.62	0.52	0.45	0.59	0.49	0.42	0.52	0.44	0.40	0.49	0.40
Chlorophyll b	0.39	0.43	0.40	0.31	0.40	0.35	0.26	0.36	0.30	0.21	0.31	0.27	0.19	0.30	0.25
Total chlorophyll	0.96	1.10	0.99	0.80	1.02	0.87	0.71	0.95	0.79	0.63	0.83	0.71	0.59	0.79	0.65

**Table 3. Effect of pulp and paper mill effluent on the growth parameters of *V.spiralis***

Days	10 Days			20 Days			30 Days			40 Days			50 Days		
	P0	P20	P40	P0	P20	P40	P0	P20	P40	P0	P20	P40	P0	P20	P40
Leaf No./ Plant	12.75	15.50	14.25	11.25	16.75	15.25	10.25	17.50	16.25	10.0	18.0	16.50	10.25	18.25	16.75
Leaf area (cm <sup>2</sup> /plant)	111.2	135.3	128.5	100.1	152.0	135.7	96.4	161.6	139.5	87.3	166.2	142.3	72.3	169.0	144.25
Chlorophyll a	0.75	0.95	0.83	0.68	0.87	0.78	0.62	0.81	0.73	0.57	0.76	0.64	0.48	0.66	0.59
Chlorophyll b	0.50	0.64	0.60	0.47	0.59	0.52	0.40	0.56	0.49	0.35	0.49	0.44	0.33	0.43	0.35
Total chlorophyll	1.28	1.59	1.43	1.15	1.45	1.30	1.02	1.37	1.22	0.92	1.25	1.08	0.81	1.09	0.94

#### ***Effect of pulp and paper mill effluent on the growth of Vallisneria spiralis***

The effect of varied concentrations of pulp and paper mill effluent on the growth characteristics of *Vallisneria spiralis* are represented in table 3. It has been observed that there is maximum increase in all the selected growth parameters in P20 treatment as compared to P40 treatment. Increased duration of phytoremediation caused corresponding increase in growth parameters of the *Vallisneria* as compared to the grown in P0 concentration. In P20 treatment of pulp and paper mill effluent per plant number of leaves and leaf area were increased by 43.1 and 37.3% and in P40 treatment the increase was 31.4 and 17.1 % respectively after a phytoremediation period of 50 days. Chlorophyll a, chlorophyll b and total chlorophyll were decreased up to 25.8, 36.7 and 30.5 percent in P20 treatment and 33.7, 48.5 and 40.1 percent in P40 treatment respectively.

#### ***Effect of pulp and paper mill effluent on the growth parameters of L. minor***

The growth parameters of *Lemna minor* like leaf number, leaf area, total chlorophyll and total biomass were analyzed in 0% conc., 20% conc. and 40% conc. of pulp and paper mill effluent for a period of 50 days. The data is represented in table 4. The data showed that maximum increase in growth parameters was observed in 20% concentration among 0%, 20% and 40% concentrations of industrial effluent.

Increased duration of phytoremediation caused corresponding increase in the all selected growth parameters. Per plant number of leaves and leaf area increased up to 50.8 and 15.5 percent in P20 treatment and

44 and 11.1 percent in P40 treatment under a phytoremediation period of 50 days. Chlorophyll a, chlorophyll b and total chlorophyll were decreased by 24.9, 8.5 and 15.3 percent in P20 treatment and 37.2, 16.6 and 23.8 percent in P40 treatment respectively for pulp and paper mill effluent. It has been observed that there is gradual increase in plant growth parameters like leaf number per plant, leaf area per plant and decrease in chlorophyll a, chlorophyll b and total chlorophyll content with the increase in phytoremediation period. The maximum increase in growth parameters was observed in phytoremediators grown in 20 % concentration followed by 40 % concentration. The experiment was done for assessing the effect of pulp and paper mill effluent including domestic waste on the growth characteristics of *E.crassipes*, *V.spiralis* and *L.minor*. The maximum growth was recorded in case of *Eichhornia* in comparison to *Vallisneria* and *Lemna* grown in wastewater for 50 days. The toxicity of pulp and paper mill effluent on chlorophyll content was studied at different intervals by Srivastava and Pandey [16]. They observed that the total chlorophyll content decreased with the increase in dilutions for 7, 14 and 21 days of exposure to varied concentrations of the effluent in case of *Eichhornia crassipes*, *Pistia stratiotes* and *Hydrilla verticillata*. The extent of reduction is proportional to the duration of exposure and concentration of the effluent. The maximum reduction in chlorophyll content was 57.72 and 28.5 percent in 100 % concentration at 168 hours of exposure in *Eichhornia crassipes* and *Spirodela polyrrhiza* respectively. The results of the present study regarding the reduction in chlorophyll content were comparable to the results of other workers [17,18].

**Table 4. Effect of pulp and paper mill effluent on the growth parameters of *L. minor***

Days	10 Days			20 Days			30 Days			40 Days			50 Days		
Parameters	P0	P20	P40	P0	P20	P40	P0	P20	P40	P0	P20	P40	P0	P20	P40
Leaf No./ Plant	2.5	3.0	2.77	3.25	3.50	3.25	3.50	3.77	3.60	4.0	4.60	4.25	4.50	5.25	4.75
Leaf area (cm <sup>2</sup> /plant)	50	54.2	53.9	52.2	57.3	56.0	53.2	58.2	56.0	53.18	58.66	56.18	53.0	58.66	56.12
Chlorophyll a	0.39	0.47	0.41	0.32	0.42	0.36	0.27	0.39	0.31	0.23	0.35	0.28	0.20	0.31	0.27
Chlorophyll b	0.61	0.74	0.69	0.58	0.70	0.61	0.52	0.69	0.64	0.49	0.63	0.59	0.42	0.60	0.55
Total chlorophyll	1.00	1.21	1.10	0.90	1.12	0.97	0.79	1.08	0.95	0.72	0.98	0.87	0.62	0.91	0.82

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