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PHYSICO- CHEMICAL CHARACTERIZATION OF PAPER MILL LEACHATE AND ITS IMPACT ON SEEDLING GROWTH OF *CICER ARIETINUM*

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Key words : Leachate, Paper mill, Physico-chemical characteristics, seedling growth, seed germination.

ABSTRACT

The experiment was conducted for the determination of physico-chemical characteristics of paper mill leachate and its effect on seed germination and seedling growth of *Cicer arietinum*. The investigation reveals reduction in seed germination and retardation of seedling growth when exposed to leachate in comparison to control. In case of leachate treatment on third day, the seed germination was 72% where as in control it was 91%. The leachate influences the length of root and shoot of young seedlings, and also retards the growth efficiency.

INTRODUCTION

Tonnes of solid wastes from Pulp and paper mill are being disposed off in the environment annually. The chemicals present in the solid waste come in the liquid form of leachate, which contaminate the soil surface and ground water, posing a threat to the ecosystem. In recent times industrial activities are constantly adding toxic substances to ground water reservoirs at an alarming rate (Tripathy *et. al*., 2000) Ground water is a valuable natural resources as it accounts for nearly 160% of water supply for many developing countries (Mariappan, *et. al*., 2000) and this is also true for India. Solid wastes after leaching become potential source of toxicity to flora and fauna by entering into the food chain. Plants are being used as ecological monitors for assessing the toxicity of pollutants. Microtox, *Daphnia magna* and Microalgae were

used as test systems by several investigators to assess the acute and chronic toxicity from water extractable fraction of various solid wastes (Lamboleze *et.al*., 1994, Middaugh *et.al*., 1996; Munkittrick *et.al*., 1991; Firth *et.al*., 1990). Various reports have shown that waste discharged from industries is capable of inhibiting seed germination and seedling growth (Shukla & Pandey, 1991). As seed germination and growth are of vital importance for continuation of plant life and agricultural production, therefore full protection of soil is needed from the dumping of industrial solid wastes.

Leachate contains various contaminants in the form of organic and inorganic chemicals. Presence of these chemicals in large quantities in leachate imparts detrimental effect on plant development including germination and seedling growth. In this regards effect of different industrial pollutants and treated or untreated waste water on seed germination were carried out by (Woolen *et. al*. 1978; Powar & Dubey, 1980) and also by (Mishra& Behera, 1991; Shukla & Pandey, 1991 and Rao & Rao, 1992). Leachtes also contain variety of heavy metals depending on the nature of raw material and final product produced. Presence of heavy metals poses risks to human health because of their possible entry into the food chain and accumulation in soil or plants (Parkhan *et. al*., 2002). The effects and mechanisms of metal stress has been the subject of many studies conducted on plants (Mesmar & Jaber, 1991; Oncel *et.al*., 2000; Barman *et.al*., 2000; Nedelkoska and Doran, 2000). The effects of metals on germination of seeds from different plants depends on interspecies, differences in seed structure and seed coat because they have a wide range of anatomic forms Wierzbieka & Obidziniska, 1998). The present investigation was carried out to study the effect of Paper mill leachates on the germination behavior and seedling growth of *Cicer arietinum.*

MATERIALS AND METHODS

Collection of sample

Samples of solid waste were collected from out side the dumping site of Yash Paper mills. "Darshan Nagar" located 11 kms away from City Faizabad (U.P.) on Lucknow- Varanasi highway. Collected samples transported to the laboratory immediately under the cold conditions. For Kraft paper manufacturing this industry consist of two units and effluent is being discharged through common drainage.

Leachate preparation

Extraction was performed by preparing a 10% leachate concentration based on the Toxicity Characteristics Leachate Procedure (TCLP), (USEPA, 1986). Collected solid waste samples were homogenized and weighed, 100 g of sample of solid waste was added to 100 ml of distilled water w/v and mixed thoroughly in a shaker for 24 hr at 30± 1^{0}C . The mixture was then centrifuged at 300 rpm for 15 minute and the supernatant was separated for experimentation.

Physico-chemical analysis

The analysis of various physico-chemical parameters like BOD, COD, DO, pH, Cl, Ca, and SO_4 were conducted according to the methodology of APHA (1989). The concentration of elements in leachates were determined with Perkin Elmer Atomic Absorption spectrophotometer (Model: 380).

TABLE - 1
Physico-chemical characteristics of leachates of pulp and paper mill solid wastes

S.No.	Parameters	Values
1.	pH	8.6± 0.15
2.	EC (m.mho/cm)	0.89±0.037
3.	Temperature 0^{o}C	30.1± 1.53
4.	BOD (mg/L)	115±1.52
5.	COD (mg/L)	308±1.52
6.	SS (mg/L)	159±6.65
7.	Sulphate (mg/L)	21.4±3.44
8.	Chloride (mg/L)	52.3±3.13
9.	Colour	Brown
10.	DO (mg/L)	Nil
11.	Ca (mg/L)	7.2±0.3
12.	Hardness (mg/L)	5.2±0.41
13.	Cd (mg/L)	2.325±0.129
14.	Cr (mg/L)	60.75±1.88
15.	Cu (mg/L)	65±3.77
16.	Fe (mg/L)	70.5±1.15
17.	Ni (mg/L)	44.75±2.41
18.	Pb (mg/L)	67.25±1.53
19.	Zn (mg/L)	138.175±2.20

All values are expressed as mean ±SD of three replicates.

TABLE - 2
Germination percentage of seeds of *Cider arietinum* in control and leachate exposed seedling at different time intervals

	Control Time in hrs.				Leachate concentration 10% Time in hrs.			
S.No.	Seeds Sown	72 hrs G	96 hrs G	Total G	Seeds Sown	72 hrs G	96hrs G	Total G
1	20	18	0	18	20	15	1	16
2	20	19	0	19	20	14	0	14
3	20	10	6	16	20	14	0	15
4	20	14	4	18	20	10	3	13
5	20	19	1	20	20	14	0	14
Total	100	80	11	91	100	67	5	72
Total %		80%	11%	91%	67%	5%	72%	

G - Germinated

Seed Germination

For seed germination studies, petriplates for control and for leachates were

TABLE- 3

Comparison of root and shoot length of *Cicer arietinum* seedlings in control and leachate of pulp and Paper mill solid wastes

S. No.	Control: 7th day Root length	Control: 7th day Shoot length	Control: 10th day Root length	Control: 10th day Shoot length	Leachate concentration 10%: 7th day Root length	Leachate concentration 10%: 7th day Shoot length	Leachate concentration 10%: 10th day Root length	Leachate concentration 10%: 10th day Shoot length
	c.m.	c.m.	c.m.	c.m.	c.m.	c.m.	c.m.	c.m.
1.	5.83±0.5	4.0±0.5	6.23±1.7	12.6±0.76	4.46±0.76	2.5±0.69	4.22±0.69	7.8±0.24
2.	4.63±0.81	3.46±0.5	10.16±3.81	8.66±1.25	3.83±0.76	1.5±0.5	6.16±0.17	6.3±0.7
3.	5.5±1.3	4.3±0.5	8.16±2.88	10.33±2.02	3.6±1.6	2.3±0.6	5.16±0.55	9.76±0.25
4.	7.16±0.76	4.66±1.5	12.5±4.7	10.9±2.35	4.83±2.3	2.5±0.6	7.5±1.5	9.6±0.4
5.	5.4±0.65	4.93±1.5	8.33±2.25	13.0±0.5	3.0±0.5	1.5±0.5	5.10±2.5	8.0±1.8

All the values are expressed as mean ± SD of three replicates

prepared separately under the controlled laboratory conditions and all the experiments were run in triplicate. Cotton beds were maintained on the petri plates. Ten percent leachate concentration was used for the experiment and tap water as control. Twenty seeds of *C. arietinum* (Gram) were placed on each petriplate, after bursting the seed coat. The germination percentage and the survival of the seeds were counted at the interval of 72h and 96h. Shoot and root lengths were measured on different time intervals with a help of meteric scale.

RESULT AND DISCUSSION

The analysis of leachate shows pH 8.6, alkaline nature of the leachate. The leachate of the waste contains Sulphate (21.4 mg/L), Chloride (52.3 mg/L), Calcium (7.2 mg/L), Hardness (5.5 mg/L) and heavy metals such as Cadmium, Chromium, Copper, Iron, Nickel, lead and Zinc etc., in different concentrations as in (table-1). The presence of high oxygen demanding chemicals leads the concentrations of dissolved oxygen 'Nil'. For evaluation of toxicity seed germination test was conducted and the germination percentage were illustrated in (table –2). After 72h, rate of germination is higher in control 91% in comparison to leachate treated seeds 72%. The decrease in rate of germination may be due to the presence of toxic substances in leachate. These toxic elements causes delay in seed germination. Salinity is also responsible for inhibition of seed germination (Rajannan & Oblisami, 1979; Mishra & Sahoo, 1989 and Mishra & Behera, 1991). Hydration of seed is basically the important requirement to regulate the sequence of metabolism and

essential for germination and growth of seedlings. At this stage, the seed as well as the seedlings are extremely vulnerable to environmental stress. The leachate interacts with the enzyme system and disturbs the metabolisms, which leads to delay and retardation of the germination process. Evidently the Paper mill leachate is toxic in anture affecting the germination of C. *arietinum* attributed delay and decline in the *C. arietinum* seedling growth.

Table -3 shows the inhibition of root and shoot length both at 10% leachate concentration in comparison to control. Inhibition of root elongation is considered to be the first evident effect of metal toxicity in plants. Cell division at the root tip and cell elongation in the extension zone is two different mechanism in root growth, both of which are affected by the presence of metals (Adrini *et.al*., 1994). It was observed that the paper mill leachate contains high amount of chloride, sulphate and the heavy metals such as Cd, Cr, Cu, Fe, Mn, Ni, Pb and Zn. These heavy metals influence the rate of germination. The effect of metals on development and reproduction of plants can be quantified first by determining the germination characteristics of seeds. In general, the germination inhibition increases with increase in concentration of metals. Each metal at certain concentration either lowers germination or inhibits it completely. The toxic effects and symptoms vary from metal to metal e.g. Cd produces toxic effects on concentration as low as 50 mg/L, where as Pb did not show the toxicity at 500 mg/L concentration (Oncel *et.al*., 2000). Copper is toxic metal and retards the growth of root and shoot length. The germination rate was substantially reduces with increasing concentration of this metal. It is not only the leachate concentration and amount but its constituents are mainly responsible for producing toxic effect (Mc Murphy *et.al*., 1996). To control the pollution of ground water and soil it is necessary to treat the paper sludge and dispose off the solid waste in a scientific manner otherwise, the toxic elements will leached down and will affect the soil properties and ground water quality.

CONCLUSION

The results of the experiment reveals that the paper mill treatment of leachates *C. arietinum* shows, retardation of germination and seedling growth. The study suggests that the leachate may be toxic to the soil and surrounding vegetation of landfill site. It is clear that the leachate influences the normal phenomenon of germination and its growth. Germination percentage indicates the sensitivity of seeds at the early developmental stages and the toxicity of leachates. Presence of trace metals in the leachates is a serious problem for ground water pollution and food chain biomagnification that may affect the productivity of the agricultural crops.

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News

Costly disaters and a call for emission trading

Natural diasters, largely weather related and probably linked with climate change, cost the world over US$ 60 billion in 2003, compared with around US$ 60 billion in 2003, compared with around US$ 55 billion the year before, experts from the Finance Intiatvie report. UNEP Executive Director Klaus Toepfer urged government and business to back trading systems for greenhouse gas emissions as one response to the trend.

Munich Re, one of the world's biggest re-sinsurance companies, and other memebrs of the Finance Intitatvies Climate Change working Group, reported that the heat wave in many parts of Europe, which resulted in some 20,000 deaths and major crop and livestock damage, was probably the most costly single event, with agricultural losses alone estiamted at over US$ 10 billion.

Flooding on China's Huai and Yangtez rivers, which damaged some 650,000 apartments, was likely the second most closly event, estimated at nearlt US$ 8 billion.

The largest insured losses were from rornadoes in the US Midwest, which are calculated to have and non-polluting way".

Some of the panels will be sold by Syndicate Bank of India, which has programmes promoting solar-powered pumping and lighting in rural areas. The resulting revenue will help fund installation of the remaining panels in areas where customers will pay an affordable fee for the service.

Other partners in the inititative include DHL, Danzas Air and Ocean, Swiss Re, Good Energies Inc. Dasag Energy Engineering and Netpro Renewable Energy India.

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