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EFFECT OF RAW AND TREATED PAPER MILL EFFLUENT IRRIGATION ON VIGOUR INDICES OF CERTAIN CROP PLANTS

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ABSTRACT

Irrigation with the combined raw effluent from paper and pulp mill reduced the germination and vigour indices of crop plants. The combined effluents after dilution did not significantly affect the germination and growth. The combined effluent after aerobic treatment in a benchscale activated sludge system, when used for irrigation without any dilution favoured the growth of crop plants.

KEY WORDS : Effluent irrigation, Paper mill effluent, vigour indices.

Although water is a renewable resource, s requirement in various continents to neet agricultural, domestic, industrial and ther demands indicate the need for egeneration of waste waters. Among the arious uses of water, agriculture draws the naximum and presently in India nearly 93 er cent of the total water withdrawn (306 x 0^9 m^3) is used for irrigation and by the year 000 AD the requirement is estimated to be round 840 x 10^9 m^3 (Subrahmanyam *et al.*, 984). Experiments carried out by Stephenson and Bollen (1949), Bishop and Wilson (1954), Khambatta and Ketkar 1977) and Prasad *et al.* (1977) revealed hat kraft pulp and paper mill waste waters ould be used to grow cereal crops, fodder rasses and vegetables on coarse textured oils. Irrigation with undiluted effluent from ulp and paper mill resulted in increased oil pH and EC (Rajannan and Oblisami, 979). Studies with anaerobically treated aper mill waste water for irrigation was eported by Juwarkar and Subrahmanyam 1987).

MATERIALS AND METHODS

The combined effluent samples were btained from M/s. Seshasayee Paper and oards Limited, Pallipalayam and the hemical characteristics of the effluent were analysed as per the methods detailed in Standard Methods for the Examination of Water and Waste Water (Anon, 1965). The effluent was studied for its effect on seed germination and vigour index of maize (Co 1), ragi (Co 11), cowpea (Co 4) and cotton (MCU 5). The experiment was conducted in a completely randomized design in cups of 200 g capacity containing red loamy soil. The cups were irrigated with the effluent at different dilutions (T_1 = 100% rain water, T_2 - 25% effluent + 75% rain water, T_3 = 50% effluent + 50% rain water, T_4 75% effluent + 25% rain water, T_5 = 100% effluent). Observations of per cent germination, shoot length and root length were made on the 10th day of sowing. The vigour index was calculated by using the formula suggested by Abdul-Baki and Andersen (1973).

Aerobic treatment of the combined effluent: A bioflow model C 30 of 10 l capacity (New Brunswick Scientific Co., Inc., USA) was converted as an activated sludge system. The influent flow to aeration chamber was adjusted to 10 ml per minute and the aeration rate used was 750 ml per minute. It was agitated at 200 rpm for 35 hrs. The collected effluent was studied for its effect on germination and vigour index of the crop plants.

RESULTS AND DISCUSSION

The physical and chemical characteristics of the combined raw as well as treated effluent are given in Table 1. The

Table 1. Physical and chemical characteristics of the combined raw as well as treated effluent.

Parameter	Raw effluent	Treated effluent
Suspended solids (mg l^{-1})	3800	840
Dissolved solids (mg l^{-1})	2200	1500
pH	7.90	7.11
EC (mmhos cm^{-1})	0.72	0.65
Organic Carbon (%)	1.00	0.68
Total phenols (mg l^{-1})	45.00	62.00
Total nitrogen (mg l^{-1})	34.00	20.00
Available nitrogen (mg l^{-1})	3.00	1.00
Available phosphorus (mg l^{-1})	14.00	7.50
Calcium (mg l^{-1})	155.20	105.20
Magnesium (mg l^{-1})	90.20	21.50
Sodium (mg l^{-1})	510.00	220.00

treated effluent recorded a reduction in the concentration of nitrogen, phosphorus, potassium, calcium and magnesium. This might be due to the utilization of these nutrients for the growth and multiplication of microorganisms during the process of aerobic treatment in the bench scal activated sludge system.

Higher concentration of the combine raw effluent affected the growth of maiz seedlings. Significant reduction in th shoot length was observed with all th treatments when compared to control (T_1) No significant deviation was noted for th vigour index in 25 per cent effluent (T_2) a compared to control (Table 2). The treate effluent did not affect the germination c maize. The shoot length and the root lengt were minimum in water control when th treated effluent was used for irrigation.

There was no significant difference i the germination percentage among T (97%), T_2 (93%), T_3 (97%) and T_4 (100%) fc ragi. Irrigation with 75% effluent recorde the maximum vigour index. This might b due to the saline tolerance nature of ra crop. The treated effluent irrigation to ra resulted in cent per cent germination at a the concentrations (Table 3).

Irrigation with undiluted raw effluer adversely affected the growth of cowpe and cotton seedlings whereas irrigatio with 25 and 50% effluent gave better growt

Table 2. Effect of combined and treated effluent irrigation on Ragi (Var. CO I)

Treatment	Germination (%)		Shoot length (cm)		Root length (cm)		Vigour index	
	R	T	R	T	R	T	R	T
T1-Control	100 (87.13)	100 (87.13)	30.00	28.63	12.80	9.73	4280	3837
T2-25% effluent	100 (87.13)	100 (87.13)	27.50	29.13	10.67	10.70	3817	3983
T3-50% effluent	100 (87.13)	100 (87.13)	26.47	30.03	10.30	11.27	3677	4130
T4-75% effluent	100 (87.13)	100 (87.13)	23.50	30.90	9.90	12.80	3340	4370
T5-100% effluent	100 (87.13)	100 (87.13)	19.67	31.27	9.23	14.67	2890	4593
SE_D	NS	NS	1.6180	0.4876	0.4710	0.3326	220.5921	63.5118
CD	NS	NS	3.6050	1.0863	1.0500	0.7411	491.4791	141.5933

R & T denote irrigation with combined and treated effluent respectively.
Figures in parentheses are transformed values

Table 3. Effect of combined and treated effluent irrigation on Ragi (Var. CO II)

Treatment	Germination (%)		Shoot length (cm)		Root length (cm)		Vigour index	
	R	T	R	T	R	T	R	T
T1-Control	96.7 (81.94)	100.0 (87.13)	10.62	10.33	7.45	7.35	1692	1768
T2-25% effluent	93.3 (79.23)	100.0 (87.13)	10.36	10.84	8.05	8.16	1716	1900
T3-50% effluent	96.7 (81.94)	100.0 (87.13)	11.64	11.88	10.14	9.97	2179	2186
T4-75% effluent	100.0 (87.13)	100.0 (87.13)	12.54	12.59	10.66	10.90	2320	2349
T5-100% effluent	83.3 (66.14)	96.7 (81.94)	10.01	12.32	8.64	10.07	1551	2165
SE_D	7.029	NS	0.471	0.384	0.332	0.250	111.370	68.942
CD	15.660	NS	1.050	0.856	0.740	0.557	248.133	153.603

R & T denote irrigation with combined and treated effluent respectively.
Figures in parentheses are transformed values

over fresh water irrigation. The suspended solids in the effluent might settle down upon the surface of the seeds, which impede the germination of crop plants. The reduction in germination might also be due to the toxic compounds, like phenols and sodium present in the effluent. The treatment T_3 recorded the maximum germination percentage and vigour index when treated effluent was used for irrigation to cowpea seedlings (Table 4).

Irrigation with the treated effluent to cotton resulted in no significant deviation in the germination percentage. The vigour index was maximum in T_4 (2037) and it ranged from 1457 to 1775 in the other treatments for cotton. The treatments T_1, T_2

Table 4. Effect of combined and treated effluent irrigation on Cowpea (Var. CO 4)

Treatment	Germination (%)		Shoot length (cm)		Root length (cm)		Vigour index	
	R	T	R	T	R	T	R	T
T1-Control	93.32 (79.23)	96.7 (81.94)	14.10	11.74	11.83	10.80	2420	2178
T2-25% effluent	90.0 (74.04)	100.0 (87.13)	14.84	12.65	12.13	11.55	2417	2420
T3-50% effluent	96.7 (81.92)	100.0 (81.13)	14.31	13.47	11.77	12.78	2516	2624
T4-75% effluent	90.0 (74.05)	96.7 (81.94)	13.63	12.10	10.24	12.00	2161	2329
T5-100% effluent	86.7 (71.33)	90.0 (74.04)	10.80	11.81	8.69	11.24	1683	2080
SE_D	9.965	NS	0.096	0.398	0.522	0.499	201.882	63.360
CD	22.202	NS	1.594	0.888	1.163	1.112	449.792	142.060

R & T denote irrigation with combined and treated effluent respectively.
Figures in parentheses are transformed values

Table 5. Effect of combined and treated effluent irrigation on Cotton (Var. MCU - 5)

Treatment	Germination (%)		Shoot length (cm)		Root length (cm)		Vigour index	
	R	T	R	T	R	T	R	T
T1-Control	93.3 (76.76)	96.7 (81.94)	8.16	8.10	8.08	9.13	1515	1663
T2-25% effluent	83.3 (66.14)	96.7 (81.94)	9.15	8.93	9.64	9.03	1563	1736
T3-50% effluent	86.7 (68.86)	93.3 (76.76)	9.72	9.53	10.84	9.50	1787	1775
T4-75% effluent	76.7 (61.72)	96.7 (81.94)	8.06	9.93	8.87	11.13	1299	2037
T5-100% effluent	70.0 (57.00)	86.7 (68.86)	5.41	7.73	7.58	8.40	911	1457
SE_D	5.630	NS	0.512	0.198	0.404	0.471	147.669	105.046
CD	12.544	NS	1.412	0.441	0.900	1.050	329.006	234.042

R & T denote irrigation with combined and treated effluent respectively.
Figures in parentheses are transformed values

and T_3 were statistically on par among themselves but significantly different from T_4 (Table 5). The effluent irrigation after activated sludge treatment resulted in increased germination percentage and vigour index of maize, ragi, cowpea and cotton seedlings. Dolar *et al.* (1972) reported that the growth reduction in the plant system was due to toxic effects of heavy metals and salts in the effluent. Rajannan and Oblisami (1979) reported that the undiluted effluent lowered the growth of rice, blackgram and tomato. Subrahmanyam *et al.* (1984) reported that crops like maize, paddy, wheat, barley and sugarcane could be successfully grown using pulp mill waste water on coarse textured soil. They also reported that certain varieties of paddy, groundnut and blackgram did not germinate and grow well with the waste water.

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