European Journal of Biotechnology and Bioscience
Online ISSN: 2321-9122
www.biosciencejournals.com
Volume 3; Issue 11; November 2015; Page No. 43-46

Impact of coir retting effluent on seed germination and seedling growth of green gram and mustard

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Abstract
This study attempts to analyze the physico-chemical characteristics of the coir retting effluent and to understand its effect on germination, relative toxicity and growth rate of greengram and mustard seeds. Seeds were raised in petriplates irrigated with various concentrations of sugar industry effluent (control, 10, 25, 50, 75 and 100%). At lower dilutions (75%) the seeds showed favourable effect on seed germination and seedling growth. The effluent can be used safely only after proper treatment and dilution for irrigation purpose.

Keywords: effluent, physico-chemical characteristics, germination, inhibitory, phytotoxicity and green gram.

1. Introduction

Pollution caused by different industries is a serious concern worldwide. Water resources are often affected by industrial pollution as they release their effluent with or without treatment into nearby water bodies [1]. The retting of coconut husk is the worst form of organic pollution. The husk (mesocarp) of coconut is associated with pectin, hemi-cellulose, tannin which bind the fibres together. The oozing fluid during the process of retting along with the coir fibre leads to major environmental hazard in estuarine environment in the coastal belt. Most of the areas in Kerala and Kanyakumari district are polluted due to the discharge of effluents from coir retting industries [2].

The husks being lignocellulosic in nature release polyphenols into the backwaters, creating a disturbance in the ecosystem [3]. A complete depletion of oxygen, leading to anoxia and the persistence of sulphide system are the characteristics of the retting ground [4, 5]. All these processes contribute to pollution of water and air, highly turbid greyish water and mercaptan-like smell pervade the yards and nearby areas. This is reported to have a devastating effect on flora and fauna [6]. There is a number of studies on the impact of industrial or domestic effluents on soil properties and crop response [7, 8]. Industrial effluents rich in organic matter and plant nutrients are finding agricultural application as cheaper way of disposal [9, 10]. Nevertheless the sensitivity of the plants varies from species to species to the effluent salinity [11]. However, there is almost negligible study on the effect of coir retting effluent on plant response. Hence the present study was carried out to analyse the physico-chemical characteristics of the retting effluent and to evaluate the effect of coir retting effluent on seed germination, relative toxicity and root length of green gram and mustard seeds.

2. Material and methods

Retting effluent was collected in plastic water cans (2l capacity) from the coir retting ponds situated in Rajakkamangalam, Nagercoil, Kanyakumari district during the month of October, 2009.

2.1. Physico-chemical analysis Effluent samples were collected and refrigerated at 40 °C prior to analysis. Physico-chemical analysis (pH, turbidity, total dissolved solids, electrical conductivity, magnesium, free ammonia, nitrate, calcium, chloride, sulphate, phosphate, dissolved oxygen and biological oxygen demand, chemical oxygen demand) was carried out according to standard methods [12]. To bioassay the concentration of the effluent control, 25%, 50%, 75% and 100% was made by diluting the effluent with distilled water in the ratio of 0:1, 1:3, 1:1, 3:1 and 1:0 respectively.

2.2. Germination percentage The seeds of greengram and mustard were obtained from Tamilnadu Agricultural University, Coimbatore and were treated with different concentration (0%, 25%, 50%, 75% and 100%) of the effluent. Then the seeds were spread on the sterilized petridishes lined with filter paper. For each treatment four replicates were maintained. Germination was observed after every 24 hours.

$$\text{Germination percentage} = \frac{\text{No.of seeds germinated}}{\text{TotalNo.of seeds sown}} \times 100$$

2.3. Relative Toxicity (% RT) Relative toxicity on seed germination and seedling growth of each determine the degree of inhibition over control, by using the following formula:

$$\text{RT (\%)} = \frac{(\text{X} - \text{Y})}{\text{X}} \times 100$$

X= Germination percentage in control at particular hour of incubation
Y= Germination percentage in the presence of effluent at the same hour of incubation.
Relative root length (cm per seed) were also determined.

3. Results and discussion

The physico-chemical characteristics of coir retting effluent are presented in Table 1. The effluent was dark brown in colour due to high suspended and dissolved solids. It suggests that the effluent could be a serious aquatic pollutant. The average pH value of the effluent was 6.40±0.49 which indicate that it is acidic in nature. Similarly olive mill wastewater also had a pH 5±0.2 [13]. Previous studies reported that pH plays a significant role in toxicity [14, 15]. It contains considerable amount of nitrogen, chloride, sulphate, and magnesium. The Electrical conductivity (EC) of the retting effluent was 2147.8± 191.7µs/cm. It appears that low pH and dissolved oxygen, high concentration of TDS and chloride also contributes to the toxicity of the effluent [8]. Dissolved oxygen, which is a critical parameter to the survival of biota showed reduced values (0.4 ml/l).

The percentage of seed germination of green gram and mustard at different exposure duration (24, 48, 72, 96 and 120 hrs) and at different concentration (25, 50, 75 and 100%) is shown in table 2 and 3. In case of green gram, 100% germination percentage was observed in control only after 120 hours of exposure whereas 100% germination percentage was noticed even after 96 hours of exposure in raw effluent and also at 25% concentration. The germination percentage increased in 100% effluent concentration. In contrast, textile effluent totally inhibited the germination rate of green gram and red gram in 100% effluent concentration [16]. In mustard, 76% germination percentage was observed in control after 120 hours of exposure. Germination percentage of 88 and 94% was observed at 50% and 75% effluent concentration after 120hours of exposure. Higher seed germination of green gram was observed at 100% concentration of effluent whereas in mustard seeds, higher seed germination was recorded at 75% concentration of effluent. The germination percentage of the selected seeds differed in their rate of germination. Lower dilutions of dairy effluent showed favourable effect on seed germination in paddy [17]. The maximum seed germination was recorded at 25% and minimum at 100% of effluent concentrations [18]. Similar results were observed in the germination rate of mustard seeds in the present study. The percentage of germination and speed of germination in Mung bean (*Vigna radiata*, L.R. Wilczek) are concentration-dependent, and declined in untreated effluent irrigation [19].

In the present study, relative toxicity in greengram was observed to be 4.26% for 24,36,48 hours of exposure in 100% concentration of the effluent and it remained 4.17% upto 120 hours of exposure. In mustard, high toxicity of 27.77% was observed at 75% concentration after 72 hours of exposure and it decreased at 100% concentration of effluent (Table 4 and 5). The relative toxicity of tannery effluent for onion, carrot and tomato is recorded as 20.67%, 32.67% and 24.66% under 100% effluent concentrations respectively [20]. The maximum relative toxicity of the distillery effluent at 100% concentration against the seed germination of *V. radiata* was 10.41% and 17.25 respectively [21].

The root length of green gram and mustard seeds at 75% concentration of the effluent was 10.37±3.87cm and 21.48±3.02cm respectively. Later they showed decreased growth at 100% concentration of raw effluent (Table 6 and 7). The promotion of seedling growth may be due to the presence of plant nutrient in the effluent [17]. Toxicity of effluent may be due to the presence of several compounds and identification of the exact compounds which contribute to the phytotoxicity is a challenging task [22].

The raw effluent directly affects the germination rate and root length of the seeds. It is recommended that only after dilution the effluent can be reused for irrigation purpose. This prevents the wastewater from being an environmental hazard.

4. Tables

Table 1: Physico-chemical characteristics of the coir retting effluent

Parameters	Mean	Permissible Limit [23]
Turbidity (NTU)	63.6±4.16	5
TDS (mg/l)	1439±136.36	500
E.C (µS/cm)	2147.8±191.7	250
p^H	6.40±0.49	6.5-9.2
Magnesium (mg/l)	110±8.17	-
Free Ammonia (mg/l)	15±0.9	50
Nitrate (mg/l)	1.8±0.09	20
Chloride (mg/l)	620.6±56.12	-
Sulphate (mg/l)	80.4±5.12	200
Phosphate (mg/l)	11.49±0.9	5
D.O (ml/l)	0.4±0.04	-
BOD (mg/l)	75±6.1	50
COD (mg/l)	210±19.63	1000

Table 2: Effect of different concentration of coir retting effluent on germination percentage of green gram seeds

Treatments (%)	Time (h)				
	24	48	72	96	120
Control	94	94	94	96	100
25	96	96	96	100	100
50	96	98	96	98	98
75	92	96	96	98	100
100	98	98	98	100	100

Table 3: Effect of different concentration of coir retting effluent on germination percentage of mustard seeds

Treatments (%)	Time (h)				
	24	48	72	96	120
Control	72	72	72	76	76
25	74	82	86	86	86
50	78	88	88	88	88
75	84	88	92	92	94
100	74	74	76	76	78

Table 4: Effect of different concentration of coir retting effluent on relative toxicity (%) of greengram seed germination

Treatments (%)	Time (h)				
	24	48	72	96	120
25	2.13	2.13	4.26	4.17	4.17
50	2.13	4.26	2.13	2.08	2.08
75	2.13	2.13	2.13	2.08	4.17
100	4.26	4.26	4.26	4.17	4.17

Table 5: Effect of different concentration of coir retting effluent on relative toxicity (%) of mustard seed germination

Treatments (%)	Time (h)				
	24	48	72	96	120
25	2.78	13.8	19.4	13.15	13.15
50	8.33	22.2	22.2	15.79	15.79
75	16.66	22.2	27.77	21.05	23.68
100	2.78	2.78	5.56	5.56	2.63

Table 6: Effect of different concentration of coir retting effluent on seedling growth of green gram seeds (root length in cm)

Treatments (%)	Length of root (cm) for different hours (h)				
	24	48	72	96	120
control	1.63 ±0.31	4.61±1.95	4.770.99	6.05±1.85	8.66±3.15
25	1.51±0.36	3.98±0.85	5.23±0.97	6.68±2.25	9.88±3.17
50	1.75±0.19	3.66±0.67	4.62±0.86	5.08±1.42	7.35±3.19
75	1.68±0.39	4.54±1.14	6.65±1.78	8.12±2.86	10.37±3.87
100	1.55±0.25	2.12±0.53	2.69±0.38	5.44±7.46	5.20±1.07

Table 7: Effect of different concentration of coir retting effluent on seedling growth of mustard seeds (root length in cm)

Treatments (%)	Length of root (cm) for different hours (h)				
	24	48	72	96	120
control	1.06±0.38	4.02±1.36	8.72±4.34	11.83±3.39	10.8±4.48
25	1.5±0.29	5.13±2.43	14.14±4.55	18.03±3.07	20.49±5.19
50	1.54±0.45	5.47±2.49	14.88±2.83	16.82±9.68	18.98±5.88
75	1.37±0.42	5.85±2.18	14.75±4.29	18.74±4.63	21.48±3.02
100	1.06±0.47	5.65±1.96	15.18±2.76	15.53±3.61	19.38±5.74

5. List of Abbreviations

1) l — litre
2) NTU — Nephelometric Turbidity Units
3) µS/cm — micro Siemens per cm
4) mg/l — milligram/litre
5) cm — centimetre

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