International Journal of Research in Chemistry and Environment
Vol. 2 Issue 1 January 2012(62-69)
ISSN 2248-9649

Research Paper

Effect of Dairy Effluent (treated and untreated) on Seed Germination, Seedling Growth and Biochemical Parameters of Maize (*Zea mays* L.)

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Available online at: www.ijrce.org

(Received 5th September 2011, Accepted 4th November 2011)

Abstract *- A laboratory experiment was carried out to study the effect of dairy effluent (DEF) at different concentrations and treated effluent on seed germination, seedling growth, dry matter production and biochemical parameters in Maize variety Nithyashri. The dairy effluent was used in different concentrations and also the treated effluent samples were used by treating the effluent by using different ameliorative techniques like physical filters (sand, clay and sand cum clay filters), chemical coagulation and combination of different treatments. Maize seeds were raised in germination towels irrigated with various concentrations of dairy effluent (0 (control), 5, 10, 25, 50, 75 and 100%) and treated effluent. At lower dilutions and in treated effluent samples, Maize showed favorable effects on seed germination, seedling growth, dry matter production and biochemical parameters. Among them 75 and 100% concentrations and raw effluent caused inhibitory effects. The study suggests that the effluent can be used safely for irrigation of Maize, only after proper treatment and dilutions.*

Keywords: Dairy Effluent (DEF), Seed germination, Physico-chemical properties, Chlorophyll content, Carotenoids, Pollution.

Introduction

Effluents are wastes produced from industries and they vary depending on the human activities that produce them. Production of these wastes is an integral part of industrial activities but unfortunately our inability to anticipate or predict the types and magnitude of undesired consequences of unbridled release of effluents in our environment, coupled with the growth of industrialization have resulted in massive and destructive operations in our ecosystems.

Dairy industry is one of the most important agro-based industry in India and produces huge amounts of effluents through its processing units. The clean water is used in various stages of dairy operations, such as, milk processing, cleaning, packaging and cleaning of the milk tankers and releases the waste water which is known as dairy effluent. Water is used for processing in the ratio of 1:10 (water: milk) per liter of milk.

Water resources are most often affected by industrial pollution. Pollution caused by industrial and dairy effluents is a serious concern throughout the world. Dairy effluent has high organic loads as milk is its basic constituent with high levels of chemical oxygen demand, biological oxygen demand, oil & grease and nitrogen and phosphorous content. To recycle nutrients through land application of dairy waste effluent requires the use of crops capable of utilization these nutrients) [8,15]. Industrial effluents rich in organic matter and plant nutrients are finding agricultural use as cheaper way of disposal. The present investigation demonstrated the effect of dairy effluent on morphological and biochemical aspect of Maize variety Nithyashri.

Material and Methods

Collection of Dairy Effluent: The dairy effluent samples were collected in dry plastic bottles which are rinsed with distilled water and then in effluent, from Mother Dairy, Yelahanka, Bengaluru, in the month of November and

December 2010. The combined samples of effluent were collected at the main drain pipe which is connected from washing tank to outside discharge unit.

Characterization of Dairy Effluent: The physico-chemical properties of dairy effluent samples were analyzed according to standard procedures. [13] The results were given in Table 1.

Amelioration of Dairy Effluent: The dairy effluent samples were treated by using different ameliorative techniques such as passing through sand, clay and sand cum clay filters [1], chemical coagulation [10] and combination of different treatments. The treated samples were used independently to know their effects on seed germination and other growth parameters of Maize.

Germination studies: Different concentrations of effluent (0, 10, 25, 50, 75 & 100%) and the treated effluent samples were prepared and used for germination experiments. Maize seeds were surface sterilized with 0.1 per cent mercuric chloride ($HgCl_2$) and washed with distilled water. Fifty seeds of Maize were placed equi-spacially in germination towels, which are soaked in different concentrations of effluents, treated effluents and distilled water. The germination towels were irrigated with different concentrations of effluent and treated effluents uniformly. Number of seed germination was counted on 10^{th} day and total germination percentage was calculated. Data were taken from three replicates of 10^{th} day old seedlings. Tenth day old seedlings were separated into root and shoot and were used for estimation of root length, shoot length and dry matter production, Chlorophyll [2], Carotenoid [3] content.

Statistical analysis: Fisher's method of analysis of variance was employed for the analysis and interpretation of the data. [14] The level of significance used in 'F' test was P=0.05 and the CD values were calculated.

Results and Discussion

The physico-chemical properties of dairy effluent were given in Table 1. The effluent was milky white in colour, turbid, with oil and having stringent and irritating in smell. Effluent is highly alkaline, consist of high amounts of oxygen demanding waste, high amounts of total dissolved and suspended solids. Effluent also consists of high amounts of plant nutrients. [6]

The different ameliorative techniques improved the quality of effluent by reducing the amount of pollutants present in it. The ameliorative techniques effectively reduced colour, odour, pH, EC, oil, suspended solids and oxygen demanding waste present in the effluent [16,8].

Lower concentrations of dairy effluent showed promoting effect on seed germination, seedling growth, and dry matter production in Maize. Results were shown in table 2. The seed germination, seedling growth and dry matter production are significantly differed in different concentrations of dairy effluent. The maximum promoting effect was recorded at control and 25% concentration (Table 2) in Maize. In general the germination (%) and seedling growth decreased with increase in concentration of the dairy effluent[5].

Germination percentage, seedling growth and other growth parameters were inhibited at 75 and 100% concentration (Figure 1). It might be due to osmotic pressure caused due to high dose. Osmotic pressure of the effluent at higher concentrations of total salts making imbibition was more difficult and retarded the germination. Presence of high amounts of sodium makes the effluent highly alkaline, which also inhibits the germination and seedling growth of Maize. [11&12] where, authors investigated the effect of fertilizer factory effluents on seed germination, seedling growth and chlorophyll content of gram seeds and reported that lower concentrations of effluents promote the seed germination and seedling growth whereas, it was inhibited at higher doses of effluents.

The treated dairy effluent samples showed favorable effects on seed germination and other growth parameters of Maize. The results were showed in Table 4 and Table 5. The seed germination, seedling growth and dry matter production are significantly differed in different treatments. The maximum promoting effect was recorded in the treatment F_3 where as treatment T1 showed inhibitory effect (Figure 2). Maximum favorable effect was observed in treatment (F_3) might be due to presence of less toxic chemicals in the treated effluent and inhibitory effects in raw effluent might be due to presence of high level of toxic substances[4,9].

The biochemical parameters like chlorophyll content and carotenoides increased at lower concentrations and in treated effluent samples. Maximum increase at 25% concentration (Table 3) and in treatment F_3 (Table 5). Enhancement of chlorophyll could be due to high nutrient uptake, synthesis and translocation probably facilitated by optimum availability of some of the beneficiary plant nutrients and also due to reduction in phenol compounds due to the dilution effect. While, decrease at raw effluent (100%) [6 ,7], where authors reported that highest chlorophyll content was recorded at 25% concentration of dairy effluent and this was inhibited at 100% concentration of effluent.

Conclusion

Dairy is one of the most important agro-based industry in India, which uses enormous amounts of fresh water for processing of milk and other purposes and releases huge amount of effluent every day. The physico-chemical analysis of effluent revealed that it is highly polluted and the quality can be improved by following, suitable ameliorative techniques. The dairy effluent at lower doses and treated effluent samples showed better results in terms of seed germination, seedling growth, dry matter production and biochemical parameters of Maize. Where as raw effluent (untreated) and the effluent at higher doses have inhibitory effects on growth and other parameters of Maize. By the study

it was revealed that Dairy effluent can be successfully used for irrigation after suitable treatments and proper dilutions.

References

1. Achak M., Mandi and Ouazzani., Removal of organic pollutants and nutrients from oil mill waste water by a sand filter. *J. Environ. Management*, **90**: 2771-2779 **(2009)**.
2. Arnon D. I., Copper enzyme is isolated chloroplasts. Polyphenol oxidase in *Beta vulgaris*. *Plant Physiol*., **24**: 1-15 **(1949)**.
3. Kirk J. T. O. and Allen R.L., Dependence of chloroplast pigments synthesis an protein synthetic effects of acitilione. *Biochemistry and Biophysical research Communication*, **27**: 523-530 **(1965)**.
4. Chidankumar C. S. and Chandraju S., Impact of irrigation of distillery spent wash on the nutrients of pulses in untreated and treated soil. *Sugar tech.,* **10**(4): 314-318 **(2009)**.
5. Day A. D., Rahaman A., Katterman F. R. M. and Jensen, V., Effect of treated municipal waste water and commercial fertilizer on growth, fiber, acid soluble nucleotides, protein and amino acid content in wheat hay. *J. Environ. Qual.,* **3:** 17-19 **(1974).**
6. Dhanam S., Effect of dairy effluent on seed germination, seedling growth and biochemical parameter in Paddy. *Botanical Res. International*, **2(2)**:61-63 **(2009)**.
7. Gautam D. D., Kumar K. and Bishnoi S., Effect of dairy effluent on seed germination of some rabi and kharif crop plants. *J. Environ. Biol*., **13**: 7-12 **(1992)**.
8. Mohana V. S., Murthy Srinivasa, Prasanna K. T and Gowda Balakrishna, Characterization of biodiesel spentwash and amelioration through chemical coagulation for irrigation., *Environ. Ecol.,* **29(3A)**: 1274-1278 **(2011a)**.
9. Mohana V. S., Gowda Balakrishna, Nandini N. and Prasanna K. T., 2011b., Effect of biodiesel spentwash on seed germination, seedling growth, dry matter production and chlorophyll content of Paddy (*Oryza sativa* L.) and French bean (*Phaseolus vulgaris* L.) crops., *Int. J. Res. Chem. Environ*., **1(1)**: 19-23 **(2011b)**.
10. Pandit B. R., Prasannakumar P. G. and Mahesh kumar R., 1996., Effect of dairy effluent on seed germination, seedling growth and pigment of *Pennesetum typhoides* Barm and *Sorghum bicolor* L. *Poll. Res.,* **15 (2)**:121-123 **(1996)**.
11. Prabhakar P. S., Manisha Mall and Jaswanth Singh, Impact of fertilizer fertilizer factory effluent on Seed Germination, Seedling growth and Chlorophyll content of Gram (*Cicer aeritenum*). *J. Environ. Biol.,* **27 (1)**:153-156 **(2004)**.
12. Rodgers M., Healy M. G. and Mulqueen J., Organic carbon removal and nitrification of high strength wastewaters using stratified sand filters. *Water res.,* **39**(14): 3279-3286 **(2005)**.
13. American Public Health Association (APHA), Standard Methods for Examination of Water and Wastewater. 20th ed. Washington, DC **(1998)**.
14. Gomez K. A. and Gomez A. A., Statistical procedure for agricultural research II. Edn., John Willey and sons, New York, P. 680 **(1976)**.
15. MoEF (Ministry of Environment and Forest), Water (Prevention and Control of Pollution) Cess (Amendment) Act, 2003. Ministry of Environment and Forests, Government of India, New Delhi **(2003)**.

Table 1: Physico-chemical properties of untreated Dairy Effluent (DEF)

Parameters		Values	ISI standards
S. No.	**General Parameters**		
1	Colour	Milky white, turbid	Clear
2	Odour	Unpleasant	Odourless
3	Temperature	28	40
4	pH	8.64	5.5-9.00
5	Electrical Conductivity (dSm^{-1})	1.35	<1.00
6	Oil content (mg/l)	138.33	10
7	Total solids (mg/l)	1182.69	-
8	Total Suspended Solids (mg/l)	448.29	100.00
9	Total Dissolved Solids (mg/l)	734.40	-
10	Biological Oxygen Demand (mg/l)	634.06	-

11	Chemical Oxygen Demand (mg/l)	1171.82	250.00

Chemical Parameters

12	Nitrogen (mg/l)	1.07	100.00
13	Phosphorus (mg/l)	1.01	-
14	Potassium (mg/l)	0.67	
15	Sulphate (mg/l)	0.33	
16	Calcium (mg/l)	1.23	
17	Chloride (mg/l)	19.83	600

All parameters were expressed in mg/l except temperature, pH, EC, colour and odour.
ISI-Indian Standard Institute

Table 2: Effect of dairy effluent on seed germination, seedling growth and dry matter production of Maize (*Zea mays* L.)

Effluent concentration (%)	Germination (%)	Seedling growth (cm)			Fresh weight (gm/plant)	Dry weight (gm/plant)
		Shoot length	Root length	Total		
0	96.67	21.70	17.30	39.00	1.357	0.543
10	92.67	20.93	15.11	36.04	1.303	0.493
25	96.00	18.61	15.19	33.80	1.337	0.579
50	94.67	17.29	10.04	27.33	1.103	0.432
75	93.33	12.63	9.55	22.18	0.977	0.338
100	82.00	11.93	4.01	15.94	0.903	0.321
DT (Treated@ Dairy)	91.33	15.82	12.63	28.45	1.293	0.566
F	*	*	*	*	*	*
CV (%)	7.12	2.89	11.68	5.19	3.42	6.21
S.Em ±	3.10	0.28	0.81	0.87	0.02	0.016
CD @ 5%	9.39	0.86	2.45	2.63	0.07	0.05

*: Significant at 5%

Table 3: Effect of dairy effluent on chlorophyll and carotenoide content of Maize

Effluent concentration (%)	Chlorophyll‘a’ (mg/fw)	Chlorophyll ‘b’ (mg/fw)	Total chlorophyll (mg/fw)	Carotenoids
0	0.635	0.876	1.060	0.857
10	0.634	0.954	1.122	0.903

25	0.624	0.962	1.138	0.914
50	0.645	0.968	1.129	0.812
75	0.640	0.824	0.973	0.782
100	0.655	0.774	0.917	0.748
DT (Treated@ Dairy)	0.662	0.730	0.852	0.908
F	NS	*	*	*
CV	2.367	2.432	3.491	0.990
S.Em ±	0.009	0.012	0.021	0.003
CD @ 5%	0.027	0.037	0.063	0.010

Note: *Significant at 5%
NS: Not Significant

Table 4: Effect of treated and untreated dairy effluent on seed germination, seedling growth and dry matter production of Maize (*Zea mays L.*).

Treatments	Germination (%)	Seedling growth (cm)			Fresh weight (gm/plant)	Dry weight (gm/plant)
		Shoot length	Root length	Total		
Control	97.33	18.2	12.71	30.91	2.143	0.757
T_1 (Raw effluent)	85.33	9.44	2.79	12.23	0.907	0.217
T_2 (Effluent treated @ dairy)	91.33	15.82	12.82	28.64	1.777	0.926
T_3 (Sand filtrate + Potassium alum)	92.67	8.68	2.72	11.40	0.930	0.356
T_4 (Clay filtrate + Potassium alum)	92.67	17.66	11.46	29.13	1.832	0.965
T_5 (Sand + Clay filtrate + Potassium alum)	92.67	11.65	6.79	18.44	1.390	0.407
T_6 (Sand filtrate + Ferric chloride)	96.67	11.6	3.78	15.38	1.743	0.912
T_7 (Clay filtrate + Ferric chloride)	95.33	8.29	2.58	10.87	0.877	0.386
T_8 (Sand + Clay filtrate + Ferric chloride)	90.33	16.27	14.15	30.42	2.293	1.028
F_1 (Sand filtrate)	90.67	18.25	14.66	32.92	2.358	1.011
F_2 (Clay filtrate)	96.67	17.18	16.36	33.54	2.523	1.049
F_3 (Sand + Clay filtrate)	97.33	21.87	16.28	38.15	2.617	1.197
C_1 (Raw effluent + Potassium alum)	94.67	7.8	2.45	10.25	0.841	0.312
C_2 (Raw effluent + Ferric chloride)	92.67	13.52	6.87	20.39	1.613	0.583
F	*	*	*	*	*	*
CV	6.04	2.91	19.21	8.35	6.100	12.333
S. Em ±	2.64	0.24	1.00	1.11	0.056	0.043
CD @ 5%	7.65	0.68	2.92	3.22	0.163	0.126

*Significant at 5%

Table 5: Effect of treated and untreated dairy effluent on chlorophyll and carotenoide ccontent of Maize

Treatments	Chlorophyll 'a' (mg/fw)	Chlorophyll 'b' (mg/fw)	Total chlorophyll (mg/fw)	Carotenoides
Control	0.635	0.984	1.170	0.857
T_1 (Raw effluent)	0.662	0.630	0.752	0.748
T_2 (Effluent treated @ dairy)	0.662	0.730	0.852	0.908
T_3 (Sand filtrate + Potassium alum)	0.678	0.838	1.017	0.900
T_4 (Clay filtrate + Potassium alum)	0.648	0.881	0.994	0.912
T_5 (Sand + Clay filtrate + Potassium alum)	0.642	0.963	1.131	0.928
T_6 (Sand filtrate + Ferric chloride)	0.653	0.718	0.852	0.880
T_7 (Clay filtrate + Ferric chloride)	0.629	0.952	0.924	0.897
T_8 (Sand + Clay filtrate + Ferric chloride)	0.655	0.774	1.111	0.891
F_1 (Sand filtrate)	0.621	0.932	1.095	0.934
F_2 (Clay filtrate)	0.638	0.937	1.101	0.938
F_3 (Sand + Clay filtrate)	0.648	0.945	1.118	0.941
C_1 (Raw effluent + Potassium alum)	0.644	0.815	0.963	0.889
C_2 (Raw effluent + Ferric chloride)	0.613	0.992	1.030	0.886
F	NS	*	*	*
CV	3.445	1.040	2.101	10.860
S.Em ±	0.012	0.005	0.012	0.090
CD @ 5%	0.037	0.015	0.035	0.310

Note: *Significant at 5%
NS: Not Significant

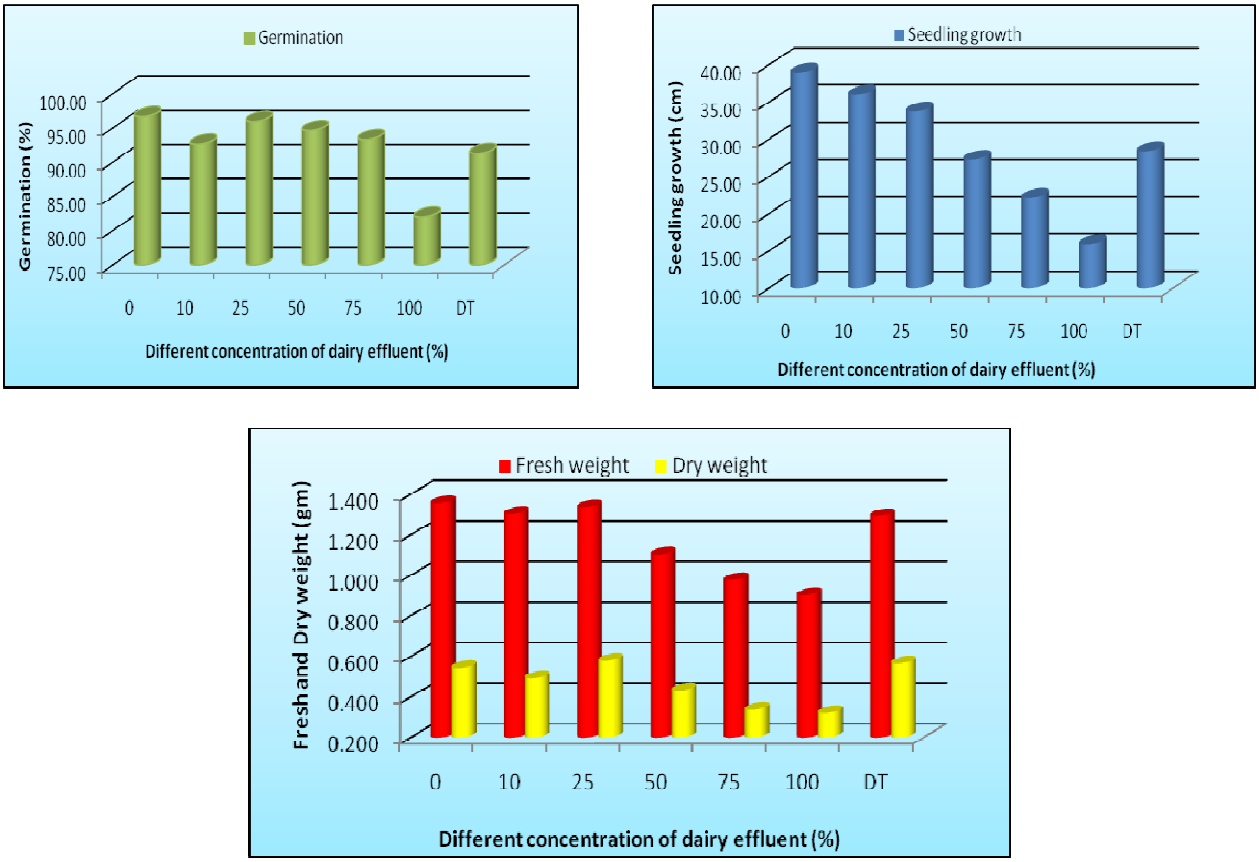


Figure 1: Effect of dairy effluent on seed germination,seedling growth and biomass accumulation of Maize *(Zea mays* L.)

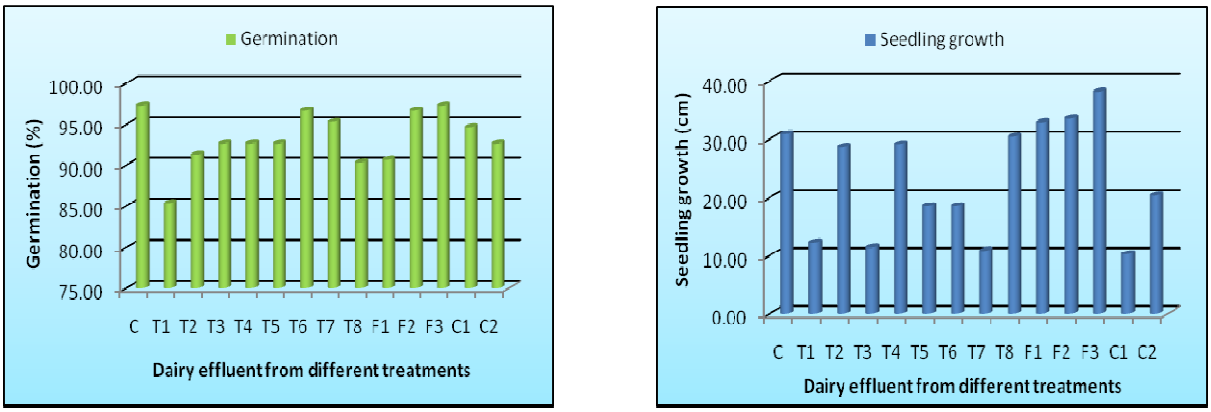
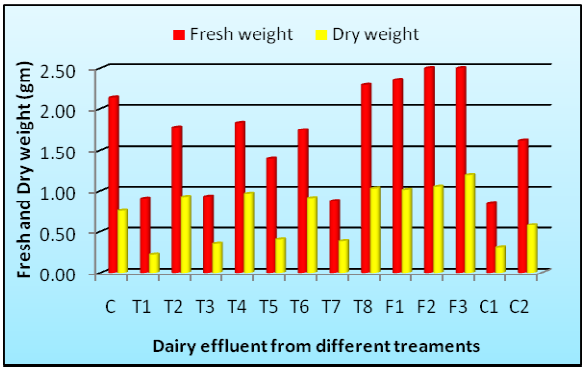


Figure 2: Effect of treated dairy effluent on seed Germination and seedling growth of Maiz (Zea mays L.)



Legend:

C: Control

T_1: Raw effluent

$T_{2:}$ Effluent treated @ dairy

T_3: Sand filtrate +Potassium alum

T_4: Clay filtrate + Potassium alum

Figure 3: Effect of treated dairy effluent on dry matter poduction of Maize (*Zea mays* L)