IMPACT OF DOMESTIC WASTE WATER ON SEED GERMINATION AND PHYSIOLOGICAL PARAMETERS OF RICE AND WHEAT

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ABSTRACT

In the present study, impact of domestic waste water (sewage) on seed germination and some physiological parameters of rice and wheat were studied. Use of sewage for irrigation purposes has emerged an important way to utilize its nutrients and removal of its pollution load by growing tolerant plant species. A two way analysis of variance showed that, the difference in rate of seed germination was statistical significant among different concentration of treatment (F_1 = 250.71 & 80.27) as well as between different time period of incubation (F_2 = 8.96 & 4.5) for both rice and wheat respectively. The effect of sewage on seedling growth was significant at various concentrations of sewage (F_1= 81.65 & 78.17) as well as between different period of incubation (F_2 = 30.04 & 26.36) for both rice and wheat respectively. Further, the difference in seedling vigour index also showed a similar trend of statistically significant with treatment at different concentrations (F_1 = 55.63 & 48.94) as well as with different time period of incubation (F_2 = 27.99. and 27.09) for both rice and wheat respectively. One way analysis of variance for total chlorophyll content between various concentrations of sewage showed a statistically significant result in both rice (F=270.11) and wheat (F = 1391. 84). Germination efficiency, seedling length, seedling vigour index and total chlorophyll content was found to be increased with increase in concentration of sewage upto 50% dilution after which it decreases. Thus, the sewage, after proper dilutions can be used as a potential source of water for seed germination and plant growth in agricultural practices.

Keywords: *Sewage, Seed germination, Seedling growth, Chlorophyll*

1. INTRODUCTION

Urban centres are discharging waste water into the water bodies and for irrigation in the agriculture fields. The major sources of organic pollution in fresh water bodies are sewage. Sewage includes domestic, hospital and small scale industrial wastes operating under municipal area. In India, all the cities and towns did not have sewage treatment facilities. Disposal of waste water is one of the major problems of Bhubaneswar, Odisha, India. The disposal of the city sewage is mainly governed by the undulating land that divides the main city into four drainage valleys. It is estimated that, 182 MLD of water is daily supplied to the city, out of which 145.6 MLD sewage is generated which is 80% of the total water supplied. There is no integrated sewage treatment facility in the city. In the absence of sewerage system, people are using septic tanks and soak pits. In most of the places sewage is discharged in to open drains without any treatment, which joints to form Gangua nallah. Gangua nallah which finally meets river Daya, serves as the ultimate for the waste water discharge of Bhubaneswar city. Gangua nallah is a natural stream which receives maximum discharge from the city.

Domestic waste water rich in organic materials and plant nutrients are finding agricultural use as a cheap way of disposal. Use of domestic waste water in agriculture may contribute considerable to alleviate the pressure in using fresh water resources. Waste water from different sources contains considerable amount of organic matter and plant nutrients (N, P, K, Ca, S, Cu, Mn & Zn) and has been reported to increase the crop yield (Pathak et al. 1998; Pathak et al. 1999; Ramana et al. 200; Lubello et al. 2004; Nagajyothi et al. 2009; Nath et al. 2009). Sewage sludge consists of multi-element organic wastes that are also used commonly as manure (Otobbang et al. 1997). Dash and Mishra (1999) has studied that, sewage enriched paper mill waste water has a positive effect on growth and pigment content of *Westiellopsis prolifica*. Efforts have been made by different workers to determine the effect of different industrial waste water on seed germination of various crops such as maze (Choudhury et at. 1987); rice (Behera & Mishra, 1982; Singh et al. 1985); wheat (Agarwal et al. 1995; Nagda et al. 2006); pine (Czabator, 1962); green gram (Subramani, 1999); mung bean (Nagda et al. 2006); pea, lentil & gram (Khan et al. 2011); lettuce (Bazai & Achakzai, 2006); *Vigna angularis*, *Vigna cylindrical* and *Sorghum cernum* (Doke et.al., 2011). However, a little work has been done on the aegropotentiality of domestic waste water.

Seed germination is a critical stage that ensures reproduction and controls the dynamics of plant populations, thus it is a critical test of probable crop productivity. In view of such perspectives, the present investigation was conducted to evaluate the impact of different concentrations of domestic waste water on seed germination, physiological characteristics and pigment content of rice and wheat.

2. MATERIALS AND METHODS

2.1. Domestic Waste Water Sample

For the present study, domestic waste water was collected from the Gangua nallah, Bhubaneswar city, Odisha, India. The sewage was collected in pre-cleaned, acid washed, 5L carboys and stored in refrigerator below 5^0C until used. Standard procedure (APHA, 1998) was followed during the collection and analysis of waste water samples. Table 1 shows the physic- chemical analysis results of domestic waste water. For the present bioassays, waste water was diluted to Control, 10%, 25%, 50%, 75% & 100% (pure waste water without dilution).

Table- 1 Physico-chemical characteristics of domestic wastewater

Sl. No.	Parameters	Values
1	Colour	Light Black
2	Odour	Unpleasant
3	Ph	6.85
4	Turbidity (NTU)	94
5	Total Suspended Solid mg/l	250
6	Total Dissolved Solid mg/l	630
7	Total Solids mg/l	880
8	Oil & Grease mg/l	4.0
9	Total Residual Chlorine mg/l	ND
10	Total Kjeldahl Nitrogen(as N) mg/l	8.2
11	Free Ammonia(as NH_3) mg/l	1.8
12	Biochemical Oxygen Demand (3 days at 27^0C) mg/l	130
13	Chemical Oxygen Demand mg/l	280
14	Copper (as Cu) mg/l	0.019
15	Zinc (as Zn) mg/l	0.057
16	Selenium (as Se) mg/l	ND
17	Dissolved Phosphate (as P) mg/l	2.5
18	Sulphide (as S) mg/l	1.1
19	Sodium (as Na) mg/l	95
20	Potassium(K) mg/l	30
21	Sulphate(SO_3) mg/l	240

2.2. Experimental Set-Up

Seeds of rice (*Oriza sativa* L.) and wheat (*Triticum aestivum* L.) were sterilized with 0.1% w/v aqueous solution of mercuric chloride for 5 minutes to remove the microbes, followed with repeated washings by using sterilized double distilled water. A laboratory experiment of petridis culture was designed with three replicates from each dilution and 20 healthy treated seeds of uniform size per petridis were used. Plant seeds were spread on equal distance in each sterilized petridis lined with blotting paper. Then each petridis were irrigated with 5ml. of different concentrations of waste water into the respective petridis and then incubated at 25 ± 2^0C. Different parameters like germination percentage, seedling length, seedling vigour index and chlorophyll content were recorded on different period of growth. First recording were done after 12hr. of incubation and subsequent recordings were after 1day interval till 10^{th} day of incubation. The petridis were rearranged at random on every 2days to ensure no systematic effects due to positioning within the incubator. Visible radical growth and emergence of hypocotyls and the cotyledons were used to determine germination (ISTA, 2004).

2.3. Germination (%)

Seed germination was observed by providing optimum conditions for each experimental set. Germination in each experimental set was recorded and total germination was calculated and expressed in percentage.

2.4. Seedling Length (cm)

The root length and shoot length of the germinated seeds were measured from each experimental set. The shoot length was measured from the base of the primary leaf to the base of the hypocotyl and the mean shoot length was expressed in centimetre. Root length was measured from the tip of the primary root to the base of hypocotyl and mean root length was expressed in centimetre. By adding the root length and shoot length, seedling length was calculated and expressed in centimetre.

2.5. Seedling Vigour Index

Vigour index was computed by adopting the formula suggested by Abul- Baki and Anderson (1973) and expressed in number.

SVI= Germination (%) X Seedling Length.

2.6. Chlorophyll Measurement

Total chlorophyll content after eight days was extracted by 80% acetone and determined spectrophotometrically at wave lengths 663nm, 645nm & 470nm, after centrifugation of the extract at 5000rpm for 5min and calculated as per Lichenthaler and Wellburn(1983).

3. RESULTS AND DISCUSSION

The rate of seed germination for both rice and wheat cultivars increases progressively with increasing concentration of domestic wastewater up to 50% and thereafter it decreases (Table 2 and 3). The effect of domestic wastewater on germination of rice and wheat was discourageable towards higher concentrations (70 to 90% inhibition rate with treatment of 75% and 100% wastewater). Khan et.al.(2011) in their experiment on impact of textile waste water on seed germination found that, in higher concentrations, the germination of seed is affected. Nagda et.al. (2006) found that, at higher concentration of industrial effluent, the seed germination efficiency decreases. Osmotic pressure of the effluent increases at higher concentrations of total salts making inhibition more difficult and retard germination efficiencies. The ability of seeds to germinate under high osmotic pressure differs with variety as well as species (Unger, 1987). Lower concentration of effluent supports 100% seed germination in Kidney bean and millet, but osmotic pressure associated with higher concentration of sugar factory effluent were found to reduce the germination in kidney bean and millet (Ajmal and Khan, 1983). The treatment with polluted water also delayed seed germination in both rice and wheat. This may be due to decrease in water uptake at higher level of salinity in view of toxicity of high osmotic pressure of the seedling medium. Khan and Sheikh (1976) have reported significant reduction and delay in the germination of *Capsium annum* seeds. In the present study, difference in the rate of seed germination in both rice and wheat was statistically significant among different concentrations of treatment (F_1 = 250.71 & 80.27 at $P \leq 0.01$) as well as between different time periods of incubation (F_2 = 8.96 & 4.5 at $P \leq 0.01$). The reduction in seed germination may be due to higher soluble salt in the polluted water. Khan and Sheikh (1976) have reported significant reduction and delay in the germination of *Capsicum annum* seeds with the treatment of sewage. They revealed that, this is due to decrease in water uptake at higher level of salinity in view of toxicity of high osmotic pressure due to high soluble salts.

Table-2 Percentage germination of rice grown in different concentrations of domestic waste water.

Time after treatment	Concentration of treated domestic waste water					
	Control	10%	25%	50%	75%	100%
12hrs	X	X	X	X	X	X
1st day	X	10	10	20	X	X
2nd day	80	90	90	100	60	50
3rd day	100	100	100	100	80	80
4th day	100	100	100	100	90	80
5th day	100	100	100	100	90	80

Table-3 Percentage germination of wheat grown in different concentrations of domestic wastewater.

Time after treatment	Concentration of treated domestic waste water					
	Control	10%	25%	50%	75%	100%
12hrs	X	X	X	X	X	X
1st day	X	X	X	X	X	X
2nd day	50	90	100	100	40	30
3rd day	100	100	100	100	80	70
4th day	100	100	100	100	90	70
5th day	100	100	100	100	90	70

The data presented here also depicted significant declined in seedling length with treatment of sewage at the concentrations (75% and 100%). However, treatment at lower concentrations (25% and 50%) seedling length in both rice and wheat increases (Figure 1 & 3). Bazai and Achakzai (2006) in their experiment on effect of waste water from Quetta city on the germination and seedling growth of Lettuce, noted that in the initial doses of polluted water, the plumule length was increased as compared with the control, but at higher concentrations it decreases.

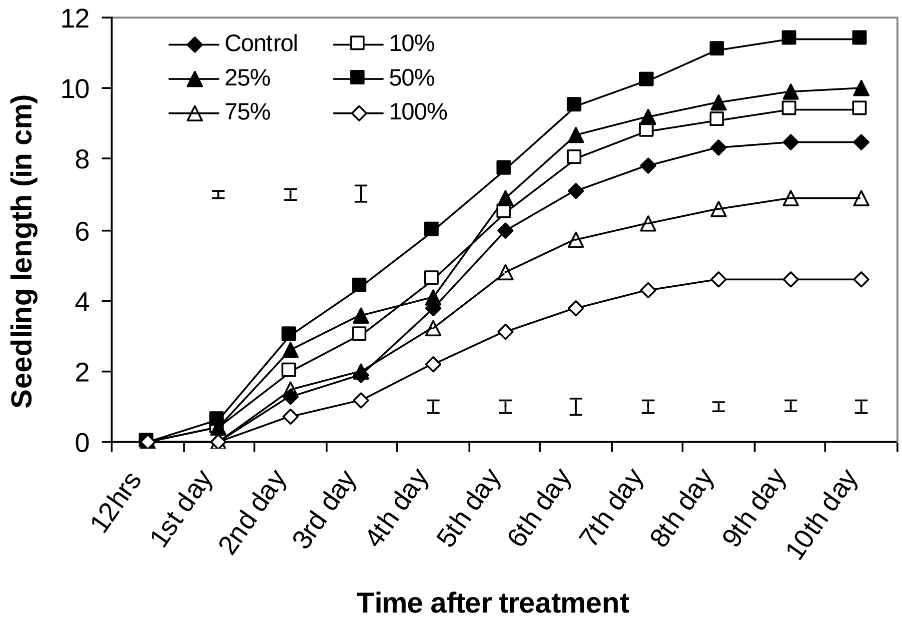

Figure 1. *Effect of domestic wastewater on seedling length of rice. The vertical bars indicate least significant difference (l.s.d) values at 0.05 level of significance.*

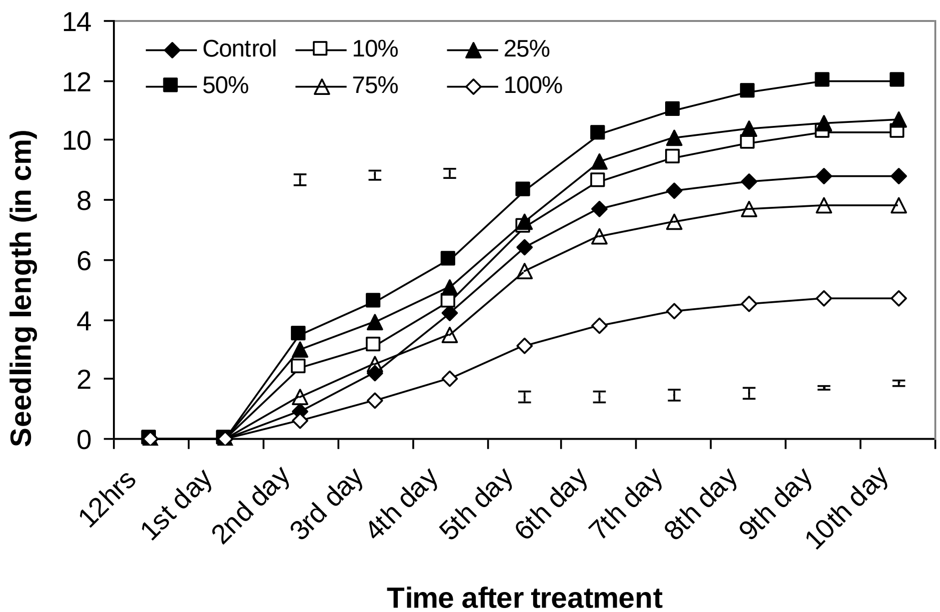

Figure 3. *Effect of domestic wastewater on seedling length of wheat. The vertical bars indicate least significant difference (l.s.d) values at 0.05 level of significance.*

The effect of polluted water on seedling length was found to be statistically significant with treatment at various concentrations of sewage (F_1 = 81.65 & 78.17 at $P \leq 0.01$) as well as between different time period of incubation (F_2 = 30.04 & 28.36 at $P \leq 0.01$) in both rice and wheat seedlings. Similar trend was observed on seedling vigour index in both rice and wheat seedling respectively. The vigour index was increased with the treatment of sewage upto 50% and thereafter it declined gradually towards high concentrations both in rice and wheat (Figure 2 & 4). The difference in vigour index was also found to be statistically significant with treatment at different concentrations (F_1 = 55.63 & 48.94 at $P \leq 0.01$) as well as with different time periods (F_2 = 27.99 & 27.09 at $P \leq 0.01$) in both rice and wheat respectively.

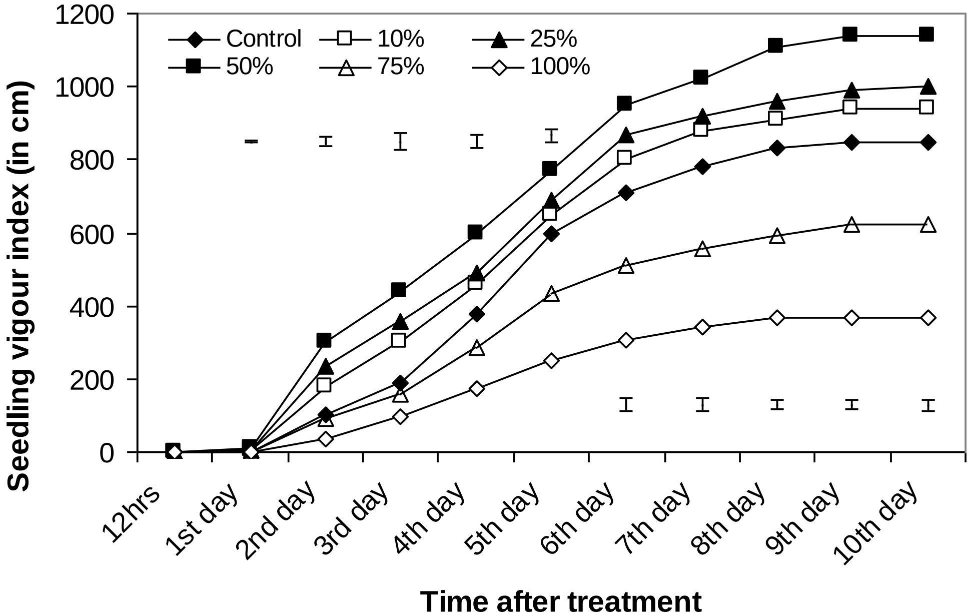

Figure 2. *Effect of domestic wastewater on seedling vigour index of rice. The vertical bars indicate least significant difference (l.s.d) values at 0.05 level of significance.*

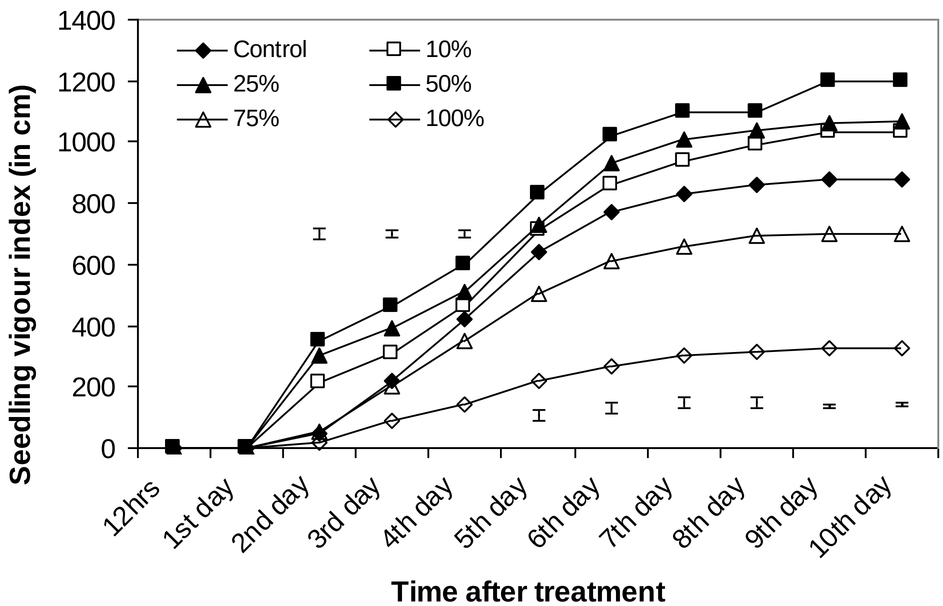

Figure 4. *Effect of domestic wastewater on seedling vigour index of wheat. The vertical bars indicate least significant difference (l.s.d) values at 0.05 level of significance.*

Further, the chlorophyll content in both rice and wheat seedling was increased upto 50% treatment of sewage and there after declined gradually at high concentrations (Figure 5). Enhancement of chlorophyll content in both rice and wheat may be due to higher nutrient uptake from the wastewater. Nagda et.al.(2006) in their experiment on seed germination bioassays to assess toxicity of molasses fermentation based bulk drug industry effluent also found similar result. Srivastava and Sanhai (1987) also found similar results using distillery wastewater. Higher concentration of waste water are inhibitory to synthesis of chlorophyll molecules particularly chlorophyll *a* (khan et. al., 2011). The variation in chlorophyll content was found to be statistically significant with treatment at various concentration of sewage ($F = 270.11$ & 1391.84 at $P \leq 0.01$ both in rice and wheat respectively).

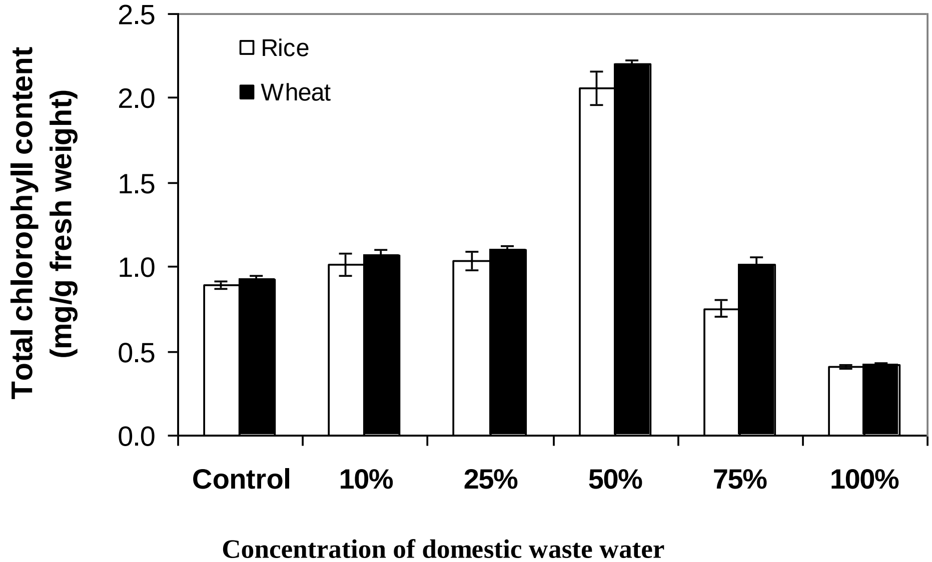

Figure 5. *Effect of domestic wastewater on total chlorophyll content of rice and wheat. The vertical bars indicate standard deviation.*

4. CONCLUSION

The use of domestic wastewater in plant nourishment would be beneficial alternative resources to fresh water. On the basis of overall performance as exhibited by two crops (rice & wheat) when subjected to domestic wastewater, it can be suggested that, sewage is a prospective source of different plant nutrients. Thus, sewage can be used for irrigation purposes in agricultural practices after proper dilutions. It is also suggested that, treatment of sewage is necessary to minimise the pollution effects before it is discharged to the land.

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