

Assessment of Industrial Effluent and Its Impact on Germination and Seedling Growth for Sustainable Agriculture

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Abstract

Industries are indispensable for economic development of any country; effluents are both resource and problem as it contains important nutrients which can serve as fertilizer in agriculture. But these effluents cause harmful effect to the human health and environment when released into the water bodies in its raw form. The amplitude of the damage depends on the size, nature, type of industries, raw materials used and their preliminary treatment. Harmful pollutants in the effluents not only brings about phenomenal changes in receiving system and makes them unfit for agricultural and domestic use, but can also convert them into sources of potential carcinogens and mutagens (Somashekar et al.,1984). Industrial effluent is the waste water generated in the industries is the second major source of water pollution and are making the water unfit for both agriculture and domestic use. But these effluents with proper dilution can be used as source of fertilizer in agriculture. In the present investigation, the treated effluent from BHEL was first analyzed for 13 physico-chemical parameters. Seed germination and seedling growth study of *Phaseolus vulgaris* and *Phaseolus mungo* was conducted in the second stage using different concentrations of [10, 25, 50, 75, 100 %] effluent. The percentage germination, shoot and root length, shoot and root inhibition, vigour index, tolerance index, phyto-toxicity were measured in all these treatments. The morphological parameters showed increase in 10 and 25% concentration of effluent. The higher concentration had inhibitory effect on all morphological parameters. Vigour Index of the seedling showed decrease in higher concentration of treatment, while the phyto-toxicity exhibited

increase with increase in concentration of treatment. The tolerance index was maximum in 10 and 25% treated plants. Bangalore being land locked city faces severe water scarcity, reuse of these treated effluents in agriculture is the best solution to mitigate this problem.

Keywords: Effluent, Germination, Root and Shoot length, Pollution

Introduction

Industrial effluents are the second major source of water pollution and are making the water unfit for both agriculture and domestic use. But these effluents with proper dilution can be used as source of fertilizer in agriculture. Recent studies on industrial effluents have revealed the nutrient and irrigational potential of the effluents specially in lower concentration for sustainable agriculture. Translocation of metals to edible part was less compared to concentrations in roots (Amori et al 2022). Recycle and reuse of the effluent is one of the best solutions envisaged by scientists all over the world. Singh and Mishra (1987) in their studies on effluent have shown that they can be used in agriculture which not only removes nutrients but also provides primary, Secondary and tertiary treatment. The increasing reuse of these effluents supports sustainable agriculture preserves scarce water resource and maintain water quality. Hayat et al., (2002) noted that in oil refinery effluents containing high content of potassium, phosphate, calcium, magnesium and sulphate can serve as fertilizer. Diluted effluent not only increased chlorophyll and protein content, but also had favourable effect on overall growth and yield of crops. Besides water-saving technologies, alternative sources of irrigation water such as waste water or effluent water, are among the opportunities that can help to cope with water scarcity (Tabatabaei et al.2020). The seed germination and seedling growth test is substantiated by APHA, 1998 as an essential component of phytotoxicity testing in aquatic environment. It is in this direction the present work is taken up. In the current research the treated Industrial effluents from BHEL is used for growing crop plants to make sustainable use of waste water. The different dilution of effluent ranging from 10, 25, 50, 75 and 100% were first made using distilled water and used for growing crop plants. Impact of diluted effluent was studied on germination and seedling growth of *Phaseolus vulgaris* and *Phaseolus mungo*. The study revealed positive effect of the effluent at lower concentration (10 and 25%) on overall germination and seedling growth.

Objectives

- To Analyse the physico-chemical parameters of the Effluent
- To study the germination and seedling growth in different concentration of effluent
- To analyze Plant Growth Parameters
- To Determine optimal effluent dilutions that is beneficial for plant growth
- To Promote Responsible Effluent Management

Data and Methodology

In the present study, the treated effluent of BHEL was collected at effluent outlet of factory and analyzed for physico-chemical parameters. The effluent was then made into different concentration ranging from 10, 25, 50, 75 and 100% using distilled water and its effect on germination and overall growth of *Phaseolus mungo* was studied with control for reference.

The germination study was made using petriplate method. The seeds of *Phaseolus mungo* were treated with 0.1% Mercuric chloride as disinfectant for 10 min, then were soaked in different concentration of effluent and control for 3 hours and transferred to sterilized petriplates containing moistened filter paper. A total of 100 seeds were used and four replicates were maintained for each expt. The petriplates were kept in indoor laboratory condition under diffused light at 28±20°C. Germination counts were made after 48 hrs. The shoot and root lengths were measured every alternate day for period of ten days (Mhatre and Chaphekar 1982). The root and shoot inhibition (Vaidehi et al, 1985) was calculated after the completion of experiment. The Germination percentage, root and shoot length and the vigour index (Abdul-Baki and Anderson, 1973) was calculated after the completion of the experiment. Tolerance Index of the seedlings was calculated using the formula of Turner and Marshall (1972). Percentage of phytotoxicity was calculated using Chou et al (1978) formula.

Results and Discussion

The effluent was tested for 13 physico-chemical parameters in Table 1. The effluent is neutral and contains 2715 mg/l total solids. Among the heavy metals Zinc was found in higher concentration followed by Copper.

S. No.	Parameters	Values (mg/l)
1	pH	7.8
2	Turbidity	18
3	Total Dissolved Solids	3160
4	Total Suspended Solids	2260
5	Alkalinity	640

6	COD	620
7	BOD	218
8	Ammoniacal Nitrogen	10
9	Zinc	1.2
10	Copper	1.12
11	Nickel	1.1
12	Lead	0.17
13	Chromium	0.42

Table 1. Physico-chemical parameters of the Effluent water.

Germination

Seed germination and Seedling growth the vital physiological process which initiates plant growth can be taken as an important growth parameter to assess pollution level of water.

The Table 2. Depicts the impact of effluent on germination and seedling growth. Beyond 50% effluent showed significant influence on both germination and seedling growth. However, 10 and 25% effluent exerted positive influence on germination percentage, shoot and root length of the seedlings. A dose dependent relationship was observed in both the plants. Barua and Das (1997) observed similar effects when they treated *Oryza* seeds with Paper mill effluent.

Seed germination percentage in both tested crops gradually decreased with increasing concentration of effluent. Seedling treated with 75% and 100% concentration of effluent indicated maximum reduction in germination Percentage. The higher level of total dissolved solids in 75 and 100% effluent might prevent germination by increasing salinity and conductivity of the solute absorbed by the seed. Vijayarengen and Lakshmanachary (1993) made similar observation in *Vigna radiata*. Both 75 and 100% concentration showed impaired seedling growth, which was observed in terms of burnt shoot and root tips, discoloration of seeds and early decaying of the seedlings. Bajji et al (2008) noted similar behaviour in their study on effluent. Generally, seedlings are more vulnerable to the environmental stresses during germination and early growth.

High germination and seedling growth was observed in 10 to 50 % effluent concentration. This depicts positive influence of effluent at lower concentration on both germination and seedlings growth. Vinod (2014) reported the increase in germination percentage over control at lower concentrations (10%) indicates the stimulation of physiologically inactive seeds by the effluent treatment.

The percentage survival of the seedlings was also more at 10 and 25%

concentration of the treatment. These results are in conformity with Madhappan (1993) in Grams. The stimulatory effect of effluent at lower concentration of effluent was due to increase in the activity of certain enzymes responsible for germination like amylase, invertase and protease (AbouZeid, 2007).

Root Length: Seedlings treated with 10% concentration showed maximum root growth followed by 25%. Similar observation was made by Sundaramoorthy and Lakshmi (2000).

Shoot Length: The growth of shoot was relatively muchless than root in all the concentrations. The diluted effluent in 10 and 25% concentration plied productive influence on shoot growth but this remained low at higher concentration. This is in accordance with Malik et al., (2014).

Root and Shoot Inhibition: Root inhibition was minimum in 10% concentration of effluent followed by 25%. Similar observations are made by Chidan kumar C.S.and Chandraju (2011) in case of distillery effluent. Both Root and Shoot inhibition increased with increase in concentration of effluent with highest inhibition was observed in 100%treatment. The interference of heavy metals decreasing the root and shoot length of plant might be due to interference of enzyme activities in physiological process of plant affecting the nutrition, water balance and alteration of hormonal balance, changed membrane permeability (Sharma and Dubey2005).

Table 2. Impact of Effluent on Germination% and Seedling Growth of *Phaseolus mungo* and *Phaseolus. Vulgaris*

<i>Phaseolus vulgaris</i>						
S. No	Effluent Concentration (%)	Germ % (Mean $\pm$ S.D.)	Root Length (Mean $\pm$ S.D.)	Shoot Length (Mean $\pm$ S.D.)	Root Inhibition (Mean $\pm$ S.D.)	Shoot Inhibition (Mean $\pm$ S.D.)
1	Control Std Dev	95.00 5.00	5.85 0.89	3.05 0.32		
2	10 Std Dev	80.00 4.00	4.95 0.39	2.88 0.49	15	5.6

3	25 Std Dev	82.00 2.50	5.05 0.68	2.63 0.39	13	13.7
4	50 Std Dev	57.50 3.50	3.05 0.63	2.50 0.32	47	18
5	75 Std Dev	50.00 4.50	1.65 0.31	1.30 0.29	71	57
6	100 Std Dev	47.00 5.00	1.25 0.20	0.68 0.22	79	77.8

Phaseolus mungo

S. No	Effluent Concentration (%)	Germ % (Mean $\pm$ S.D.)	Root Length (Mean $\pm$ S.D.)	Shoot Length (Mean $\pm$ S.D.)	Root Inhibition (Mean $\pm$ S.D.)	Shoot Inhibition (Mean $\pm$ S.D.)
1	Control Std Dev	92.00 10.00	3.65 0.91	4.62 0.83		
2	10 Std Dev	90.00 4.79	4.10 0.28	4.62 0.82	-12	0
3	25 Std Dev	91.00 4.79	3.95 0.36	4.93 0.8	-8	-6.7
4	50 Std Dev	72.50 9.57	2.45 0.09	2.50 0.81	32	45.9
5	75 Std Dev	75.00 10.00	1.83 0.62	1.75 0.24	49	62.1
6	100 Std Dev	75.00 10.00	1.35 0.34	1.78 0.49	63	61.5

The Vigour Index (Fig 1) of both *P. vulgaris* and *P. mungo* seedlings were significantly low in undiluted effluent when compared to control. Conversely, at

lower concentration both seedlings showed marked increase in vigour index over control. Prathibha and Azra (2019) noticed similar findings in Glycine max treated with Dyeing factory effluent. There is continuous decrease in Vigour index of the seedlings with increase in concentration of effluent from 50% treatment. Tolerance index (Figure 2) of seedlings was minimum at 100% of effluent concentration and maximum at 25% concentration. Similar observation was made by David and Rajan (2015) in their studies on Dyeing factory effluent. As far as percentage of phytotoxicity (Figure 3) of effluent is concerned, minimum phytotoxicity was observed at 25% and maximum at 100% concentration. Vaithiyanathan and Sundaramoorthy (2017) noticed similar observation in sugar mill effluent.

Fig 1. Effect of Diff Conc of BHEL effluent on Vigour Index of Phaseolus vulgaris and Phaseolus mungo

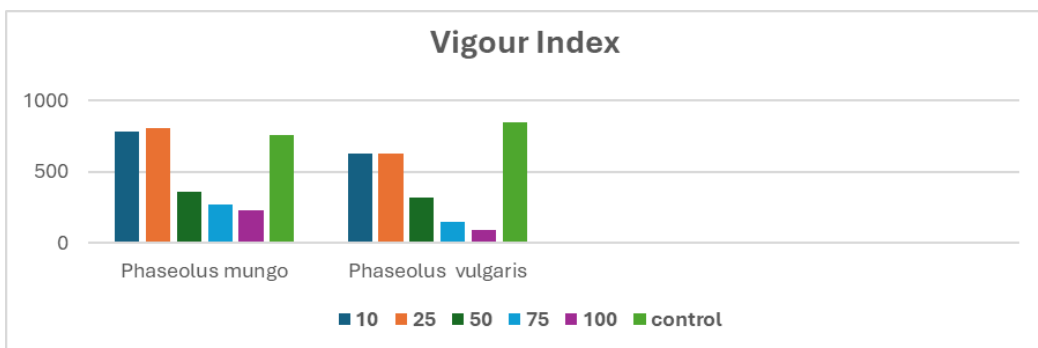


Fig 2. Effect of Diff Conc of BHEL effluent on Tolerance Index of Phaseolus vulgaris and Phaseolus mungo

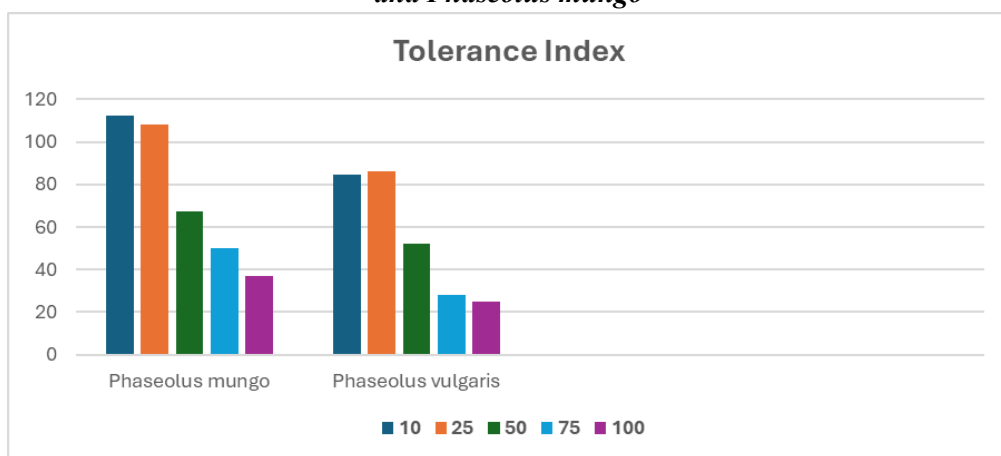
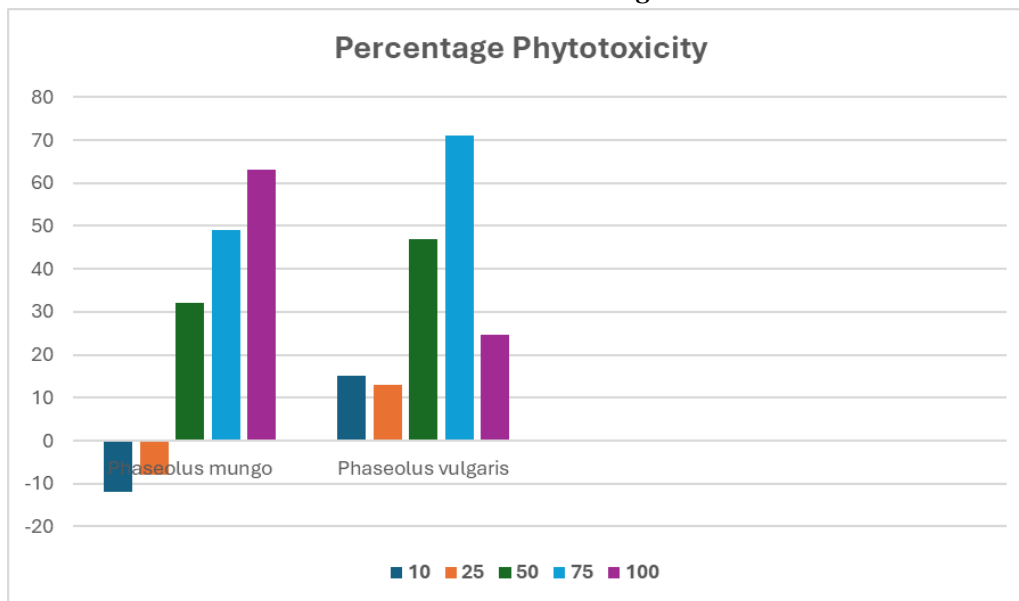


Fig 3. Effect of Diff Conc of BHEL effluent on Phyto- toxicity of Phaseolus vulgaris and Phaseolus mungo



Conclusion

The findings in the present work have revealed that the 10 and 25% treated effluent has increased both germination and seedlings growth, in some cases it is more than control. This indicates the optimum amount of nutrients at lower dilutions has positive effect on germination and overall growth and could be recommended for irrigation, to reduce the lethality of the pollutants and as a substitute for chemical fertilizers. Hence there is every need to develop program that could convince the public and government authorities in such a way that the treated effluent should not be regarded as waste/toxicant, but as one of the finished product, which could be readily used in lower concentration for sustainable agriculture in peri urban areas of Bangalore.

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