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ORIGINAL ARTICLE

Physico-Chemical Analysis of Textile Industry Effluent and Its Impact on Changes of Growth in *Vigna Mungo* (Black Gram)

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ABSTRACT
The toxicity of textile industry effluent on germination and early growth of Vigna mungo (Black gram) seed was studied. Physico-chemical parameters in textile industry effluent like temperature, pH, total dissolved solids (TSS), total suspended solids (TDS), biological oxygen demand (BOD), chemical oxygen demand (COD), sulphate, nitrate, and heavy metals such as cadmium and lead levels were analyzed. The results were compared with CPCB guidelines. It was discovered that the measured parameters exceeded the Central Pollution Control Board standards (CPCB). Black gram seed was germinated in different effluent dilutions like 25%, 50%, 75% and raw effluent. A control was also used. Higher dilutions, such as 75% dilution and raw (beyond 50 percent), exhibited inhibitory effects on germination percentage and initial growth, but lower dilutions, such as 25% and 50% dilution, had stimulatory effects on germination rate. The proportion of seed germination and seedling growth dropped as effluent concentration increased.
Keywords: *Textile industry Wastewater, Biological Oxygen Demand, Chemical Oxygen Demand, Vigna mungo and Germination*

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INTRODUCTION

Water is considered a rare and important commodity, with just around 0.03 percent of the world's water reserves available for human consumption. As a result of industrialization and urbanisation, all of our basic needs are addressed. Simultaneously, they poison all aspects of the environment, including air, water, and soil, altering their inherent characteristics. Every day, large amount of wastewater is produced by a variety of industrial processes (1). Contamination of the environment has long been seen as one of the world's most severe problems. As a result of increased industrialization and urbanisation, various types of chemicals are produced and used in everyday life. If industrial waste water is not treated appropriately, it might harm the biota in the area where it is discharged. This water is thrown straight into nearby bodies of water or onto land, affecting soil fertility. When untreated wastewater is thrown into the environment, it harms the ecological niches of living (2). Textile industry in India is one of the country's oldest and largest industries. Not long ago in India's textile history, the East India Company began its business in the cotton industry. India has emerged as a significant exporter of finished textile materials. When it comes to both volume and substance of effluent, India's textile industry is quickly developing, and its wastewater is the most harmful of all industrial sectors. The textile industry has a large impact on the global economy as well as our daily life. Textile mills utilize a lot of water and as a result, their effluents are brilliantly coloured. Environmental issues have arisen as a result of the widespread use of synthetic dyes in textile production (3). It is estimated that 10% to 15% of the dyes used in the dyeing process are released into the environment. The two biggest sources of dye leakage into the environment are textile processing unit effluents and dyestuff manufacturing companies. Due to environmental considerations, health hazards, and aesthetic concerns, excess dyestuff in effluent is particularly undesirable. Before wastewater may be discharged into the environment, it must first be identified and eliminated as a contamination. Textile wastewater is one of the hardest to clean among industrial effluents, owing to the use of mostly synthetic colours with complex aromatic chemical structures (4). Unfortunately, the vast majority of dyes survive in the environment due to their high resistance to physical variables such as light and temperature. The contaminates remain in environment and have an adverse effect on water ecosystem integrity, soil fertility, plant growth and productivity, and plant disease susceptibility (5).

The aim of the present work was to estimate the physico-chemical parameters of textile industry wastewater. The effect of effluent dilutions (25%, 50%, 75% and 100%) on seed germination of Vigna mungo (Back gram) was investigated. Plant response to pollutants is measured using germination percentage, seedling survival, shoot and root length, and other parameters.

MATERIAL AND METHODS

Sample collection

Effluent was collected in dry, sterile, polypropylene bottles, which were kept in ice during transportation. Sample was stored in the refrigerator (4^0 C) for further studies.

Physico-chemical characterization of the effluent

Physico-chemical characteristics of effluent like pH, temperature, Total Dissolved Solids, Total Suspended Solids, Biological Oxygen Demand, Chemical Oxygen Demand, nitrate, sulphate and heavy metals like cadmium & lead were analysed using the following standard methods of APHA, 2017 (**6)** (Table: 2.2).

Table 2.2: Standard methods for physico-chemical analysis of textile industry effluent

Germination Experiment

Parameter	Units	Test Method APHA (2017)	Instrument used
pH	--	Electrometric method	pH Meter
Temperature	^{0}C	Mechanical method	Thermometer
TDS	mgL^{-1}	Gravimetric Method	Hot air oven
TSS	mgL^{-1}	Gravimetric Method	Hot air oven
Nitrate	mgL^{-1}	Spectrophotometric Method	Spectrophotometer
Sulphate	mgL^{-1}	Spectrophotometric Method	Spectrophotometer
BOD	mgL^{-1}	Winkler's Method	Titration
COD	mgL^{-1}	Potassium dichromate Method	COD Reflux Unit
Cadmium	mgL^{-1}	Spectrophotometric Method	Spectrophotometer
Lead	mgL^{-1}	Spectrophotometric Method	Spectrophotometer

Only healthy Vigna mungo seeds were utilised in the experiment, which were purchased from a local seed vendor. The effluent was diluted with distilled water to achieve varying dilutions of 25%, 50%, 75%, and 100% (raw). The germination experiment was conducted using the paper towel method. Vigna mungo seed was surface sterilised for 2 minutes with a 0.1 percent $HgCl_2$ solution before being washed three times with sterile distilled water. Seeds were distributed on paper towel that had been wetted with raw, 75%, 50%, and 25% dilutions of effluent sample, respectively. After that, they were watered with 20ml of different dilutions of textile effluent. As a control, the same set was run using distilled water. Each treatment consisted of three paper towels with 40 seeds per paper towel, which were checked for germination every 24 hours. The percentage of seed germination was calculated, and the root and shoot lengths of the plants were measured every 24 hours for seven days. After seven days of testing, fresh and total dry weight of Vigna mungo was determined. The plants were then packaged in paper envelopes and oven dried for 36 hours at 70 degrees Celsius.

RESULTS AND DISCUSSION

Physico-chemical Analysis

Physico-chemical characteristics of textile effluent are presented in Table- 3.1.

Table 3.1: Physico-chemical characterization of textile industry effluent

Parameters	Analyzed Values	CPCB Standard
pH	9.5 ± 0.057	6.0-8.5
Temperature (^oC)	47 ± 1.15	Not exceed 40^o C
TDS (mgL^{-1})	2689 ± 3.60	2100
TSS (mgL^{-1})	377.4 ± 2.27	100
BOD (mgL^{-1})	694 ± 4.27	30
COD (mgL^{-1})	2662.6 ± 2.82	250
Sulphate (mgL^{-1})	1454.6 ± 2.25	1000
Nitrate (mgL^{-1})	12.3 ± 0.57	10
Cadmium (mgL^{-1})	0.51 ± 0.03	0.2
Lead (mgL^{-1})	0.26 ± 0.02	0.1

The effluent was found to have an alkaline pH of 9.5. Most metal ions become insoluble at high pH and accumulate in sludge and sediments, limiting biological activity in receiving water bodies (**7)**. The effluent was found to have a temperature of 47^o C. The chemical and biological interactions in water are disrupted by high temperatures. The temperature of dissolved oxygen in water varies, causing variations in DO levels and impacting aquatic life. TDS of the effluent was found to be 2689 mgL^{-1}. High TDS is caused by high solids loading & its high concentration increases salinity of water. TSS was found to be 377.4mgL^{-1}. CPCB standard for TSS is 100mgL^{-1}. As a result, it is evident that the effluent has a high TSS value, which could be attributed to the presence of suspended particles in the waste water. If this effluent is dumped into a river or stream, aquatic life will be harmed (8). The effluent's BOD and COD were measured to be 694mgL^{-1} and 2662.6mgL^{-1}, respectively. The allowable limits for BOD and COD have been exceeded. High BOD levels decrease dissolved oxygen, resulting in the death of aerobic species and increasing the water's anaerobic qualities. The high levels of COD indicate the toxicity of the effluents and the presence of large amount of biologically resistant organic substances. The high BOD/COD level indicates waste water, which necessitates a large amount of dissolved oxygen for improved intrinsic remediation. The findings are in agreement with those seen in other investigations (9, 10). A Sulphate concentration in wastewater are higher due to the use of sulphate compounds such as sulphuric acid, sodium sulphate, and aluminium sulphate. The effluent contained 1454.6mgL^{-1} of sulphate and 12.3mgL^{-1} of nitrate, respectively. Sulphate and nitrate compounds in effluent can deplete the amount of dissolved oxygen in receiving water bodies. Similar result was observed by Agoro et al., 2018 (11). Heavy metals accumulate in the food chain (bioaccumulation), and biomagnification allows them to enter the human body (12). Cadmium and lead concentrations were found to be 0.51mgL^{-1} and 0.26mgL^{-1}, respectively. In their investigation, Ogemdi & Gold, 2018 (13) found that cadmium and lead concentrations in wastewater were 0.14mgL^{-1} and 0.10mgL^{-1}, respectively. Even at low concentrations, these two heavy metals are incredibly hazardous.

Phytotoxicity studies

The relationship between germination percentage, root length, and shoot length and the dilution of textile industry effluent used for seed treatment clearly shows that effluent has a significant impact on the physiological parameters described above. The results of the research show that as the dilution of effluent (50-100 percent) increases, the germination rate, as well as root and shoot length, decreases. Effluent dilutions used for the study are 25%, 50%, 75 %, and raw effluent. Of these 25% dilution of effluent was found to be most effective in increasing the germination rate and other parameters in Vigna mungo (Figure. 3.2). The findings are consistent with previous research (14 & 15), which found that lower effluent concentration favored plant growth. In black gram seed treated with 25% effluent dilution, 71.42 percent germination rate was recorded, with average root length, shoot length, fresh weight, and dry weight of 13.86cm, 19.66cm, 1.75g, and 0.7g, respectively (Figure 3.2.1, 3.2.2., 3.2.4 & Table. 3.2). In the literature, the same effects on maize germination percentage have been described (16). When seeds were treated with a low dilution of effluent (50-100 percent), however, germination percentage dropped by 60-20% in Vigna mungo. On lesser dilutions of effluent, a comparable reduction in root and shoot length was seen (Table 3.2 and Figure 3.2.3). The fact that low dilutions of effluent restrict seed growth and germination could be attributed to increased osmotic pressure, which makes imbibitions more difficult and reduce oxygen intake by seedlings (17 & 18). Diluting the effluent enhances the plant activities by providing required amount of nutrient present. Because each plant has its unique tolerance capability, the effect of varied effluent dilutions differs from crop to crop (19).


Raw
75% Dilution
50% Dilution
25% Dilution
Control

A


Control


Raw

B C


25% Dilution


50% Dilution

D E

F

Figure 3.2. Germination and growth pattern of Vigna mungo at different effluent dilutions (A- Growth at different dilutions, B- Control, C-Raw, D-75% dilution, E-50% dilution and F- 25% dilution)

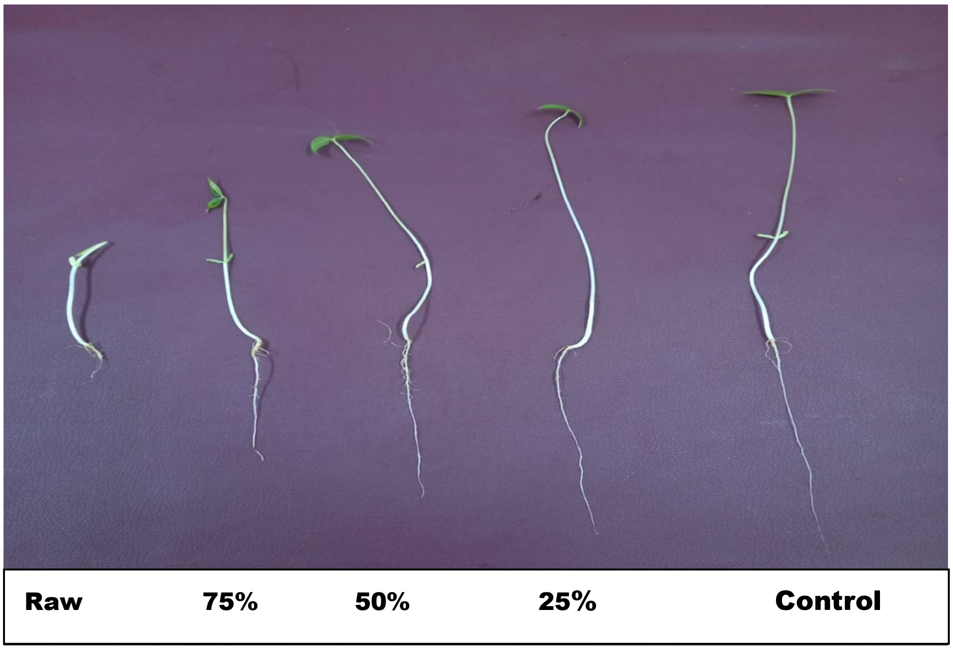

Figure 3.2.1. Root and shoot length of Vigna mungo at different effluent dilutions

Table 3.2. Effect of effluent on various growth parameters of Vigna mungo

Dilution %	Rate of Germination (%)	Length of root (cm)	Length of shoot (cm)	Fresh weight (g)	Dry weight (g)
Control	89.02	17.08±1.58	21.71±1.23	1.78±0.20	0.99±0.04
Raw	21.88	4.4±0.30	10.26±0.76	1.34±0.18	0.03±0.02
75%	42.85	9.58±1.97	12.6±0.77	1.51±0.17	0.3±0.04
50%	58.57	11.06±1.52	15.4±1.41	1.39±0.13	0.47±0.03
25%	71.42	13.86±0.877	19.66±0.76	1.75±0.20	0.7±0.04

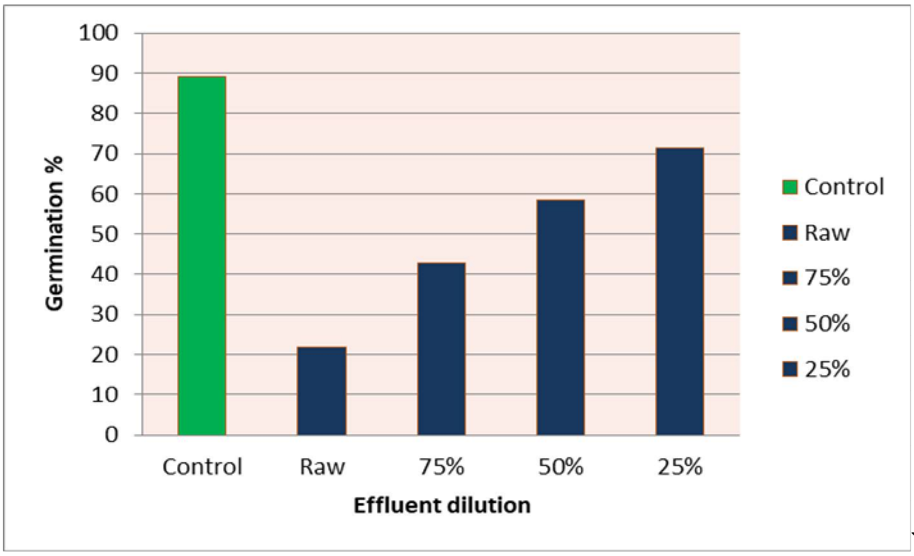

Figure 3.2.2. Germination percentage of Vigna mungo at different effluent dilutions

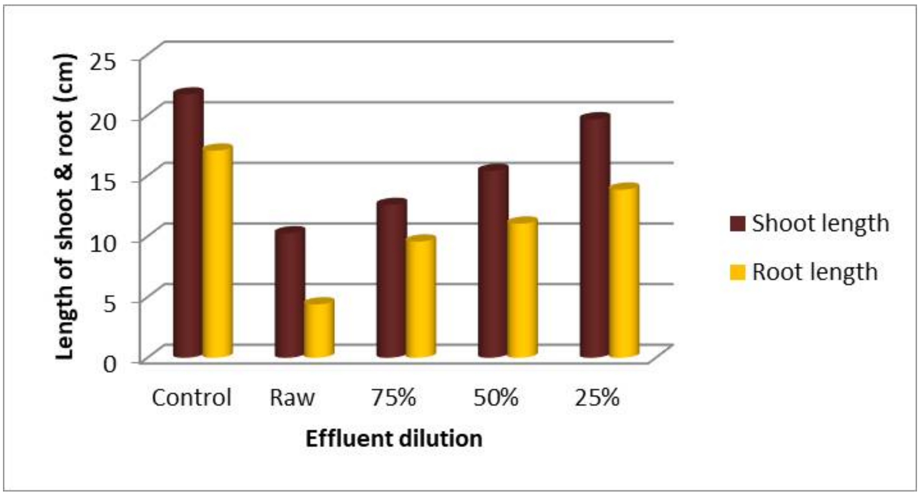

Figure 3.2.3. Length of Root and Shoot of Vigna mungo at different effluent dilutions

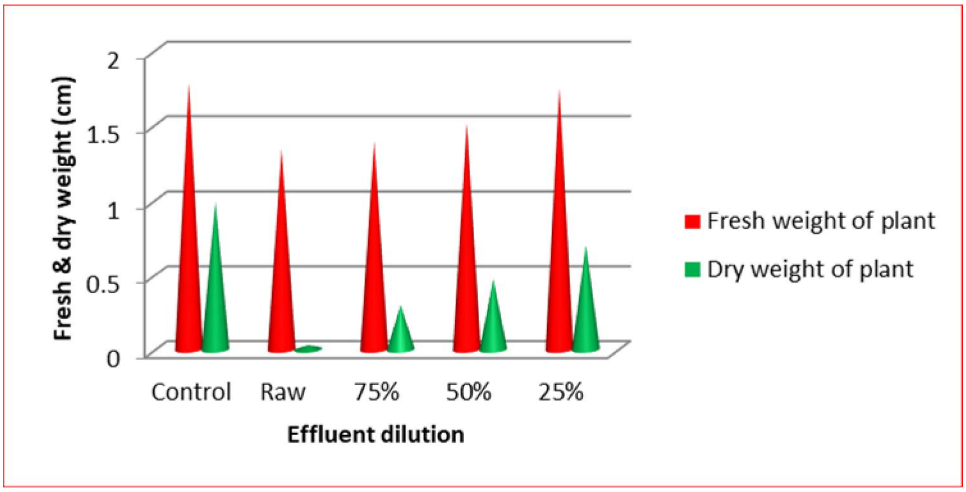

Figure 3.2.4. Fresh and dry weight of Vigna mungo at different effluent dilutions

CONCLUSION

Textile industry wastewater has a high concentration of physico-chemical characteristics, which have a negative impact on plant growth. In comparison to other dilutions, the textile industry effluent at 25%

dilution has a positive influence on Vigna mungo germination rate and growth characteristics such as root length, shoot length, fresh and dry weight. When irrigated with effluent dilutions from 50% to 100%, however, unfavorable impacts were observed in all growth indices of Vigna mungo. Based on the experimental observation it can be concluded that effluent with controlled physico-chemical properties and higher dilutions can be used for irrigation.

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Competing interests:
"The authors have declared that no competing interest exists".

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