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Effect of Textile Effluent on Seed Germination and Early Growth of Wheat (*Triticum aestivum* L.) and Mustard (*Brassica juncea* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

An experiment was conducted during *rabi* season in the year 2021-22 at Soil Science & Agricultural Chemistry, Laboratory of Sangam University, Bhilwara (Rajasthan) India, to evaluate the "Effect of textile effluent on seed germination and early growth of Wheat (*Triticum aestivum* L.) and Mustard (*Brassica juncea* L.): A case study" consist of four (Treated industrial effluent) treatment (T_1) freshwater, (T_2) 25% effluent+75% fresh water, (T_3) 50% effluent+50 % fresh water, (T_4) 75 % effluent+25% freshwater to determine the effects of textile effluent's toxicity on wheat and mustard seed germination rates and early growth as well as growth factors like plumule and radicle length.

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With higher effluent concentrations, the proportion of seed germination and seedling growth gradually decreased. Germination percentage, plumule and radicle length of seedlings were lowest in the treatment T4 (75% effluent + 25% fresh water) and highest in treatment T2 (25% effluent + 75 fresh water) treatment.

Keywords: Textile waste water; seed germination; wheat; mustard.

1. INTRODUCTION

"Water is one of the most important valuable resource found on the earth. The water resources are most often affected by anthropogenic activities and also from industries. Growth of population, massive urbanization, rapid rate of industrialization and modern techniques in agriculture have sped up the water pollution and led to gradual deterioration of its quality" Prabhakar et al. [1], APHA [2]. "Textile industries have been placed in the category of most polluting industries by the Ministry of Environment and Forests, Government of India. India has a large network of textile industries of varying capacity that are distributed throughout the country. Textile city (Bhilwara district) has maximum textile industries in Rajasthan of India. The textile effluent contains organic and inorganic chemical species have adverse effect on growth of all plants and animals, because textile effluent used for irrigation contains heavy metals (Ni, Cd, Cr, Pb, Hg etc.), which accumulate in various parts of plants that result in various clinical problems in animals and in human beings including hepatic and renal system damages, mental retardation and degradation of basal ganglia of brain and liver" [3]. "Effluent in higher concentration affects the soil and causes heavy damage to the crop growth conditions. Using such wastewater in an irrigation system definitely provides some nutrients to enhance the fertility of soil, but it also deposits toxicants that change soil properties in the long run. The low amount of O_2 in dissolved form because of the presence of high concentration of solid in the effluent reduces the energy supply through anaerobic respiration, resulting in restriction of growth of seedlings" [4]. "Improper disposal of the textile effluent in natural water resources, causing serious problems for the planet" [5]. Exposure of seedlings to effluent with a lower concentration shows growth, general development of seedlings. The decrease in seed germination rate at higher wastewater concentrations may be due to higher solids in the wastewater causing changes in the seed-to-water osmotic ratio [1].

2. MATERIALS AND METHODS

2.1 Collection of Textile Effluents

The Industrial effluent waste water collected from discharge points of the recycled waste water tank and the respective sources. Samples of effluent water from textile industry in Bhilwara were collected in 50 liter drums.

2.2 Seed Collection

The effect of textile effluent has been studied on two different crop wheat (*Triticum aestivum* L.) variety Raj-4079 and Mustard (*Brassica juncea* L.) variety SM-21. The seeds were procured from the certified local seed supplier. Seeds were surface sterilized with 0.1% $HgCl_2$ and thoroughly rinsed with distilled water for 10 minutes to avoid fungal contamination before plating.

2.3 Experimental Design

The experiment was laid out were evaluated in Completely Randomized Design with three replications. Sterilized Petri plates prepared with Whatman filter paper and known volume of different concentration of textile effluent (0%, 25%, 50% and 75%) was poured into different petriplates marked with the concentration. Twenty-five seeds were placed especially in a sterilized Petri plate. The effluent (50ml) was irrigated periodically every 24-hours.

2.4 Germination of Wheat and Mustard

Number of seeds responded for germination percent, plumule and radicle length of the seedlings were observed on second, fourth and eighth day's incubator with 12h of light illumination per day.

1. The seeds of wheat and mustard were surface sterilized with 0.1% of $HgCl_2$ for 2-3 minutes, washed in running tap water for 3 minutes and in distilled water for 2 minutes.

Table 1. Physico-chemical parameters of textile effluent water

S.N.	Parameter	Treated waste water	Surface /irrigation water
1.	pH	8.15	7.90
2.	EC (mmho cm-1)	3.30	0.98
3.	TDS	4200	605
4.	Hardness ppm	91	55
5.	Calcium (mg/l)	41	20
6.	Magnesium (mg/l)	50	35
7.	Sodium (mg/l)	200	80
8.	Sulphate (mg/l)	101	45
9.	Chloride (mg/l)	250	42

*Note- Treatment Level
1. T_1- Control (100% Fresh water)
2. T2- Effluent: Fresh water (25% + 75%)
3. T3- Effluent: Fresh water (50% + 50%)
4. T4- Effluent: Fresh water (75% + 25%)

2. 25 seeds of each wheat and mustard were placed in sterilized glass petri plate of size 15 X 100 mm lined with two Whatman filter paper discs.
3. The Whatman filter papers were wetted with 5ml of Fresh water (control) and same (5ml) of various concentration of textile effluent.
4. After seed inoculation the plates were incubated at room temperature, in the laboratory.
5. The preparation was moistened with 5ml of effluent every 12 hours and observed for radicle emergence. Triplicates were maintained, the results were averaged.
6. Germination percentage, relative radicle length and plumule length were determined.

2.4.1 Germination percentage

The formula given by Rehman et al. [6] was used to estimate germination percentage.

Formula of germination percentage **=** Number of seed germination /Total number of seed x 100

2.4.2 Radicle and plumule length

Length of radicle and plumule of seedlings were calculated by using the standard centimeter scale.

2.5 Study Area

Wheat and mustard seeds were allowed to germinate in different concentrations of water. The physicochemical characteristics of wastewater were analyzed using the APHA method [7] at the Laboratory of Soil Science and Agricultural Chemistry, School of Agricultural Sciences and Technology, Sangam University, Bhilwara, Raj. Analysis results of various parameters and effects of textile wastewater were discussed in Table 1.

3. RESULTS AND DISCUSSION

In the present investigation, results revealed that irrigation water related treatments were significantly affected to seed germination percentage as well Plumule Length and Radicle Length in both wheat and mustard crop. In wheat, maximum seed germination rates were V1T1 (94.33%, 94.67% and 96%) and minimum seed germination rates were V1T4 (51%, 64% and 70%) recorded at 2, 4 and 8 days. Similarly, mustard germination percentage was recorded in V1T1 (79.33%, 87% and 89%), while minimum seed germination percentage was recorded in V1T4 (48%, 60% and 64.33%) after 2, 4 and 8 days.

Both crops were very sensitive to textile waste water. Table 2 shows the effect of wastewater on radicle length and plumule length, which showed a decreasing trend with increasing wastewater concentration. A similar trend was observed for regulations. The radicle length and plumule length was significantly increased compared to fresh water control. All the growth parameters increased at 25% effluent concentration and decreased at 50% and 75% effluent concentration. 100% effluent cannot be used because it is toxic, resulting in reduced root and

Table 2. Effect of textile effluents on germination percentage and early growth parameters of wheat and mustard crop

Source	Effect after two days of test			Effect after four days of test			Effect after eight days of test		
	SG%	**PL**	**RL**	**SG%**	**PL**	**RL**	**SG%**	**PL**	**RL**
V_1	80.50a	0.48a	1.16a	85.58a	1.27b	2.15a	88.08 a	2.93 a	3.16a
V_2	66.41b	0.46b	1.22a	79.91b	1.52a	1.52b	83.08 b	2.22 b	2.10b
SEm	0.482	0.004	0.024	0.328	0.033	0.035	0.27	0.039	0.048
SEd	0.682	0.005	0.033	0.464	0.046	0.05	0.382	0.055	0.067
CV	2.27	2.866	6.900	1.373	8.118	6.650	1.092	5.250	6.259
T_1	85.67a	0.50b	1.42a	91.33a	1.85a	2.58a	93.83a	3.55a	3.27a
T_2	83.67a	0.51a	1.45a	90.66a	1.58b	1.87b	92.17b	3.03b	2.75b
T_3	75.00b	0.46c	0.87c	87.00b	1.43c	1.90b	89.00c	2.65c	2.80b
T_4	49.50c	0.40d	1.01b	62.00c	0.73d	1.017c	67.33d	1.08c	1.70c
SEm	0.682	0.005	0.033	0.464	0.046	0.05	0.382	0.055	0.067
SEd	0.965	0.008	0.047	0.656	0.066	0.071	0.54	0.078	0.095
CV	2.274	2.866	6.899	1.373	8.118	6.650	1.093	5.250	6.259
$V_1:T_1$	88.00b	0.50ab	1.36b	94.33a	1.30c	2.17c	95.33a	3.56ab	3.03c
$V_1:T_2$	94.33a	0.52a	1.47ab	94.67a	1.53b	2.80a	96.00a	3.80a	3.47b
$V_1:T_3$	88.66b	0.50ab	0.85d	89.33b	1.57b	2.57b	90.66b	3.40bc	3.93a
$V_1:T_4$	51.00e	0.40c	0.95cd	64.00e	0.70d	1.10ef	70.33e	0.96f	2.20d
$V_2:T_1$	77.00c	0.49b	1.37b	87.00c	2.40a	2.37bc	89.00c	2.50d	2.03d
$V_2:T_2$	79.33c	0.51ab	1.53a	88.00bc	1.63b	1.57d	91.66b	3.30c	3.50b
$V_2:T_3$	61.33d	0.42c	0.90d	84.66d	1.30c	1.23e	87.33d	1.90e	1.67e
$V_2:T_4$	48.00f	0.40c	1.07c	60.00f	0.77d	0.93f	64.33f	1.20f	1.20f
SEm	0.965	0.011	0.047	0.656	0.066	0.071	0.54	0.078	0.095
SEd	1.364	0.008	0.067	0.928	0.093	0.1	0.764	0.111	0.134
CV	2.275	2.866	6.899	1.373	8.118	6.650	1.093	5.250	6.259
CD	1.446	0.023	0.071	1.967	0.139	0.149	1.619	0.234	0.284

** Means not sharing a letter in common differ significantly at 5% level of significance*

Note- SG%=Seed Germination percentage, PL=Plumule Length, RL=Radicle Length, V_1=Wheat, V_2=Mustard, T_1=Control (100% Fresh water), T_2- Effluent: Fresh water (25% + 75%), T_3- Effluent: Fresh water (50% + 50%), T_4- Effluent: Fresh water (75% + 25%)

shoot length, Dutta and Boissya [8]. Mohammad and Khan [9] also, no harmful effects of textile wastewater were found at lower concentrations (50% effluent concentration), which is consistent with the present results (25% effluent effective concentration). Similar observations were also notice by Malaviya and Sharma [10] and Rashmi, et al. [11] from the present study, it can be concluded that textile waste by itself inhibits radicle length and plumule length, while diluting it promotes the germination and growth parameters of wheat and mustard. The exposure of seedlings to less concentration of effluent shows improved growth, overall seedling development and chlorophyll content. The decrease in seed germination rate at higher wastewater concentrations may be due to the higher amount of solids in the wastewater, which causes an osmotic relationship between the seed and the water.

4. CONCLUSION

Effluent from the textile industry resulted healthy growth of wheat and mustard at 25% dilution. Waste water could be used as diluents in the irrigation water. It was suggested that the wastewater from textile mills, after proper dilution, could be used for irrigation and this could contribute at least partially to solving the problem of textile waste. However, such a recommendation requires more work to minimize risk.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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