Poll Res. 41 (2) : 569-575 (2022)

ISSN 0257–8050
DOI No.: http://doi.org/10.53550/PR.2022.v41i02.025

EFFECT OF TEXTILE INDUSTRY WASTE WATER ON SEED GERMINATION AND PLANT GROWTH OF MUSTARD

SAVITA RANI, POOJA, NANDNI*, KASHISH SHARMA AND SHIVI CHOUDHARY

Department of Microbiology, College of Basic Science & Humanities, Chaudhary Charan Singh Haryana Agricultural University, Hisar 125 004, Haryana, India

(Received 7 October, 2021; Accepted 28 September, 2021)

ABSTRACT

The assessment of the toxicity of textile waste water is of great concern as most of them exert toxic effects on plants, animals and microorganisms, when released in water stream and used for irrigation purpose on land. During the present investigation, seed germination of mustard was markedly affected by different concentration of waste water. Lower concentrations of waste water (10%) were not inhibitory to seed germination, while germination rate was poor with 20, 50 and 100% waste water concentration as compared to control and the seeds germination was slow at 3rd and 5th day with higher textile waste water. The effect of different levels of textile waste water under pot house conditions have shown that lower concentrations (10 and 20%) of waste water were not inhibitory to plant growth when irrigated with after germination. However, plant growth was affected drastically at higher concentration of waste water when applied after germination, while with more than 20% waste water concentration, growth was suppressed in both after and regular germination throughout the experiment.

KEY WORDS : Textile, Waste water, Seed germination, Plant growth

INTRODUCTION

During the last few decades, a strong global awakening regarding the proper management of existing natural resources has been done. Due to increasing demand of human population and food had brought more and more land under cultivation focusing attention on irrigation is becoming costlier (Saravanamoorthy and Ranjitha Kumari, 2007). Farmers are now doing irrigation with industrial waste water due to water scarcity especially in arid and semiarid regions. Therefore, special attention required for managing of irrigation water (Dhanam, 2009). The use of such waste water in irrigation system definitely provides some nutrients to enhance the fertility of soil but also deposit toxicants that change soil properties in the long run (Yasmin *et al.*, 2011). Effluent of different industries may vary in composition depending upon the source of production and may contain essential nutrients and some toxic substances (Garg and Kaushik, 2007). The major industries are textiles, lather tanning, fertilizer production, sugar refining, chemical, and pharmaceutical and oil refining. In India, only 30% of waste water is treated before discharged into the environment. Mostly serious water pollution occurs in untreated water which directly finds way into rivers, lakes, ground water and coastal water etc. (Thapliyal *et al.*, 2011). Every day a large amount of effluent, sewage sludge and solid waste material get generated by textile industries. The effluents enter finally into the river system when they are discharged into the surrounding channels, agricultural fields, irrigation channels and surface water (Kanan *et al.*, 2014). Important pollutants in textile effluent are mainly recalcitrant organics, color, toxicants and surfactants, chlorinated compounds (AOX). On the other hand, heavy metals and toxic components also get accumulated in soil. Land irrigated with textile effluents causes serious impacts on plant growth as soil can act as a sink for heavy metals and other resistant chemicals resulting in the reduction of productivity (Mahmood *et al.*, 2013).

Different tolerance to various pollutants is acquired by different crops. To evaluate phytotoxicity seed germination and plant growth bioassays are the most common techniques (Kapanen and Itavaara, 2001). The soil fertility and crop productivity (Castro *et al.*, 2015) adversity affected by textile mill effluent particularly at higher concentrations inhibits seed germination (Carr *et al.*, 2011) and growth of crop plant seedlings (Singh *et al.*, 2013) while lower concentrations of effluents were not toxic. So, industrial waste water is commonly used for irrigating agricultural fields in developing countries (Sharma *et al.*, 2014) which increases the amount of macro and micronutrients including heavy metals and these under high concentrations are harmful for plants (Kocak *et al.*, 2005).

MATERIALS AND METHODS

Effect of textile industry waste water on seed germination of mustard (RH- 749)

Pot experiment was conducted where three pots were used for each treatment 0, 10, 20, 50 and 100% of textile waste water. These were irrigated with water one day before sowing of seeds. After irrigation five seeds were sown in every pot. After the initiation of seed germination till 5th, 6th and 7th day of germination, percentage was recorded and only healthier plants were used for the experimental purpose. Plant height was measured at maturity after 3 months. Recommended dose of fertilizer, single super phosphate and urea was added @ 270 mg/pot and 240 mg/pot respectively, in all the treatments except control. Weights of plant roots and shoots were taken from each pot after the harvesting.

Effect of textile industry waste water on seed germination of mustard under laboratory conditions

For the germination experiments, certified healthy and equal sized seeds of mustard *(Brassica juncea* L.) were sterilized with 0.1% $HgC1_2$. After repeated washings with sterilized distilled water, 10 sterilized seeds were arranged in sterilized petridishes, lined with double layer of filter paper saturated with equal volume of different concentration of textile waste water (0, 10, 20, 30, 50 and 100%). The germination percentage was observed in each petridish for 48 hours. The growth parameters like germination, 21st day after seedling emergence.

Germination percentage

Germination percentage was determined by the following formula as described by Li (2008):

Germination percentage (G %) = n/N x 100,

Where n is the number of germinated seeds at the fifth day and N is the total number of seeds.

Effect of textile industrial waste water on plant growth

A pot experiment was conducted using mustard (RH-749) as a test crop with following treatments:

T_1 : Control irrigated with water throughout the experiment

T_2 : Irrigated with waste water + 50% RDF

T_3 : Irrigated with waste water + 100% RDF

T_4 : Irrigated with different concentrations (10, 20, 50 and 100%) of waste water throughout the experiment

T_5 : Irrigated with different concentrations (10, 20, 50 and 100%) of waste water after seed germination

Plant fresh and dry weight

Plants were carefully uprooted and washed under tap water. Roots were separated from shoots. Shoot and root portions of the plants were weighted. Then, they were dried in oven at 90°C for 24 hrs and weighted again to determine root and shoot dry weight. Data regarding fresh and dry biomass of shoot and root was recorded.

RESULTS AND DISCUSSION

Physico-chemical properties of soil used during the present investigation

Physico-chemical properties of soil are presented in Table 1. The soil was sandy loam with pH 7.6 and 1.2 d Sm^{-1} electrical conductivity (EC). Total organic carbon and nitrogen were 0.385 and 0.052% respectively.

Table 1. Physico-chemical properties of soil used in laboratory and pot house experiments

S. No.	Parameters	Value
1.	Soil type	Sandy loam
2.	pH	7.6
3.	EC (d Sm^{-1})	1.2
4.	Organic carbon (%)	0.385
5.	Total nitrogen (%)	0.052

Effect of textile industry waste water on germination of mustard seeds under laboratory conditions

Effect of textile industry waste water on seed germination of mustard (*Brassica juncea* L.) was studied (Table 2) (Plate 1). Seeds were kept in petri dishes having double layer of filter paper saturated with different concentrations of waste water. Seed germination of mustard was markedly affected by different concentrations of waste water. The germination of seeds increased with increasing the incubation period from 3rd to 5th day. The percent germination of seeds varied from 35 to 100% from 3rd to 5th day of incubation. Less inhibition in seeds, germination was observed at 10% waste water concentration in comparison to 20, 50 and 100% of waste water concentration. However, 100% seed germination was observed with distilled water and 10% waste water concentration at 5th day of incubation period and with further increase in waste water concentration, germination of seeds decreased (Plate 6). Germination of seeds was 100% with 10% waste water amendment and 35 with 100% textile waste water amendments.

Effect of textile industry waste water on seed germination under pot house conditions

In the treatment with soil +50% RDF and soil +100% RDF, percent germination of seed was 86 and 93% respectively under pot house conditions. However, with increasing the waste water concentration from 10 to 20, 50 and 100%, germination of seeds decreased significantly under pot house conditions. Only 40% seeds were germinated when the pots were irrigated with 100% waste water every day.

Effect of textile industry waste water on plant growth of mustard

Table 4 shows the effect of different concentration of textile waste water on plant growth (plant height, dry weight of shoot and roots). Seeds irrigated with different concentration of waste water after the germination, showed better growth as compared to seeds which were irrigated with waste water before germination regularly and control (Fig. 1 and 2). In

Table 2. Effect of different concentrations of textile industry waste water on germination of mustard seeds under laboratory conditions

Textile waste water concentration (%)	Germination of mustard seeds (%)		
	Days		
	3rd	4th	5th
0	85	90	100
10	90	100	100
20	80	95	95
50	50	50	50
100	35	35	35
CD at 5% level	5	7	6

Table 3. Effect of different concentrations of textile industry waste water on germination of mustard seeds in soil under pot house conditions

S. No.	Treatments	Germination (%)
1.	Control	80
2.	50% RDF	86
3.	100% RDF	93
Set-I	**Regular irrigation with textile waste water**	
4.	10% waste water + RDF	93
5.	20% waste water + RDF	80
6.	50% waste water + RDF	73
7.	100% waste water +RDF	60
Set-II	**Always irrigated with textile waste water after germination**	
8.	10% waste water + RDF	93
9.	20% waste water + RDF	86
10.	50% waste water + RDF	86
11.	100% waste water +RDF	80

the treatments with 50 and 100% RDF plant height, dry weight of shoot and roots were 59.93 and 65.52 cm, 2.984 and 1.944, 1.033 and 1.258 g plant^{-1} respectively, which were higher than control. Plant height varied from 57.33 to 28.24 cm and 64.33 to 31.56 cm when seeds were irrigated with different concentration of waste water (10 to 100%) before seed germination and after seed germination respectively. Maximum plant height (64.33 cm) was observed in the seeds treated with 10% waste water + RDF after seed germination, whereas minimum plant height was observed in the plants, which were irrigated with 100%+ RDF waste water regularly after seed germination.

Dry weight of the mustard shoot varied from 2.060 to 0.773 g plant^{-1} when they were treated with 10 to 100% waste water before seed germination whereas 2.288 to 0.947 g plant^{-1} dry weight was observed in seeds treated with 10 to 100% waste water after germination of seeds. Maximum (2.288 g plant^{-1}) and minimum (0.773 g plant^{-1}) shoot dry weight was observed a treatment with 10% and 100% treated with waste water regularly and after the germination respectively. Plant height, dry weight of root and shoot were significantly higher in 10 and 20% textile waste water in both the sets. Irrigation of mustard crop after the germination of seeds with textile waste water upto 20% gave better dry matter yield and plant height than irrigation regularly.

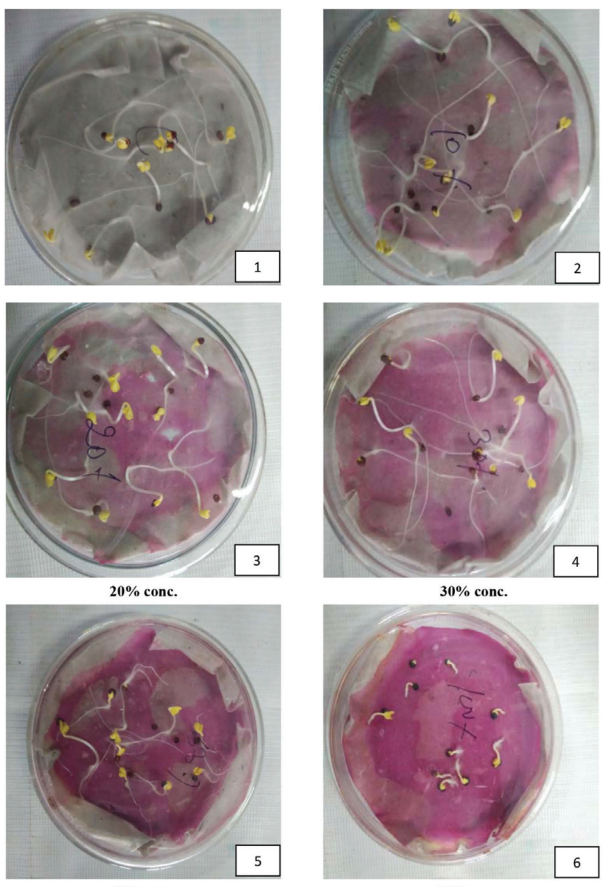

Fig. 1. Effect of different concentrations of textile industry waste water on germination of mustard seeds under laboratory conditions

Effect of textile industry waste water on microbial population in soil under pot house conditions after 90 days of plant growth and its harvest

Post-harvest soil was analyzed to check the effect of different concentration of textile waste water on microbial population. Total microbial count was taken and it was observed that bacterial population was maximum with 100% RDF than 50% RDF and it decreased after waste water application and minimum bacterial count was observed with 100% waste water application always. Bacterial, actinomycetes, diazotrophs and fungal counts were found to be 119 and 150 ×10^6 cfu g^{-1} dry soil, 48 and 52×10^2 cfu g^{-1}dry soil, 50 and 54×10^1 cfu g^{-1} dry soil and 49 and 54×10^4 cfu g^{-1} dry soil respectively in the treatments with Soil + 50% and soil + 100% RDF.

Bacterial count and actinomycetes count varied from 38 to 90×10^6 cfu g^{-1} dry soil and 20 to 33×10^2 cfu g^{-1} dry soil, diazotrophs and fungal ranged from 28 to 46×10^1 cfu g^{-1} dry soil and 25 to 54×10^4 cfu g^{-1} dry soils treated with 100 to 10% textile waste water (set-II). Count of bacteria, actinomycetes, diazotrophs and fungi varied from 25 to 80×10^6 cfu g^{-1} dry soil, 18 to 32×10^2 cfu g^{-1} dry soil, 15 to 40×10^1 cfu g^{-1} dry soil and 27 to 52×10^4 cfu g^{-1} dry soil treated with 100 to 10% textile waste water (set –I). Maximum 95×10^6,

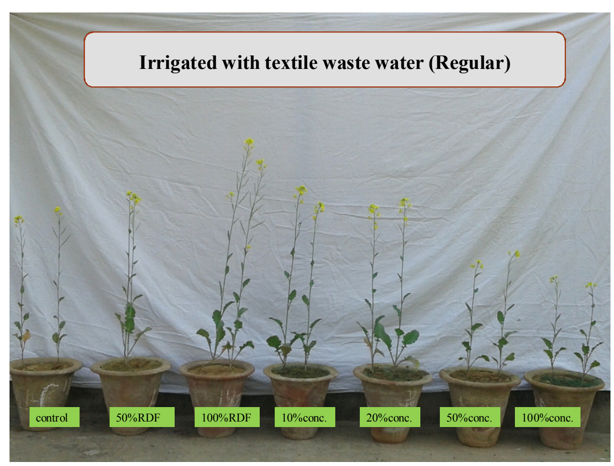

Fig. 2. Plants irrigated with textile waste water (regular) under pot house conditions

36×10^2, 48×10^1 and 55×10^4 cfu g^{-1} dry soil count of bacteria, actinomycetes, diazotrophs and fungi were observed in 20% waste water added after the germination respectively.

Effect of textile industry waste water on seed germination

Under pot house conditions also, lower concentrations (10 and 20%) of waste water were not inhibitory to seed germination and 93 and 86% of seeds were germinated, while germination rate decreased, when pots were irrigated with more than 20% waste water concentration in both regular and after germination of seeds. It has been reported that the germination is directly affected by the presence of higher concentration of effluent. Our findings are in agreement with Parameswari *et al.* 2013 who reported retarded rate of germination and seedling growth in the soil treated with higher concentrations of effluent and higher doses of textile effluent had detrimental effect on seed germination while lower doses remarkably improved seed germination. Anbuselvam *et al.*, 2016 also found less inhibitory effect of textile waste water on green gram (*Vigna radiate* (L) *Wilczez*) seed germination at different concentrations (25, 50 and 100%), and there was a failure in seed germination at higher concentration of effluent.

Effect of different concentrations of textile industry waste water on plant growth

Effect of different levels of textile waste water under pot house conditions have shown that lower concentrations (10 and 20%) of waste water were not inhibitory to plant growth when irrigated with after germination. However, plant growth was affected drastically at higher concentration of waste water when applied after germination, while with more than 20% waste water concentration, growth was suppressed in both after and regular germination throughout the experiment. However, higher concentration (50%) of waste water was not inhibitory when plants were irrigated after germination. Other workers have also reported that there was a positive effect on crop growth and soil productivity when effluent was diluted (Marwari and Khan 2012, Aswasthi *et al.*, 2013). Kathirvel, 2012 reported higher growth of Bengal gram (*Cicer arientinum*) at lower concentration of dye effluent

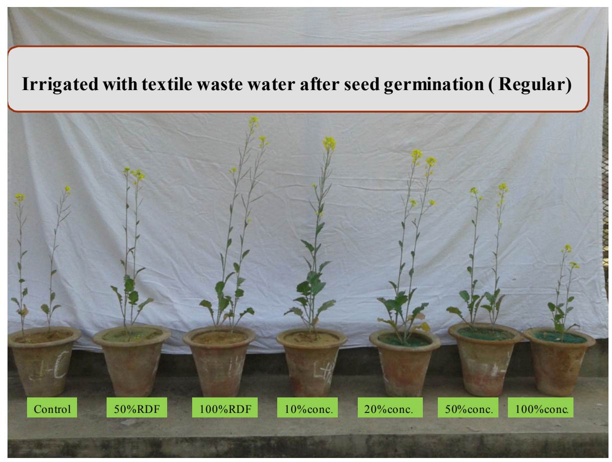

Fig. 3. Plants irrigated with textile waste water after seed germination (regular) under pot house conditions

Table 4. Effect of different concentrations of textile industry waste water on plant growth, dry matter

S. No.		Treatments	Plant height (cm)	Dry weight of shoot (g $plant^{-1}$)	Dry weight of root (g $plant^{-1}$)
1.		Control	52.73	1.392	0.640
2.		50% RDF	59.93	1.949	1.033
3.		100% RDF	65.52	2.984	1.258
	Set-I	**Irrigated with textile waste water always**			
4.		10% waste water+ RDF	57.33	2.060	1.158
5.		20% waste water+ RDF	53.72	1.993	1.044
6.		50% waste water+ RDF	39.56	1.016	0.838
7.		100% waste water+ RDF	28.24	0.773	0.215
	Set-II	**Always irrigated with textile waste water after germination**			
8.		10% waste water+ RDF	64.33	2.288	1.571
9.		20% waste water+ RDF	61.40	2.047	1.397
10.		50% waste water+ RDF	48.5	1.775	0.882
11.		100% waste water+ RDF	31.56	0.947	0.319
		CD at 5% level	5.12	0.146	0.124

Table 5. Effect of different concentrations of textile industry waste water on microbial population in soil under pot house conditions after the harvest of mustard (*Brassica juncea*) crop.

S. No.	Treatments	Bacterial count × 10^6 cfu g^{-1} dry soil	Actinomycetes ×10^2 cfu g^{-1} dry soil	Diazotrophs ×10^1 cfu g^{-1} dry soil	Fungal colony ×10^4 cfu g^{-1} dry soil
1.	Control	78	38	42	50
2.	50% RDF	119	48	50	49
3.	100% RDF	150	52	54	54
Set-I	Irrigated with textile waste water regular				
	10% waste water+ RDF	80	32	40	52
	20% waste water+ RDF	85	34	44	53
	50% waste water+ RDF	48	25	32	38
	100% waste water+ RDF	25	18	15	27
Set-II	Regular irrigated with textile waste water after germination				
	10% waste water+ RDF	90	33	46	54
	20% waste water+ RDF	95	36	48	55
	50% waste water+ RDF	50	27	34	31
	100% waste water+ RDF	38	20	28	25
	CD at 5% level	15	7	6	6

than control, while at higher concentration of dye effluent, seedling growth gradually decreased and concluded that with proper treatment and dilution of dye effluent upto 20% could be safe for irrigation purpose. When seeds irrigated with waste water before germination, plant height were 28.24 to 57.33cm and dry weight of shoot and dry weight of root were 0.773 to 2.060, 0.215 to 1.158g plant^{-1} respectively. However, in case of seed treated after germination with waste water plant height, dry weight of shoot and dry weight of root ranges from 31.56 to 64.33cm, 0.947 to 2.288 and 0.319 to 1.571g plant $^{-1}$ respectively. There was an increase in total soil microorganisms in rhizosphere of plant roots, which was as a result of more nutrients or exudates secreted by the crops.

REFERENCES

Anbuselvam, J., Sridhar, A., Anbuselvam, M. and Periyasamy, S. 2016. Effect of Textile Waste Water Irrigation on Seed Germination, Plant Growth, Biomass, and Crop Yield in Green Gram Seeds (*Vigna radiate(L) Wilczez*) under Plating Technique and Pot Experiment. *Journal of Environmental Science, Toxicology and Food Technology*. 10(5) : 86-89.

Aswathi, K., Rajan, M.R. and David, N.S. 2013. Impact of Dyeing Industry Effluent Residue on Growth, Biochemical Characteristics and Yield of Bhindi *Abelmoschus Esculentus*. *Indian Journal of Applied Research*. 3 : 14-26.

Carr, G., Potter, R.B. and Nortcliff, S. 2011. Water reuse for irrigation in Jordan: Perceptions of water quality among farmers. *Agricultural Waste Management*. 98 (5) : 847-854.

Castro, C.B., Ana, R.L., Ivone, V., Elisabete, F.S., Celia, M.M. and Olga, C.N. 2015. Wastewater reuse in irrigation: A microbiological perspective on implications in soil fertility and human and environmental health. *Environment International*. 75: 117-135.

Dhanam, S. 2009. Effect of dairy effluent on seed germination, seedling growth and biochemical parameters in Paddy. *International Journal of Botany and Research*. 2 : 61-63.

Garg, V.K. and Kaushik, P. 2007. Influence of textile mill wastewater irrigation on the growth of *Sorghum cultivars*. *Applied Ecology and Environmental Research*. 6(2) : 1-12.

Kanan, A.H., Marine, S.S., Raihan, F., Redowan, M. and Miah, M.D. 2014. Textile effluents changes physiochemical parameters of water and soil: Threat for agriculture. *African Journal of Agronomy*. 2(10) : 219-223.

Kapanen, A. and Itawara, M. 2001. Ecotoxicity tests for compost application. *Ecotoxicology and Environmental Safety*. 49 : 1-16.

Kathirvel, P. 2012. The effect of dye factory effluent on growth, yield and biochemical attributes of Bengal gram (*Cicer arientinum* L.). *International Journal of Applied Biology and Pharmaceutical Technology*. 3: 146-150.

Kocak, S., Tokusoglu, O. and Aycan, S. 2005. Some heavy metal and trace essential element detection in canned vegetable foodstuffs by differential pulse polarography (DPP). *Electronic Journal of Environmental, Agriculture and Food Chemistry*. 4: 871-878.

Mahmood, R., Sharif, F., Ali, S. and Hayyat, M.U. 2013.

Bioremediation of textile effluent by indigenous bacteria consortia and its effects on *Zea mays* L. CV C1415. *The Journal of Animal & Plant Sciences*, 23(4) : 1193-1199.

Marwari, R. and Khan, T.I. 2012. Effect of textile waste water on tomato plant *(Lycopersicon esculentum). Journal of Environmental Biology.* 33 : 849-854.

Parameswari, M., Udayasooriyan, C. and Sumathi, M. 2013. Impact of textile and dye effluent irrigation on the cereals like Paddy and Maize crops and its growth parameters. *Journal of Enviromental Sciences and Sustainable.* 2: 61-65.

Saravanamoorthy, M.D. and Ranjitha, B.D. 2007. Effect of textile waste water on morphology and yield on two varieties of peanut (*Arachis hypogaea* L.). *Journal of Agriculture and Technology.* 3(2) : 335-343.

Sharma, S., Singh, A., Mathur, N. and Verma, A. 2014. Studies on the characterization of textile industrial waste water in Jaipur city. *International Journal of Current Chemical Science*. 3(1) : 1-3.

Singh, D., Singh, V. and Agnihotri, A.K. 2013. Study of textile effluent in and around Ludhiana district in Punjab, India. *International Journal of Environmental Sciences.* 3 : 1271-1278.

Thapliyal, A., Vasudevan, P., Dastidar, M.G., Tandon, M. and Mishra, S. 2011. Irrigation with domestic wastewater: Responses on growth and yield of ladyfinger *Abelmoschus esculentus* and on soil nutrients. *Journal of Environmental Biology.* 32 : 645-651.

Yasmin, A., Nawaz, S. and Ali, M.S. 2011. Impact of industrial effluents on germination and seedling growth of *Lens esculentum* varieties. *Pakistan Journal of Botany*. 43(6) : 2759-2763.