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# Effect of textile mill effluent on growth of *Sorghum vulgare* and *Vigna aconitifolia* seedlings

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## Abstract

The wastewater discharges are unavoidable in the process of industrial developments which lead to the pollution of water and soil. The water bodies and soils are becoming major sinks for industrial pollutants. These pollutants affect the ecosystems and agricultural lands. The establishment of industries or any manufacturing unit accelerates the development and helps to increase employment opportunities but unintentionally pollutes the environment, especially through the release of effluent and emissions. Such impact of industrial development is highly complex and many times unintentional. The production of wastewater is a continuous process; in water shortage regions of the Solapur, where water becomes limiting factor, the effluent is being used for irrigational purposes by the farmers in agriculture and agro-forestry practices. The present research work deals with assess the physico-chemical characteristics of industrial effluent and the effect of Industrial effluents on germination of various seeds such as *Sorghum vulgare* (Jowar), *Vigna aconitifolia* (Matki), which grow abundantly in study area and very demanding species for food purposes. The effects were examined in relation to various concentrations (viz. 20,40,60,80 & 100%) of effluent and distilled water as control and various parameters such as seed germination, mean root length of germinated seedlings, plumule germination, mean plumule length of germinated seedlings, disease (fungus) causes in germinated seedlings and other morphological characters.

**Keywords:** Seed germination, textile mill effluent, growth, seedlings.

## Introduction

The wastewater discharges are unavoidable in the process of industrial developments which lead to the pollution of water and soil. The water bodies and soils are becoming major sinks for industrial pollutants. These pollutants affect the ecosystems and agricultural lands. The establishment of industries or any manufacturing unit accelerates the development and helps to increase employment opportunities but unintentionally pollutes the environment, especially through the release of effluent and emissions. Such impact of industrial development is highly complex and many times unintentional. The textile mill effluent discharges from various units contain different types of pollutants like colours, solids, traces of heavy metals etc. These released pollutants lead to the pollution of surface water, groundwater and the soils directly or indirectly. Many on times the wastewater is used for the irrigation purposes. Solapur is one of the major cities in the State of Maharashtra, India. Being one of the important industrial cities, Solapur is a leading center for cotton mills and power-looms. Various textile products like bed-sheets, terry-towels and chaddars etc are exported to different countries in different parts of the world which have earned international fame and reputation due to their novel designs, attractive colours and durability. In solapur region water shortage is more; hence for irrigational purposes farmers are using wastewater in the agricultural practices. The present research work deals with the effect of Industrial effluents on germination of various seeds such as *Sorghum vulgare* (Jowar) and *Vigna aconitifolia* (Matki); which grow abundantly in study area and is very demanding species for food purposes. The effects were examined in relation to various concentrations of effluent and various parameters such as Seed Germination, mean root length of germinated seedlings, plumule germination, mean plumule length of germinated seedlings, disease (fungus) causes in germinated seedlings and other morphological characters.

## Materials and methods

The effluent sample was collected from the textile mill of solapur in polythene bottles and stored in dark place. The sample was analysed for various physico-chemical characteristics as per the standard methods described by APHA (1971). The effluents were stored at 4 °C during storage period to avoid changes in its characteristics. The effluent colour was bluish and had pungent smell. The other properties are described in Table 1. The seeds of *Sorghum vulgare* (Jowar) and *Vigna aconitifolia* (Matki) were collected from the local area. Only healthy and uniformly similar seeds were selected for exposure to different concentrations of textile mill effluent (Viz. 20, 40, 60, 80, and 100%) and distilled water as a control. The experiment was laid out in the petri-plates (covered with filter paper) with 10 seeds (n=3) in each treatment of effluent concentrations and control. The observations of seeds and growth parameters were recorded up to period of 7 d.

## Results and discussion

The characteristics of Textile Mill effluent of the Solapur Industrial Area are shown in the table no 1. On the contrary, the untreated effluent had a negative effect by inhibition of the growth of all the species (Gouider *et al.,* 2010). The pH of the effluent sample was 6.74, i.e. slightly acidic in nature. We can also conclude that no pH neutralization was needed since this factor minimally affects phytotoxicity (Komilis *et al.,* 2005). The electric conductivity (EC) of effluent was 151.6 mS/cm. The EC was higher than the permissible limit. It can also be

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attributed to the relatively high salinity of the effluent. Ramana *et al.* (2002) reported that crop species such as tomato, chilli, bottlegourd, cucumber, and onion showed a decrease in germination percentage with increase in concentration of effluent salinity. The TDS was 97024 mg/l of effluent. The total Alkalinity was 1170 mg/l of the effluent. The DO was 1.2 mg/l of the effluent. Acidity was 355 mg/l of the effluent. Total Hardness (TH) concentration was 542 mg/l of the effluent. The effluent is very hard. The calcium (Ca) content was 132.264 mg/l of the effluent. Magnesium ion (Mg) concentration was 51.66 mg/l of the effluent. The chloride ($Cl_2$) concentration was 1904.22 mg/l of the effluent. The chloride content is very higher than the permissible limit. The sodium (Na) concentration was 1252.56 mg/l of the effluent, which was higher than the permissible limit. The potassium (K) concentration was 162.76 mg/l of the effluent. The sulphate ($SO_4$) concentration was 79.6 mg/l of the effluent. The use of treated wastewater in irrigation experiment, confirmed its beneficial effect on plant growth. This finding corroborated those reported by Seastedt and Suding (2007) who showed that, after fertilization experiment, P additions significantly increased primary productivity for a number of plant species. The various concentration of effluent was studied in order to find out the effect and suitable concentration of effluent water for agricultural seeds. The results of the present study are presented in Table 2 to 11. It is revealed that the effect of different concentrations of textile industrial effluent on germination of seeds was highly significant. The observation shows that effect of effluent has remarkable, which were highly bad affect in comparison to control. Under the environmental stress conditions, the energy forming molecules may be disturbed and subsequently carbohydrate and protein metabolites of the membrane are altered (Kannan and Upreti, 2008). Sufficient water absorption is essential for proper seed germination, without which seedling growth and development is severely affected (Kelly *et al.,* 1992; Debeaujan *et al.,* 2000).

From the Table 2 it is seen that in 20% effluent concentration for the initial three days there was no *Sorghum vulgare* seed germination but on 4$^{th}$ day one seed got germinated and after that on 5$^{th}$, 6$^{th}$ and 7$^{th}$ day 3 seeds seen to be germinated. In 60% effluent concentration for the initial 3 d there was no *Sorghum vulgare* seed germination but from 4$^{th}$ day one seed seen to be germination and same is remained till 7$^{th}$ day (Fig.1). In 40%, 80% and 100% effluent concentration it was observed that not a single *Sorghum vulgare* seed is germinated. From the Table 3 it is seen that in 20%, 60% and 80% effluent concentration the *Vigna aconitifolia* seed germination growth faster than the other concentration and less as compare to the control. In 40% effluent concentration the initial 4 d there was two *Vigna aconitifolia* seed germination and after that on 5$^{th}$ and 6$^{th}$ day 5 seeds and 7$^{th}$ day 6 seeds seen to be germinated (Fig.2). In 100% effluent concentration it was observed that slow growth of *Vigna aconitifolia* seed germination.

From the Table 4 it is seen that in 20% and 60% effluent concentration for the initial three days there was no mean root length of germinated *Sorghum vulgare* seedlings but on 4$^{th}$ day root got germinated and after that on 5$^{th}$, 6$^{th}$ and 7$^{th}$ day it faster in 40% and slower in 60%. In 40%, 80% and 100% effluent concentration it was observed that not a single root is germinated (Figure 3). From the Table 5 it is seen that in 60% and 80% effluent concentration the mean root length of germinated *Vigna aconitifolia* seedlings faster than the other concentration and less as compare to the control. In 20% and 40% effluent concentration for the initial four days the growth of mean root length of germinated *Vigna aconitifolia* seedlings was faster and after that on 5$^{th}$, 6$^{th}$ and 7$^{th}$ day mean root length was constant (Figure 4). In 100% effluent concentration the initial two days growth of mean root length of germinated *Vigna aconitifolia* seedlings was faster and after that on 3$^{rd}$, 4$^{th}$, 5$^{th}$, 6$^{th}$ and 7$^{th}$ day mean root length was constant.

From the Table 6 it is seen that in all 20%, 40%, 60%, 80%, 100% effluent concentration and control for the initial three days there was no *Sorghum vulgare* plumule germination but on 4$^{th}$ day plumule germination started only in control and on 7$^{th}$ day the only one plumule seen to be germinated in 20% effluent concentration (Fig.5). In 40%, 60%, 80% and 100% effluent concentration it was observed that not a single plumule is germinated. From the Table 7 it is seen that in all 20%, 40%, 60%, 80%, 100% effluent concentration and control for the initial two days there was no *Vigna aconitifolia* plumule germination but on 3$^{rd}$ day plumule germination started only in control and 20% effluent concentration. In 40%, 60%, 80% and 100% effluent concentration it was observed that not a single plumule is germinated (Fig. 6). From the Table 8 it is seen that in all 20%, 40%, 60%, 80%, 100% effluent concentration and control for the initial three days there was no mean plumule length of germinated *Sorghum vulgare* seedlings but on 4$^{th}$ day plumule got germinated in only control and on 7$^{th}$ day plumule got germinated in only 20% effluent concentration (Fig.7). It was observed that not a single root is germinated. From the Table 9 it is seen that in all 20%, 40%, 60%, 80%, 100% effluent concentration and control for the initial two days there was no mean plumule length of germinated *Vigna aconitifolia* seedlings but on 3$^{rd}$ day plumule got germinated in only control and 20% effluent concentration. In 40%, 60%, 80% and 100% effluent concentration it was observed that not a single plumule is germinated (Fig. 8).

From the Table 10 it is seen that in all 20%, 40%, 60%, 80% and 100% effluent concentration and control for the initial one day there was no *Sorghum vulgare* seeds infected to the disease (fungus) but on 2$^{nd}$ day infection started in control, 20% and 60% effluent concentration.

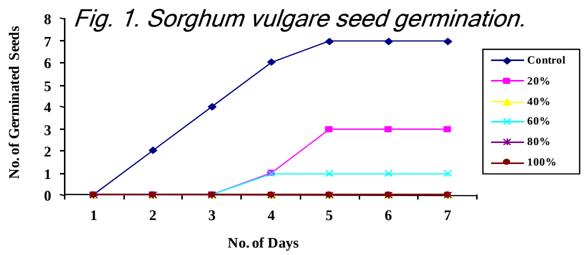

Fig. 1. Sorghum vulgare seed germination.

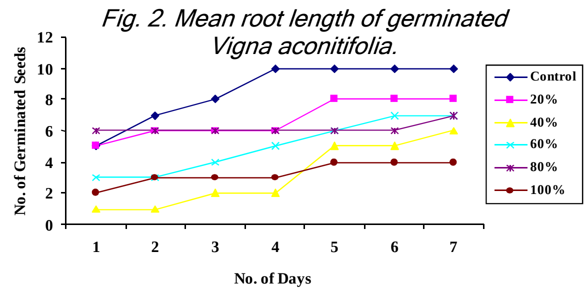

Fig. 2. Mean root length of germinated Vigna aconitifolia.

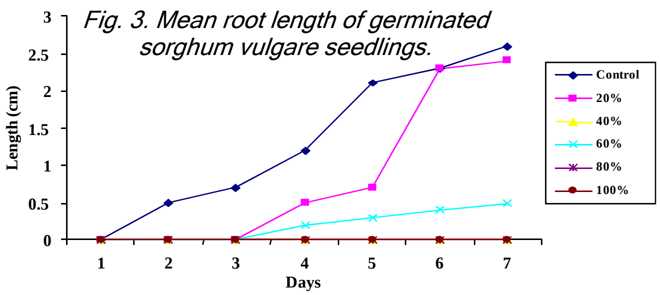

Fig. 3. Mean root length of germinated sorghum vulgare seedlings.

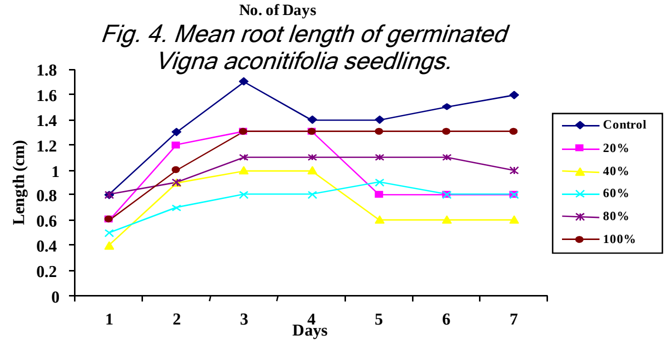

Fig. 4. Mean root length of germinated Vigna aconitifolia seedlings.

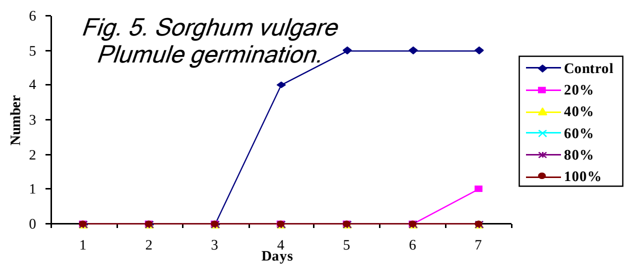

Fig. 5. Sorghum vulgare Plumule germination.

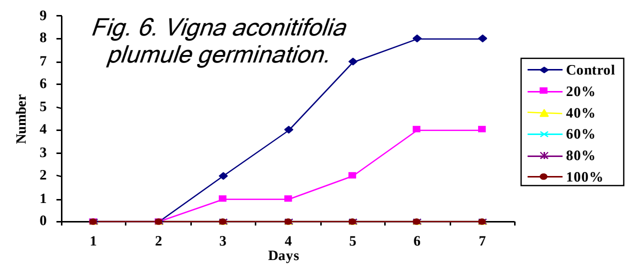

Fig. 6. Vigna aconitifolia plumule germination.

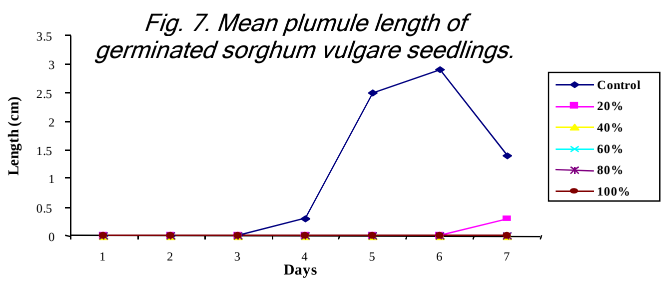

Fig. 7. Mean plumule length of germinated sorghum vulgare seedlings.

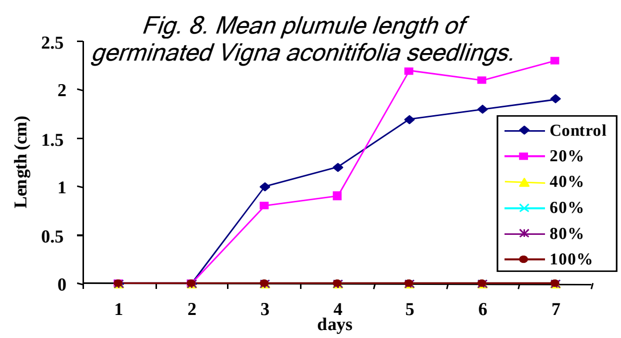

Fig. 8. Mean plumule length of germinated Vigna aconitifolia seedlings.

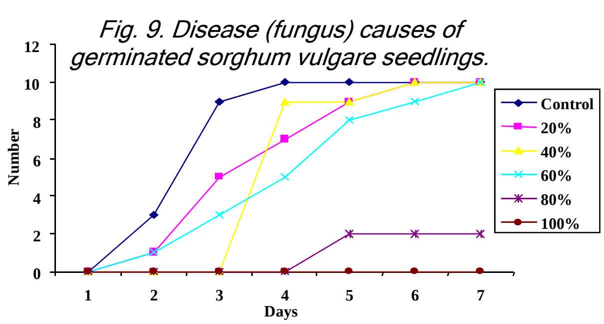

Fig. 9. Disease (fungus) causes of germinated sorghum vulgare seedlings.

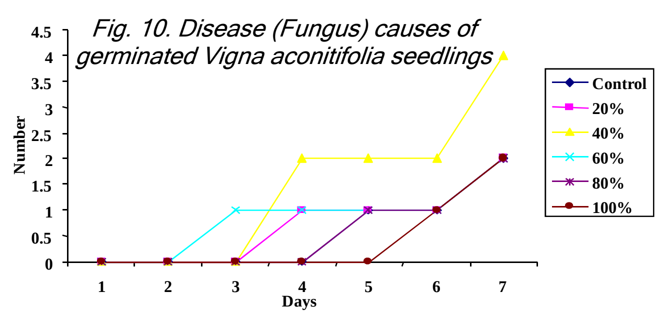

Fig. 10. Disease (Fungus) causes of germinated Vigna aconitifolia seedlings

*Table 1. Characteristics of effluent in the Solapur industrial area.*

| Parameters | | Results |
|---|---|---|
| Colour | | Bluish |
| pH | | 6.74 |
| EC | $mScm^{-1}$ | 151.6 |
| TDS | $MgL^{-1}$ | 97024 |
| Alkalinity | | 1170 |
| Acidity | | 355 |
| DO | | 1.2 |
| Hardness | | 542 |
| Calcium | | 132.26 |
| Magnesium | | 51.66 |
| Chloride | | 1904.22 |
| Sodium | | 1252.56 |
| Potassium | | 162.76 |
| Sulphate | | 79.6 |

*Table 3. Vigna aconitifolia seed germination (n=3).*

| Days | Effluent % in distilled water | | | | | |
|---|---|---|---|---|---|---|
| | Control | 20% | 40% | 60% | 80% | 100% |
| I | 5 | 5 | 1 | 3 | 6 | 2 |
| II | 7 | 6 | 1 | 3 | 6 | 3 |
| III | 8 | 6 | 2 | 4 | 6 | 3 |
| IV | 10 | 6 | 2 | 5 | 6 | 3 |
| V | 10 | 8 | 5 | 6 | 6 | 4 |
| VI | 10 | 8 | 5 | 7 | 6 | 4 |
| VII | 10 | 8 | 6 | 7 | 7 | 4 |

*Table 5. Mean root length of germinated Vigna aconitifolia seedlings.*

| Days | Effluent % in distilled water | | | | | |
|---|---|---|---|---|---|---|
| | Control | 20% | 40% | 60% | 80% | 100% |
| I | 0.8 | 0.6 | 0.4 | 0.5 | 0.8 | 0.6 |
| II | 1.3 | 1.2 | 0.9 | 0.7 | 0.9 | 1 |
| III | 1.7 | 1.3 | 1 | 0.8 | 1.1 | 1.3 |
| IV | 1.4 | 1.3 | 1 | 0.8 | 1.1 | 1.3 |
| V | 1.4 | 0.8 | 0.6 | 0.9 | 1.1 | 1.3 |
| VI | 1.5 | 0.8 | 0.6 | 0.8 | 1.1 | 1.3 |
| VII | 1.6 | 0.8 | 0.6 | 0.8 | 1 | 1.3 |

*Table 7. Vigna aconitifolia plumule germination.*

| Days | Effluent % in distilled water | | | | | |
|---|---|---|---|---|---|---|
| | Control | 20% | 40% | 60% | 80% | 100% |
| I | 0 | 0 | 0 | 0 | 0 | 0 |
| II | 0 | 0 | 0 | 0 | 0 | 0 |
| III | 2 | 1 | 0 | 0 | 0 | 0 |
| IV | 4 | 1 | 0 | 0 | 0 | 0 |
| V | 7 | 2 | 0 | 0 | 0 | 0 |
| VI | 8 | 4 | 0 | 0 | 0 | 0 |
| VII | 8 | 4 | 0 | 0 | 0 | 0 |

*Table 2. Sorghum vulgare seed germination (n=3)*

| Days | Effluent % in distilled water | | | | | |
|---|---|---|---|---|---|---|
| | Control | 20% | 40% | 60% | 80% | 100% |
| I | 0 | 0 | 0 | 0 | 0 | 0 |
| II | 2 | 0 | 0 | 0 | 0 | 0 |
| III | 4 | 0 | 0 | 0 | 0 | 0 |
| IV | 6 | 1 | 0 | 1 | 0 | 0 |
| V | 7 | 3 | 0 | 1 | 0 | 0 |
| VI | 7 | 3 | 0 | 1 | 0 | 0 |
| VII | 7 | 3 | 0 | 1 | 0 | 0 |

*Table 4. Mean root length of germinated sorghum vulgare seedlings.*

| Days | Effluent % in Distilled Water | | | | | |
|---|---|---|---|---|---|---|
| | Control | 20% | 40% | 60% | 80% | 100% |
| I | 0 | 0 | 0 | 0 | 0 | 0 |
| II | 0.5 | 0 | 0 | 0 | 0 | 0 |
| III | 0.7 | 0 | 0 | 0 | 0 | 0 |
| IV | 1.2 | 0.5 | 0 | 0.2 | 0 | 0 |
| V | 2.1 | 0.7 | 0 | 0.3 | 0 | 0 |
| VI | 2.3 | 2.3 | 0 | 0.4 | 0 | 0 |
| VII | 2.6 | 2.4 | 0 | 0.5 | 0 | 0 |

*Table 6. Sorghum vulgare plumule germination.*

| Days | Effluent % in distilled water | | | | | |
|---|---|---|---|---|---|---|
| | Control | 20% | 40% | 60% | 80% | 100% |
| I | 0 | 0 | 0 | 0 | 0 | 0 |
| II | 0 | 0 | 0 | 0 | 0 | 0 |
| III | 0 | 0 | 0 | 0 | 0 | 0 |
| IV | 4 | 0 | 0 | 0 | 0 | 0 |
| V | 5 | 0 | 0 | 0 | 0 | 0 |
| VI | 5 | 0 | 0 | 0 | 0 | 0 |
| VII | 5 | 1 | 0 | 0 | 0 | 0 |

*Table 8. Mean plumule length of germinated sorghum vulgare seedlings.*

| Days | Effluent % in distilled water | | | | | |
|---|---|---|---|---|---|---|
| | Control | 20% | 40% | 60% | 80% | 100% |
| I | 0 | 0 | 0 | 0 | 0 | 0 |
| II | 0 | 0 | 0 | 0 | 0 | 0 |
| III | 0 | 0 | 0 | 0 | 0 | 0 |
| IV | 0.3 | 0 | 0 | 0 | 0 | 0 |
| V | 2.5 | 0 | 0 | 0 | 0 | 0 |
| VI | 2.9 | 0 | 0 | 0 | 0 | 0 |
| VII | 1.4 | 0.3 | 0 | 0 | 0 | 0 |

*Table 9. Mean plumule length of germinated Vigna aconitifolia seedlings.*

| Days | Effluent % in distilled water | | | | | |
|---|---|---|---|---|---|---|
| | Control | 20% | 40% | 60% | 80% | 100% |
| I | 0 | 0 | 0 | 0 | 0 | 0 |
| II | 0 | 0 | 0 | 0 | 0 | 0 |
| III | 1 | 0.8 | 0 | 0 | 0 | 0 |
| IV | 1.2 | 0.9 | 0 | 0 | 0 | 0 |
| V | 1.7 | 2.2 | 0 | 0 | 0 | 0 |
| VI | 1.8 | 2.1 | 0 | 0 | 0 | 0 |
| VII | 1.9 | 2.3 | 0 | 0 | 0 | 0 |

In 40% effluent concentration seeds infected to the disease (Fungus) starts on 4th day and in 80% it starts on 5th day (Fig.9). In 100% effluent concentration no anyone seed was infected. The infection in control was very higher than the other effluent concentration. From the Table 11 it is seen that in all 20%, 40%, 60%, 80%, 100% effluent concentration and control for the initial two day there was no *Vigna aconitifolia* seeds infected to the disease (Fungus) but on 3rd day infection started in 60% effluent concentration, on 4th day infection started in 20% and 40% effluent concentration, on 5th day infection started in control and 80% effluent concentration and on 6th day infection started in 100% effluent concentration (Fig.10). Speedy germination results due to soaking of seeds for large interval (Visser & Tillekeratne, 1958). According to Hetherington and Woodward (2003) differences in environmental conditions may be the cause for variable plasticity in responses within species, especially in relatively short-termed studies.

*Table 10. Disease (fungus) causes of germinated sorghum vulgare seedlings.*

| Days | Effluent % in distilled water | | | | | |
|---|---|---|---|---|---|---|
| | Control | 20% | 40% | 60% | 80% | 100% |
| I | 0 | 0 | 0 | 0 | 0 | 0 |
| II | 3 | 1 | 0 | 1 | 0 | 0 |
| III | 9 | 5 | 0 | 3 | 0 | 0 |
| IV | 10 | 7 | 9 | 5 | 0 | 0 |
| V | 10 | 9 | 9 | 8 | 2 | 0 |
| VI | 10 | 10 | 10 | 9 | 2 | 0 |
| VII | 10 | 10 | 10 | 10 | 2 | 0 |

*Table 11. Disease (fungus) causes of germinated Vigna aconitifolia seedlings.*

| Days | Effluent % in distilled water | | | | | |
|---|---|---|---|---|---|---|
| | Control | 20% | 40% | 60% | 80% | 100% |
| I | 0 | 0 | 0 | 0 | 0 | 0 |
| II | 0 | 0 | 0 | 0 | 0 | 0 |
| III | 0 | 0 | 0 | 1 | 0 | 0 |
| IV | 0 | 1 | 2 | 1 | 0 | 0 |
| V | 1 | 1 | 2 | 1 | 1 | 0 |
| VI | 1 | 1 | 2 | 1 | 1 | 1 |
| VII | 2 | 2 | 4 | 2 | 2 | 2 |

## Conclusion

The physico-chemical characteristics of textile mill effluent sample are analyzed. The pH of the effluent sample was 6.74, i.e. slightly acidic in nature. In this effluent EC, TDS, total hardness, chloride and sodium content was higher than the permissible limit and the calcium, magnesium, potassium and sulphate content was less than the permissible limit. It can also be attributed to the relatively high salinity of the effluent, which is affected to the growth of the plant species. Due to degradation of water quality it became a concern when population growth and industrial development produces a concentration of society's wastes that imperiled public health (Anonymous, 1971). The collected effluent sample contains anion which can be beneficial for plant growth but its excessive level could be toxic retard the growth of the plants. Industrial effluents, which wastewater from manufacturing or chemical processes contribute to water pollution, which significantly affect the entire food chain (Agarwal *et al.,* 1996). Certain physical, chemical and biological properties of water up to an adequate level are good for health but became toxic at excessive level (Nawaz *et al.,* 2006). The textile mill effluent can be successfully utilized as irrigation for the germination and growth of *Sorghum vulgare* and *Vigna aconitifolia* seeds after appropriate dilution.

The findings of present study may be proved useful in agriculture for large scale irrigation of diluted effluent. The results of the present findings showed that sent percent germination and best seedling growth occurred in 20% effluent concentration and therefore a progressive decline is germination percentages, root and plumule length of germination was observed. In 40%, 80% and 100% effluent concentration it was observed that not a single *Sorghum vulgare* seed is germinated. In 100% effluent concentration it was observed that slow growth of *Vigna aconitifolia* seed germination. In 40%, 80% and 100% effluent concentration it was observed that not a single *Sorghum vulgare* root is germinated. In 100% effluent concentration the initial two days growth of mean root length of germinated *Vigna aconitifolia* seedlings was faster and after that on 3rd, 4th, 5th, 6th and 7th day mean root length was constant. In 40%, 60%, 80% and 100% effluent concentration it was observed that not a single *Sorghum vulgare* plumule and *Vigna aconitifolia* plumule is germinated. In 100% effluent concentration no anyone *Sorghum vulgare* seed was infected. The infection in control was very higher than the other effluent concentration of *Sorghum vulgare* seeds. The disease (fungus) infection in *Sorghum vulgare* seeds is higher than the *Vigna aconitifolia* seeds.

The textile mill effluent used for irrigation for the germination of seeds with increase in effluent concentration (20-100%) the germination value was adversely affected. Consequently, it was proved that although pure textile mill effluent could not be used for the germination of *Sorghum vulgare* and *Vigna aconitifolia* seeds but the little dilution (20%) of effluent concentration may be used. The better growth of all the seeds at 20% effluent concentration may be due to the growth promoting effect of nitrogen and other mineral elements present in the effluent (Sahai *et al.,* 1979; Sahai *et al.,* 1983). Vegetables when treated continuously with textile factory effluent showed that different effluents exceed their recommended level that results in potential health risks (Itanna, 1998). The benefits of wastewater use in irrigation are numerous but precautions should be taken to avoid short and long-term environmental risks.

## References

1. Abu Shakra S and Aqil BA (1970) Observation of germination of tea seed as influenced by soaking, shell removal and shell cracking. *Infl. Seed Test Assoc.* 35, 631.
2. Agarwal SK, Swarnlata T and Dubey PS (1996) Sources of water pollution in: Biodiversity and Environment. *APH. Publishing Corporation*, New Delhi. pp:180-182.

3. Anonymous (1971) International Standards for Drinking Water. 3rd Edn. WHO, Geneva.
4. Daniele Quaratino, Alessandro D'Annibale, Federico Federici, Carlo Fausto Cereti, Francesco Rossini and Massimiliano Fenice (2007) Enzyme and fungal treatments and a combination thereof reduce olive mill wastewater phytotoxicity on *Zea mays* L. seeds. *Chemosphere.* 66(9), 1627-1633.
5. Debeaujan I, Karen M and Koorneef LM (2000) Influence of the testa on seed dormancy, germination and longivity in Arabidopsis. *Plant Physiol*. 122, 403-413.
6. Dunlop SG, Twedt RM & Wang W (1961) Studies on the use of sewage effluent for the irrigation of truck crop. *J. Milk & Food Technol.* 24, 44-50.
7. Fazal Akbar, Fazal Hadi, Zakir Ullah and Muhammad Amir Zia (2007) Effect of Marble Industry Effluent on Seed Germination, Post Germinative Growth and Productivity of *Zea mays* L. *Pakistan J. Biol. Sci.* 10(22), 4148-4151.
8. Garg VK and Kaushik P (2008) Influence of Textile Mill Wastewater Irrigation on the Growth of Sorghum Cultivars. *Appl.Ecol. Environ. Res.* 6(2), 1-12.
9. Hetherington AM and Woodward IF (2003) The role of stomata in sensing and driving environmental change. *Nature.* 424, 901-908.
10. Itanna F (1998) Metal concentration of some vegetables irrigated with industrial liquid waste at Akaki, Ethiopia. *Sinet. Ethiopian Sci. J.* 21, 133-144.
11. Kannan A and Upreti Raj K (2008) Influence of distillery effluent on germination and growth of mung bean (*Vigna radiata*) seeds. *J. Hazardous Materials*. 153(1-2), 609-615.
12. Kelly KM, J Van Staden and Bell WE (1992) Seed coat structure and dormancy. *Plant Growth Reg.* 11, 201-209.
13. Komilis DP, Karatzas E and Halvadakis CP (2005) The effect of olive mill wastewater on seed germination after various pretreatment techniques. *J. Environ. Manage.* 74, 339-348.
14. Mbarka Gouider, Mongi Feki and Sami Sayadi (2010) Bioassay and use in irrigation of untreated and treated wastewaters from phosphate fertilizer industry. *Ecotoxicology and Environmental Safety*. Article in press. Corrected proof. Domain site: http://www.sciencedirect.com.scopeesprx.elsevier.com.
15. Mohammad Ajmal and Ahsan Ullah Khan (1983) Effects of Sugar Factory Ettluent on Soil and Crop Plants. *Environ. Pollution (Series A).* 30, 135-141.
16. Ogunwenmo KO, Oyelana OA, Ibidunmoye O, Anyasor G and Ogunnowo AA (2010) Effects of Brewery, Textile and Paint Effluent on Seed Germination of Leafy Vegetables-Amaranthus hybrids and Celosia argentea (Amaranthaceae). *J. Biol. Sci.* 10(2), 151-156.
17. Priya Kaushik, Garg VK and Bhupinder Singh (2005) Effect of textile effluents on growth performance of wheat cultivars. *Bioresource Technol*. 96(10), 1189-1193.
18. Ramana S, Biswas AK, Kundu S, Saha JK and Yadava RBR (2002) Effect of distillery effluent on seed germination in some vegetable crops. *Bioresource Technol* 82, 273-275.
19. Rodger JBB, Williams GG and Davis A (1957) A rapid method for determining winter hardness of alfalfa. *Agro. J.* 49, 88-92.
20. Sahai R, Agrawal N and Khosla N (1979) Effect of fertilizer factory effluent on seed germination, seedling growth and chlorophyll content of *Phaseolus radiatus* Linn. *Tropical Ecol.* 22, 156-162.
21. Sahai R, Shukla N, Jabeen S and Saxena PK (1983) Pollution effect of distillery waste on the growth behaviour of *Phaseolus radiatus* L. *Environ. Pollution (Series A).* 37, 245-253.
22. Seastedt GP and Suding KN (2007) Biotic constraints on the invasion of diffuse knapweed (*Centaurea diffusa*) in a Colorado grassland. *Oecologia.* 151, 626-636.
23. Sofia Nawaz, Syeda Maria Ali and Arza Yasmin (2006) Effect of Industrial Effluents on Seed Germination and early Growth of *Cicer arientum*. *J. Biol. Sci.* 6(1), 49-54.
24. Thabaraj GJ, Bose SM and Nayudamma Y (1964) Utilisation of tannery effluent for agricultural purposes. *Ind. J. Environ. Hlth.,* 6, 18-36.
25. Umebese CE and Onasanya OM (2007) Effect of Minta Effluent on the Phenology, Growth and Tield of *Vigna unguiculata* (L) Walp Var. Ife Brown. *J. Biol. Sci.* 10(1), 160-162.
26. Ungar IA (1987) Halophyte seed germination. *Botanical Rev.* 44, 233-264.
27. Vahram Elagoz, Susan S Han and William J Manning (2006) Acquired changes in stomatal characteristics in response to ozone during plant growth and leaf development of bush beans (*Phaseolus vulgaris* L.) indicate phenotypic plasticity. *Environmental Pollution*. 140(3), 395-405.
28. Visser T and Tillekeratne LM (1958) Tea quality. *J. Sci. Ind. Res*. 29, 30.
29. Zahoor Ahmad Bazai and Abdul Kabir Khan Achakzai (2006) Effect of Wastewater from Quetta City on the Germination and Seedling Growth of Lettuce (*Lactuca sativa* L.). *J. Appl. Sci.* 6(2), 380-382.