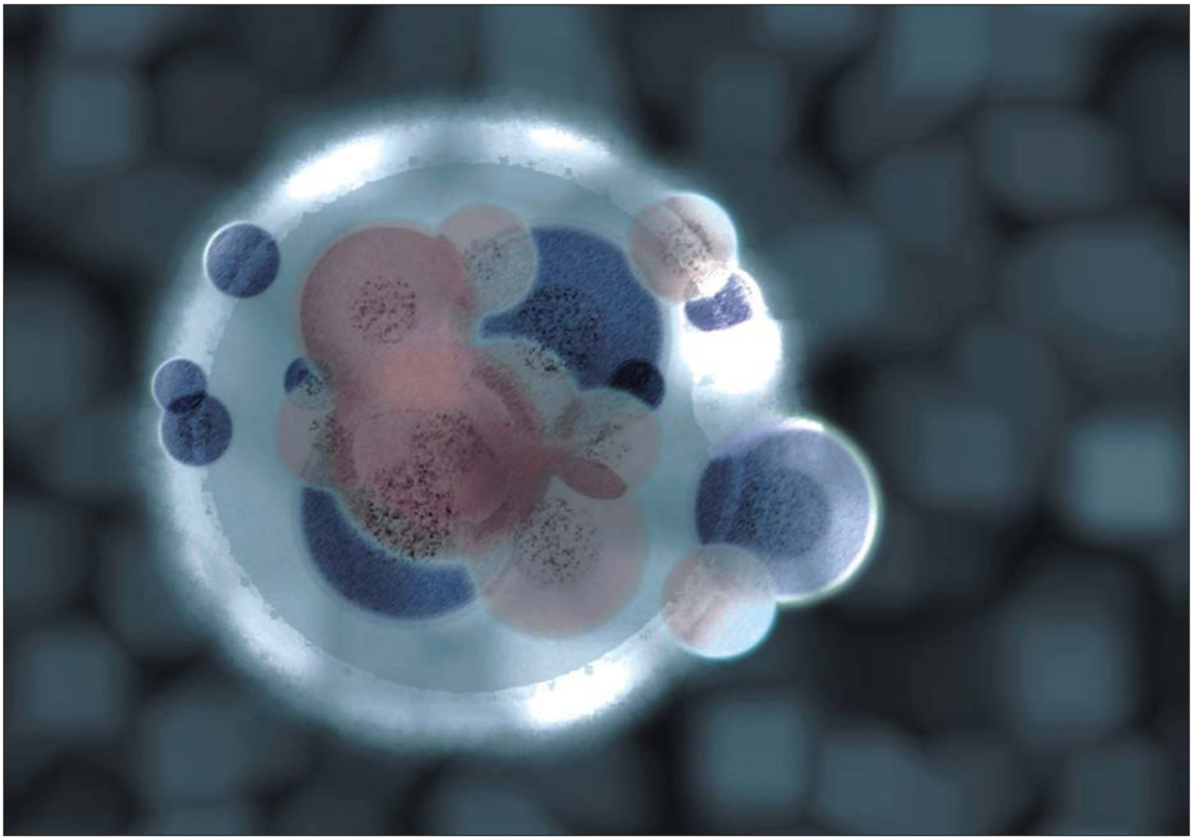

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Effect of Industrial Effluents on Seed Germination and Early Growth of *Cicer arientum*

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Abstract: The aim of this study was to determine the effects of different effluents on seed germination and early growth of plants. Water samples were collected from three different industries of Rawalpindi, which were Koh-e-Noor textile mill (KNM), Marble Industry (MI) and Attock Refinery Limited (ARL). Two different varieties of *Cicer arientum* (P-91 and P-2000) were selected to grow in these effluents. Physicochemical parameters (pH, temperature, Dissolved Oxygen (DO), conductivity, turbidity, Total Dissolved Solids (TDS), Total Suspended Solids (TSS) etc.) of these samples were analyzed. Both varieties were grown in different dilutions of effluents. With t he increase in effluent concentration, growth of plants was found more affected in Koh-e-Noor mill effluent while, less effect was seen in Marble and ARL effluents. Increase in root and shoot lengths were observed in these effluents at different concentrations. Fresh weight was less in Koh-e-Noor mill effluent as compared to control while in other two effluents both increases and decreases in dry weight were observed. Dry weights of plants were greater in most of the treatments. Variety P-91 was more tolerant as compared to P-2000.

Key words: Industrial effluents, *Cicer arientum*, seed germination, early growth

INTRODUCTION

Environmental pollution is a matter of great concern and has been accepted as a global problem because of its adverse effects on human health, plants, animals and exposed materials[1]. Land pollution occurs from different degradable and non-degradable materials. These materials may be solid waste, trash, chemicals and leaf litter etc.[2]. Pollutants may be toxic organic and inorganic or dissolved and suspended solids[3]. Water pollution is a result of addition of large amount of toxic materials[4]. The major causes of water pollution can be classified as municipal, agricultural and industrial wastes. Industrial waste water usually contains specific and readily identifiable chemical compounds[5] .

The effluents generated by various processes in factories are directly discharged without any end pipe treatment into the nearby water body. This results in decrease of water pH, and an increase of temperature, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), turbidity, heavy metals and toxic chemicals[6]. Effluents released by textile industries into the river body without adequate treatment can cause irreversible changes. The effluents released with high temperature can raise the temperature of the water body thus reducing the solubility of oxygen in the water. It also increases the pH value of the receiving body. The colloidal particle in the wastewater will increase the turbidity along with dyes[7].

A petroleum refinery is a liquid consisting principally of hydrocarbons, but may contain sulphur, oxygen, nitrogen compounds and metals. It is a mixture of hundreds of hydrocarbons with a wide range of boiling points[8].

Cement forms one of the important inputs in the development activities of a country. Cement industry contributes to air pollution in the form of particulate matter[9]. Extraction of mineral resources is an essential element for industrial path. Mining operations can result in the release of gases and particulates to the atmosphere.

During mining operations fall of dust, seepage from the dumping area, run off through pit and coal stockpile contaminates water. Huge amount of the unwanted materials, make the ground unsuitable for any use including vegetation[10].

Purpose of this research was to determine the effect of different factory effluents on seed germination and early growth, for which waste water samples from three different factories were collected. Early growth and germination of chickpea (*Cicer arientum*) seeds were studied under the influence of effluents.

MATERIALS AND METHODS

Sampling for industrial effluents was done from the outlets of three different industries of Rawalpindi city. They were placed in cold place throughout the work.

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Samples were preserved for nitrates by adding 2 mL concentrated H_2SO_4 L^{-1} and it was stored at 4°C.

Effluents taken from different industries were subjected to different tests for analysis. Standard methods[11] were used to determine pH, conductivity, turbidity, total dissolved solids, hardness, total alkalinity, phosphates, sulphates and nitrates.

Two different varieties of *Cicer arientum*, P-91 and P-2000 were selected. Seeds were sterilized with 0.1% $HgCl_2$ solution. After $HgCl_2$ treatment, seeds were washed thrice to remove all the traces of mercury. Then seeds were soaked for 2-3 h in distilled water. Different concentrations of effluents were prepared along with control (0% effluent). Ten seeds for each varieties were placed in pre-labelled petridishes (lined with filter paper). Then 5 mL of each treatment (effluent concentration) were added in respective petridishes, which were then kept in dark for two days for germination. After two days petridishes were shifted to light (10-Klux) with a photoperiod of 14 h d^{-1}.

Nutrient solution was made[12] and effluent concentrations were prepared with nutrient solution. On third day of germination 15 mL of nutrient solution was given and seedlings were harvested after ten days of growth.

Parameters considered to study the effects of effluents were percentage germination, root length (cm), shoot length (cm), seedling length (cm), fresh weight per seedling (g), dry weight per seedling (by keeping plants at 80°C for overnight (mg)) and dry matter accumulation (mg g^{-1}). Data was subjected to statistical analyses[13].

RESULTS

Analyses of different parameters (Table 1) in different effluents indicated that color of Koh-e-Noor mill effluent was light green while other two were colorless. pH of marble effluent was maximum i.e., 7.96. Maximum hardness and alkalinity was found in marble effluent, which was 1666 and 9000 ppm, respectively. In the same way sulphates were more in Koh-e-Noor mill and minimum in ARL effluent. No ammonia was found in Koh-e-Noor mill and ARL effluents but it was present in marble industry. Phosphate contents were zero in all effluents.

Percentage germination of variety P-91 in Koh-e-Noor mill effluent showed 100% germination in all concentrations except in 80% effluent, where germination decreased to 93.75%. Marble industry effluent showed 100% germination in all concentrations except at 10% concentration where germination was 93.75%. Minimum germination was found in ARL effluent at 80% level, which was 87.5% (Fig. 1a). Variety P-2000 showed germination in Koh-e-Noor mill effluent at 20 and 80% but in all other concentrations it decreased to 93.75%. In marble effluents, this variety showed germination in only 20% effluent and in all others decreased significantly. In ARL effluent, it showed 100% germination except at 10 and 80% where germination was 93.75% (Fig. 1b).

Table 1: Analyses of effluents taken from different industries

Parameters	Effluent from Koh-e-Noor Mill	Marble Industry	Attock Refinery Limited
pH	6.80	7.96	7.06
Temperature (°C)	26.1	25.5	26.4
DO (ppm)	5.23	6.46	1.50
Conductivity (μS^{-1} cm)	16	7	4
Turbidity (NTU)	61	59.6	5.86
TDS (ppm)	9.35	4.4	289
TSS (ppm)	11.76	56.27	0.09
Total hardness (ppm)	300	1666	150
Total alkalinity (ppm)	400	9000	200
Phosphates (ppm)	Nil	Nil	Nil
Sulphates (ppm)	40	12	8
Nitrates (ppm)	42.8	3.76	45
Ammonia (ppm)	Nil	150.27	Nil

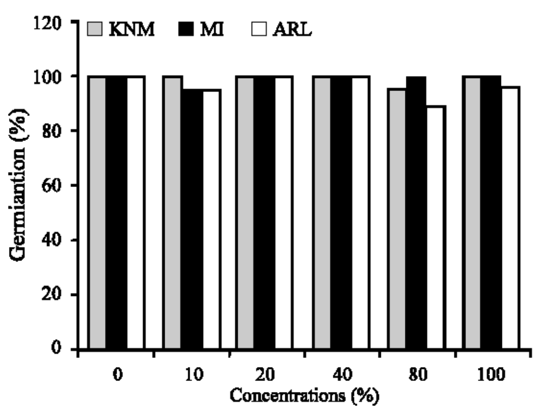

Fig. 1a: Effects of effluents on percentage germination (Variety P-91)

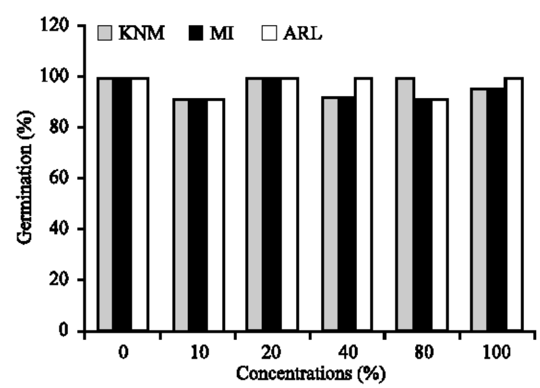

Fig. 1b: Effects of effluents on percentage germination (Variety P-2000)

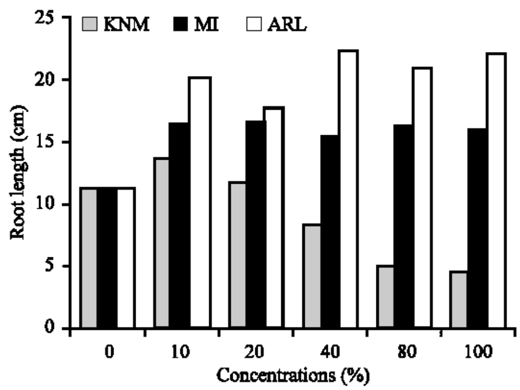

Fig. 2a: Effects of effluents on root length (cm) in Variety P-91

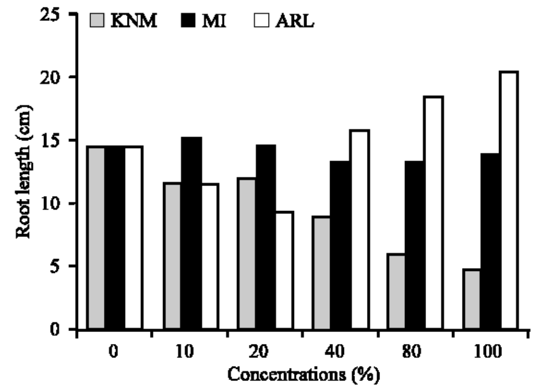

Fig. 2b: Effects of effluents on root length (cm) in Variety P-2000

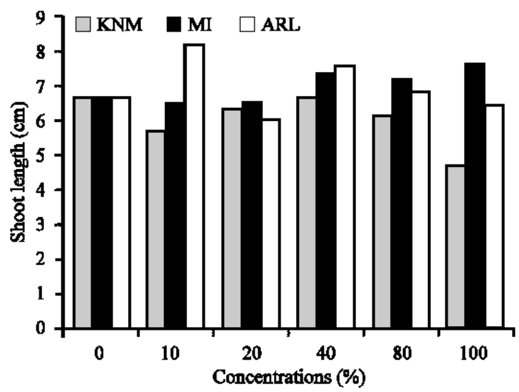

Fig. 3a: Effects of effluents on shoot length (cm) in variety P-91

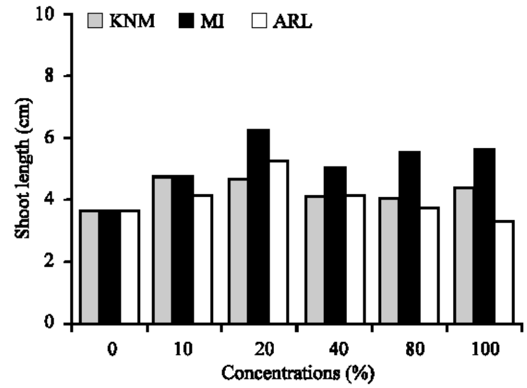

Fig. 3b: Effects of effluents on shoot length (cm) in variety P-2000

Decrease in root length was found with the increase of concentration in Koh-e-Noor mill effluent. Increase in root length was recorded at 10% effluent, which decreased to 62.32% at 100% effluent in variety P-91. In marble effluent, increase in root length was recorded in all concentrations of effluents. Maximum increase was at 20% while minimum increase was found at 40%. ARL effluents showed significant increase in all treatments as compared to control (Fig. 2a). Variety P-2000 showed minimum growth of root at 100% effluent in Koh-e-Noor textile mill. Minimum decrease was 18.34% at 20% effluent. Marble industry effluents showed decrease (though non-significant) in root length in most of the treatments except at 10% where it showed a little growth. In ARL effluents it showed maximum increase (42.49%) at 100% and minimum decrease (38.66%) at 20% effluent concentration (Fig. 2b).

Variety P-91 in Koh-e-Noor mill effluent showed decrease in shoot length in all treatments as compared to control. Marble effluents indicated increases at 40, 80 and 100% but in 10 and 20% treatment, reduction in shoot lengths was found. This variety showed increase in shoot length in almost all of the cases in ARL effluent (Fig. 3a). Increase in shoot length of variety P-2000 was found in all treatments of Koh-e-Noor mill. Minimum increase in shoot length (4.48%) was observed at 100 percent effluent. Better results were shown in all concentrations of marble industry. Maximum increase of shoot length was observed at 20% effluent. In ARL effluents minimum increase in shoot length was found in all treatments except 100% where decrease in shoot length was observed (Fig. 3b).

Seedling length of variety P-91 in Koh-e-Noor mill effluent decreased with increase in concentration of the effluent. Increases in seedling length were recorded at 10 and 20% treatments but it reached to its minimum reduction in the presence of 100% effluent, which was 50.48%. In marble industry effluent increase in seedling length was recorded in all treatments as compared to control. It was dominant in ARL effluent as compared to control. Maximum increase in seedling length at 40% and minimum increase at 20% effluent was found (Fig. 4a). Variety P-2000 also showed decrease in seedling length 40% effluent concentration. In ARL effluent, it showed decrease in seedling length initially but started to increase from 40% effluent (Fig. 4b).

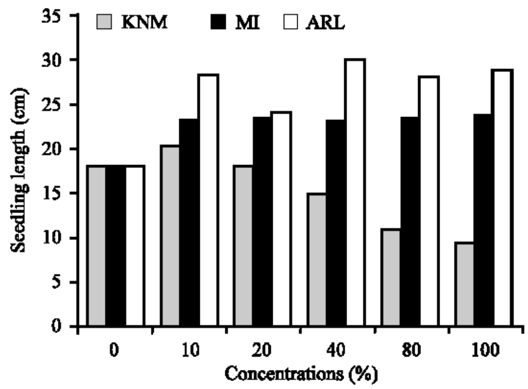

Fig. 4a: Effects of effluents on seedling length (cm) in variety P-91

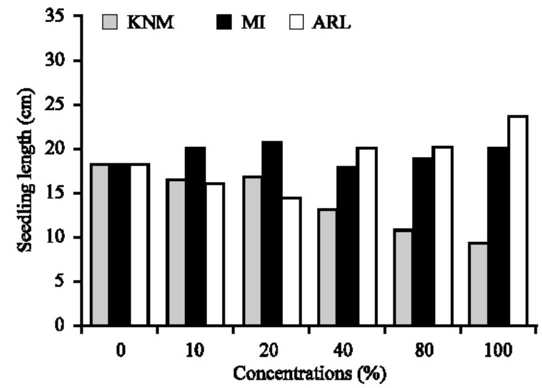

Fig. 4b: Effects of effluents on seedling length (cm) in variety P-2000

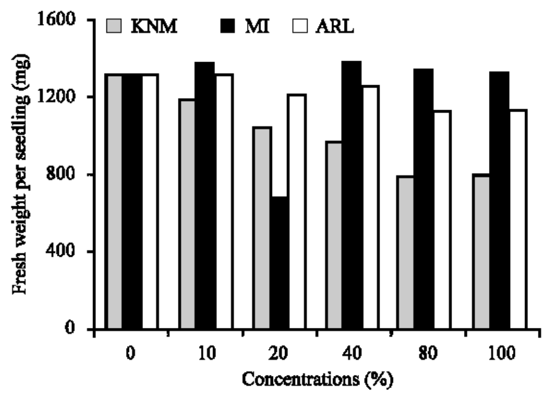

Fig. 5a: Effects of effluents on fresh weight per seeding (mg) in variety P-91

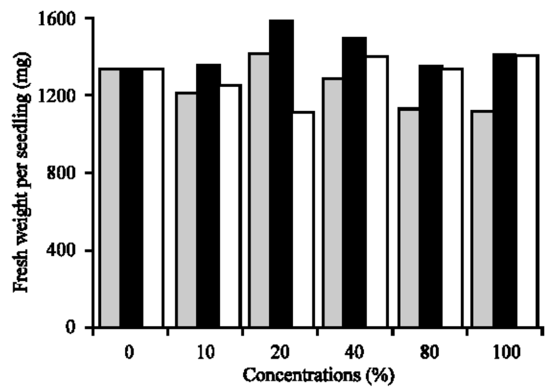

Fig. 5b: Effects of effluents on fresh weight per seeding (mg) in variety P-2000

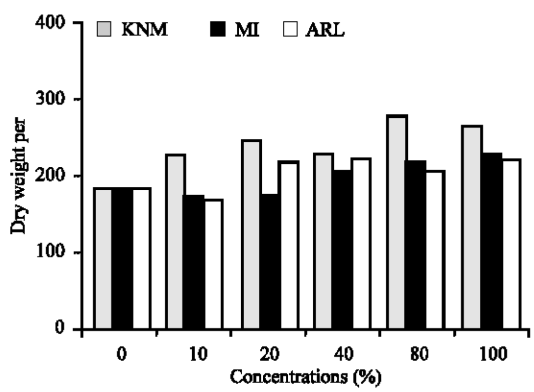

Fig. 6a: Effects of effluents on dry weight per seeding (mg) in variety P-91

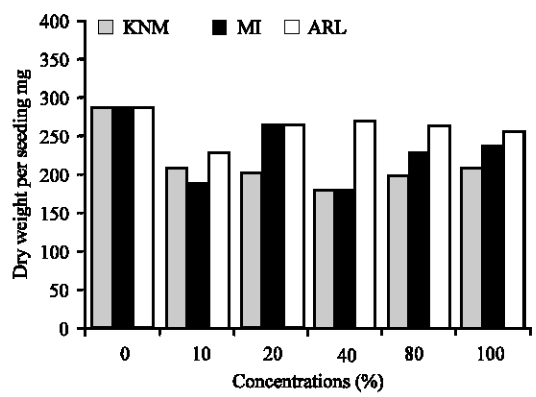

Fig. 6b: Effects of effluents on dry weight per seeding (mg) in variety P-2000

Variety P-91 showed minimum decrease in fresh weight at 10% effluent and maximum decrease of 40% at 100% concentration of Koh-e-Noor mill effluents. Increases were found in marble effluents except at 20% where reduction was noted. In ARL effluent it showed both increases and decreases in fresh weight (Fig. 5a).

Variety P-2000 showed decrease in fresh weight in all treatments except at 20% effluent where increase (6.15%) in fresh weight were recorded. In marble effluents it showed increases in all concentrations of effluents. Maximum increase was recorded at 20% effluent (Fig. 5b).

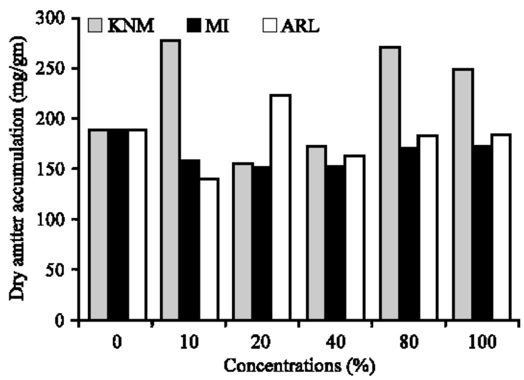

Fig. 7a: Effects of effluents on dry matter accumulation (mg/gm) in variety P-91

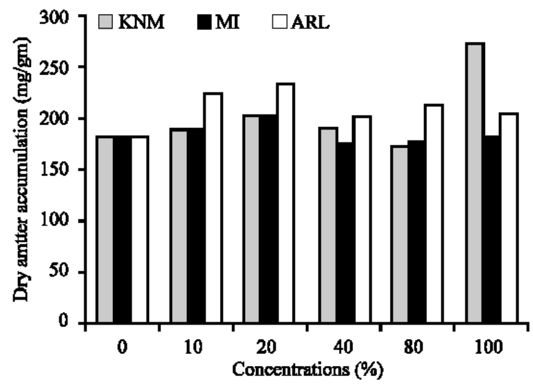

Fig. 7b: Effects of effluents on dry matter accumulation (mg/gm) in variety P-2000

Variety P-91 showed increase in dry weight in Koh-e-Noor mill effluent. Maximum increase (52.27%) was recorded in 80% effluent application. In marble industry dry weight increased with an increase in concentration except at 10 and 20% concentration where it reduce a little. Better growth of this variety was seen in ARL effluent except at 10% effluent where 8.88% reduction in dry weight was recorded (Fig. 6a). Variety P-2000 showed reduction in dry weight in all treatments of Koh-e-Noor mill, marble and ARL effluent, though the pattern was not regular (Fig. 6b).

Both increases and decreases were found in variety P-91 in Koh-e-Noor mill effluent. At 20 and 40% concentrations, decrease in dry matter accumulation was found while in remaining treatments enhancement in dry matter accumulation was recorded. Growth of this variety was found suppressed in all treatments of marble industry. Maximum decrease at 20% effluent was observed whereas, ARL effluent showed increase only at 20% effluent (Fig. 7a). Variety P-2000 showed increase in dry matter accumulation except at 80% effluent of Koh-e-Noor mill. In marble factory effluent it showed decrease in most of the treatments but at both extremes 10% (3.2%) and 100% (0.7%) showed increases in dry matter accumulation. In ARL effluent it showed both increases and decreases in different concentrations (Fig. 7b).

DISCUSSION

Due to degradation in water quality it became a concern when population growth and industrial development produces a concentration of society's wastes that imperiled public health[14]. Wastewater of different industries contain 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[15]. Certain physical, chemical and biological properties of water up to an adequate level are good for health but became toxic at excessive level. Keeping in view the toxic effects of wastewater, three different water samples were collected from different industries i.e. Koh-e-Noor textile mill, Marble Industry and Attock Refinery Limited. Two different varieties of *Cicer arientum* were selected and grown in these water samples.

In precise study, both varieties showed reduced root length as compared to control in textile mill effluent. Vegetables when treated continuously with textile factory effluent showed that different effluents exceed their recommended level that results in potential health risks[16]. In Marble and ARL effluents both varieties showed increases and decreases in root lengths. Highest ammonia concentration was observed in Marble effluents, which might have played a role in the enhancement of plant growth. Rao and Kumar[17] observed a decline in root length in *Cicer arientum* due to tannery effluents. Chromium, a principal constituent of tanneries is known to inhibit soil microorganisms such as nitrifying bacteria[18] that in turn affect the root length of plants. Increase in root length was noticed in both varieties.

In recent study difference in shoot length was negligible in all effluents but plants grown in textile effluent showed reduction in shoot length with the increase of concentration as compared to control. Plant varieties showed better growth of shoots in marble and ARL effluents. Ramamoorthy *et al.*[19] reported good shoot length at 48 h in sewage sludge application. In present case interaction of varieties with different effluents and their concentrations were found significant. In a previous study Ordinance factory effluents were found to be deleterious for early growth performance and germination in Pea seeds, as the concentration of effluents increased[20]. There is a need to combat the pollution of our environment and release of toxic substances, which is evident in the form of waste water effluents which are being thrown out relentlessly into the environment causing ecodisasters of varying types and magnitude[21].

Plants were soaked in distilled water prior shifting to petridishes for good germination. Maximum germination in sugar beet was also recorded when the seeds were washed in running water for 24 h or soaked in water for 12 h[22]. Speedy germination results due to soaking of seeds for large interval[23].

Variety P-91 of *Cicer areintum* in all Marble and ARL effluents showed increase in dry weight in all treatments as compared to control but variety P-2000 showed decrease in all treatments of all effluents. A reduction in dry weight was reported with the increase in sewage sludge treatments[24].

Both increases and decreases were found in dry matter accumulation of each variety. Dry matter accumulation in variety P-91 decreased in marble industry effluent.

It was concluded from the present study that growth of plants in Koh-e-Noor mill effluent was very much affected as compared to other two industries when compared with control. Good growth was observed in ARL and Marble effluents. Growth of variety P-91 was less affected as compared to P-2000. Anyhow further studies will reveal the actual tolerance status of these varieties under effluent stress.

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