SEED GERMINATION AND GROWTH OF SOME CULTIVATED AND WILD PLANTS UNDER WASTE WATER FROM LYARI AND MALIR RIVERS

M. SAEED AKHTAR[1], MOINUDDIN AHMED[2], QAMARULHAQ[1], ARIF ZUBAIR[3] AND AFZAL FAROOQ[3]

[1]Department of Chemistry,
[2]Laboratory of Dendrochronology and Plant Ecology, Department of Botany,
[3]Department of Environmental Science,
Federal Urdu University of Arts Science & Technology, Gulshan-e-Iqbal Campus, Karachi, Pakistan
[*]Corresponding author e-mail: saeed1akhtar1@hotmail.com

Abstract

Presently, aquatic pollution is a worldwide problem especially in thickly populated areas. Karachi is the most developed city of Pakistan where a big part of its crop is cultivated by two main rivers; Malir River and Lyari River. This study was conducted to examine the effect of the polluted water of the two rivers on growth of different plant species. Healthy seeds of nine plant species including, *Zea mays* L., *(maize), Helianthus annuus* L., *(sunflower), Abutilon indicum* (L.) Sweet.,*(abutilon), Phaseolus lunatus* L., *(lobia), Lens esculenta* Moench *(masoor), Capsicum annuum* L., *(chili), Spinacia oleracea* L.,*(spinach), Leucaena leucocephala* (Lam.) de wit, (*lucaena)* and *Thespesia populnea* (L.), Soland. ex Correa (thespesia) were collected and planted in pots. Seeds were treated with seven different treatments including control. The results showed that Malir River waste water was highly lethal for all plants due to the presence of toxic pollutants. Therefore no growth was recorded in any test specimen while Lyari river waste water was less toxic to the plants.

The controls (fresh water) of spinach showed maximum percentage germination (100%) in soil. Maximum speed of germination was 55.98, recorded in thespesia in treatment of Lyari mix .The maximum moisture content was 81.54% in case of spinach when treated by Lyari industrial. Organic content was maximum in the case of thespesia treated with Lyari mix and it was 96.6% and maximum minerals contents were found in spinach and chilies and the values were around 35%.

In view of the nature of pollution in the rivers the inhabitants of Karachi are likely to get affected due to the mixing of this water with drinking water and consumption in food chain. The response of plants to the use of polluted water in particular Malir River makes it necessary to conduct further study on hazardous elements present in the water.

Introduction

Water pollution is the degradation of water quality that renders the water unusable for its intended purposes. The sources are point source like industries and sewerage, nonpoint sources are organic chemicals applied to crops which may enter soil and pollute the water. Water with high concentration of nutrients such as phosphorus and nitrogen may damage the ecosystem by lowering the oxygen level and the retard the growth. With the increase in the population and industries water pollution due to municipal and industrial discharges have become a major concern. Untreated waste water not only affects marine life but also causes serious concerns of health hazards.

Industrial waste containing toxic heavy metals are real problems to the environment, since they do not degrade like organic matter and persist in the ecosystem having accumulated at different trophic levels of the food chain (Smejkalova *et al*., 2003; lgew *et al*., 2005). During industrial activities, huge quantity of solids, semi-solid and liquid wastes are generated that may contain substantial amount of toxic organic and inorganic pollutants (Uzair *et al*., 2009) and when dumped in the environment without treatment lead to serious environmental consequences. This also deteriorates soil productivity and adversely effect crop production (Islam *et al*., 2006). The polluted water directly affects soil, not only in the industrial areas but also in agriculture fields and river beds, creating secondary source of pollution (Kisku *et al*., 2000; Barman *et al*., 2000).

Heavy metal accumulation in soils is of concern in agricultural production due to adverse effects on food quality (safety and marketability), crop growth (Fergusson, 1990) and environmental health. The mobilization of heavy metals into the biosphere by human activity has become an important process in the geochemical cycling of these metals. This is acutely evident in urban areas where various stationary and mobile sources release large quantities of heavy metals into the atmosphere, soil and waste water exceeding the natural emission rates (Nriagu, 1989; Bilos *et al*., 2001). Heavy metal bioaccumulation in the food chain can be especially highly dangerous to human health. This problem is receiving increasing attention from the public as well as governmental agencies, particularly in developing countries.

Vegetables constitute essential diet components by contributing proteins, vitamins, iron, calcium and other nutrients, which are usually in short supply (Thompson and Kelly, 1990). Vegetables take up metals by absorbing them from contaminated soils, as well as from deposits on different parts of the vegetables exposed to the air from polluted environments (Zurera-Cosano *et al*., 1989).

Soil threshold for heavy metal toxicity is an important factor affecting soil environmental capacity of heavy metals and determines their cumulative loading limits. Factors affecting the thresholds of dietary toxicity of heavy metal in soil-crop system include: soil type, which includes soil pH, organic matter content, clay mineral, water quality and other soil chemical and physical properties; and crop species regulated by genetic basis for heavy metal transport and accumulation in plants. Agronomic practices such as fertilizer and water management as well as and crop rotation system can affect bioavailability and crop accumulation of heavy metals,

In Pakistan the use of untreated sewerage water for irrigation is a common practice. Wastewater is often the only source of water for irrigation. Due to the high price of chemical fertilizer, farmers sometime prefer wastewater because of its high nutrient contents. They consider applying waste water to agriculture lands is an economical alternative. Industries in Pakistan specially textile utilize millions of gallons water a day and discharge it either after treatment only to meet NEQS or without treatment. Therefore waste water is available in abundant which is being used.

Urban agriculture is also a means of securing income and therefore has an important role in planning of the city like Karachi. It also converts the idle land into green spaces and green belts which are important for city authorities. There are two main rivers of Karachi which carry almost all the wastewater of the city and some of this wastewater is being used for plantation before discharging into the sea.

The benefits of wastewater irrigation could be offset by the health and environment aspects. The objective of the study is to evaluate these. The risks involved need to be carefully considered. This means that it is necessary to find affordable ways of monitoring the presence of contaminants in waste water that can be absorbed in food chain and harm the users. The study attempt to evaluate the potential toxicity of plants due to application of polluted water.

Materials and Methods

Nine species of plants were tested by seven different types of waste water including control (or tap water). These were Lyari (mix, industrial, sewerage) and Malir River (mix, industrial, sewerage) and control water. 20 gallons of each kind of water were collected from various locations along Lyari and Malir rivers. Maize, Sunflower, Lobia, Lentil, Chili, Spinach, Lucaena, Thespesia and Abutilon were selected for trials.

Ten seeds of each kind were planted in pots containing with soil and 20g cow dung as fertilizer. Five replications were used for each treatment. Seeds were planted 2cm (emerged) deep in the soil. These were watered every alternate day. The number of seeds of each plant germinated were recorded daily. After ample time passed the seeds grew into plants. Those responded for growth were observed. The speed of germination index was calculated as described by Khandakar and Bradbeer (1983).

S= [N1/1+N2/2+N3/3+…………Nn/n]×100

Where N1,N2,N3………..Nn proportion of seeds which germinated on day 1,2,3,………….n following setup of the experiment. S varies from 100(if all seeds germinated on the first day following setup) to 0(if no seeds germinated by the end of the experiment). Length of radicles were measured and analysis of variance was performed.

Three healthy plants of each species were selected and left for further growth in the pot. The length of these plants was measured after each week. This was continued for four weeks. The values were recorded and tabulated. These were then harvested. Immediately fresh weight of each species was taken. The plants were then carefully placed in small bags made from recycled papers. The species were kept for oven drying. Dry weights were then recorded. The difference between fresh and dry weights gave amount of moisture present in each species. The plants were removed from each bag. 2 to 3g of each dried plant were heated in the furnace up to 500^{o}C for an hour and then allowed to cool. The residue leftover and removed matter during heating represented the amount of heavy metals and organic content respectively.

Amount of moisture (wm) = fresh weight - dry weight

Percentage of moisture = wm/fresh weight*100

Organic contents (wo) = dry weight-residue left

Percentage of organic contents = wo/dry weight*100

Results and Discussion

Effects of different polluted water on nine species are shown in Table 1 to Table 9 while amount of organic matter, ash and heavy metals in each species is presented in Table 10. Germination started within a week and the trial was completed in one month. The height recorded in one month time was 3.62cm for maize in Lyari mix.

As per study of Nazim *et al*., 2010, germination started within four days, mean height recorded was 45.19cm for *Avicennia marina* at one site in 14 months. The percentage of germination was highest in case of Lyari mix. It was 96% for maize compared to 90% when treated with control. The maize values in the case of Lyari industrial and Lyari sewerage were 88% and 90% respectively. In case of lentil the seeds germinated, and speed of germination was also recorded, but the plants could not survive. This may be due to the toxic effect of the water used. Similar results was obtained with chili. The percentage and speed of germination were 46 and 19.1 but growth of the plant could go beyond 3.64mm in case of Lyari industrial. It is anticipated that the growth was retarded due to toxic chemicals present in the water.

The percentage of germination and speed for spinach in case of Lyari mix was 100 and 45 respectively, whereas the plant could not sustain the toxic effect of waste water and plant height could not exceed 6mm. The result for lentil, chili and spinach were almost same. Thespesia did manage to grow and was tolerant to all the waste water despite its toxicity.

Speed of germination for maize when treated with Lyari mix was 7.8 as compared to 40 as in control water. The speed of germinations for maize when treated with Lyari industrial and Lyari sewerage were 15.24 and 13.8 respectively.

The percentage germination was 90% for maize in control and Lyari sewerage and speed of germination was 40 and 15.24 in control and Lyari industrial respectively. The response can be noted in case of lobia because the percentage and speed of germination was 94 and 41.83 in case of control. Percentage of germination was 82 and 33.04 was speed of germination when treated with Lyari sewerage. Percentage of germination recorded in spinach was 100 when treated with control and Lyari mix. Speed of germination ranged from 20.6 to 45 in case of spinach.

Malir water did not promote growth in soil while Lyari water showed some promontory affect in some cases and the results were better as compared to control. The waste water from Malir River gave no positive results. The seeds did not germinate at all. The reason was due to the toxic elements present in the water. The location, where the samples were taken is the centre of tanneries and refineries and the waste water is highly toxic.

The mean length of maize when treated with Lyari mix was 36.25cm ± 1.44 as compared to control water 26.48cm ± 0.95. Sunflower mean length was 22.53cm ± 1.21 when treated with Lyari mix as compared to control which was 19.3 ± 1.07. Lobia mean length was 22.25cm ± 0.9 in the case of Lyari mix as compared to control 20.35cm ± .89. The response of plants to Lyari mix was similar to that of control or even better in some cases. This may be due to the nutrients present in Lyari mix waste water. Maize mean length was 22.51cm ± 1.75 and 24.1cm ± 1.79 when treated with Lyari sewerage and Lyari industrial respectively. The lobia mean length was 13.43cm ± 1.06 and 14.69cm ± 1.16 when treated by Lyari sewerage and Lyari industrial respectively. This means Lyari sewerage and Lyari industrial responded in the same manner.

Spinach and Lucaena contained maximum and minimum amount of moisture respectively. . In the case of Lyari sewerage, the contents of moisture in lucaena and spinach were 51% and 86% respectively. Lobia moisture content was in between 44.29% to 53.79% when treated with control water and Lyari mix respectively. Lobia responded the best in terms of growth in soil as compared to other plants. Spinach contained the maximum percentage of moisture. It was 80.0% in the case of Lyari sewerage. Thespesia responded well in control and as well in the Lyari waters. The moisture content in maize was in the range of 52.96% to 65.71%.

Maximum fresh weight was 39.11grams in approximately one month time when treated with Lyari.mix and it was 19grams in case of control water. It means that Lyari mix responded to growth. Similar results were found in case of sunflower. Abutilon plant grew in soil but it did not germinate when tested in Petrie plates.

The maximum amount of organic contents was found in Thespesia when in control value was 96.6% and the minimum content 66.6% was recorded in case of chilies when treated with control. Residue matter *i.e*. amount of heavy metals was maximum in chilies and minimum was recorded in Thespesia plant.

Karachi is the largest industrial city of Pakistan. The factories discharge various kinds of waste water depending upon the nature of industry. Leather units use toxic chemicals in the production process and effluent is very hazardous which become part of water of Malir River. Leather industries effluent will undoubtedly deteriorate soil productivity and adversely affect crop production in the surrounding land (Islam *et al*., 2006). This is in agreement with results of Malir water because there was no growth of plants in this water. Heavy metals are real problems to the environment, since they do not degrade like organic matter and persist in the ecosystem having accumulated in different trophic level of the food chain (Smejkalova *et al*., 2003; lgew *et al*., 2005; Nazim *et al*., 2011). It is shown that all test species accumulated different percentage of heavy metals in their tissues, therefore this polluted water should not be used for irrigation purpose.

Each species has its own physical and chemical requirements and industrial waste may or may not suppress the germination of certain species. (Uzair *et al*., 2009). According to Atiq-ur-Rahman and Iqbal (2007), increased concentration of Cr reduced the dry weight of *Leucaena leucocephala*. Present investigation showed similar results. It is experienced that Malir River water was highly toxic to all nine test species, even for seed germination stage while with Lyari River water different species gave different response with different amount of heavy metal accumulation. The application of both organic material and fertilizer in the field could be highly important and may release nutrients slowly and gradually which consequently affect plant growth (Ahmed *et al*., 2000). Sewage and industrial water normally contain high amount of organic matter and heavy metals and may release nutrients, toxic chemical and heavy metals faster than fertilizers consequently affect plant growth immediately. Therefore, this type of waste water is only recommended for growing crop if they do not have heavy metals.

Table 1. Effect of different treatments on germination and growth of Maize.

Treatments	% of Germination	Speed of Germination	Height of plant cm	Fresh weight of plant (g)	Dry weight of plant (g)	Moisture content (g)	% of moisture
Control	90	40	26.48 ± 0.95	19.05	8.96	10.09	52.96
Lyari Industrial	88	15.24	24.1 ± 1.79	12.60	5.00	7.60	60.30
Lyari Sewerage	90	13.8	22.51 ± 1.15	11.00	5.00	6.00	54.30
Lyari Mix	96	7.8	36.25 ± 1.44	39.11	13.41	25.70	65.71

Table 2. Effect of different treatments on germination and growth of Sunflower.

Treatments	% of Germination	Speed of Germination	Height of plant cm	Fresh weight of plant (g)	Dry weight of plant (g)	Moisture content (g)	% of moisture
Control	56	24.5	19.3 ± 1.07	17.20	9.46	7.74	45.00
Lyari Industrial	56	12.3	4.09 ± 0.46	10.60	5.00	5.60	53.80
Lyari Sewerage	8	1.25	4.06 ± 0.46	11.00	5.00	6.00	54.00
Lyari Mix	90	8.6	22.53 ± 1.21	29.11	13.41	15.70	53.90

Table 3. Effect of different treatments on germination and growth of Abutilon

Treatments	% of Germination	Speed of Germination	Height of plant cm	Fresh weight of plant (g)	Dry weight of plant (g)	Moisture content (g)	% of moisture
Control	56	6.4	8.42 ±0.5	18.2	8.25	9.95	54.60
Lyari industrial	18	1.8	7.11 ±0.4	3.24	1.75	2.49	76.50
Lyari sewerage	18	12	7.88 ±0.94	3.8	2.35	1.55	40.78
Lyari mix	14	1.5	5.3 ±0.2	3.1	1.50	1.60	51.60

Table 4. Effect of different treatments on germination and growth of Lobia

Treatments	% of Germination	Speed of Germination	Height of plant cm	Fresh weight of plant (g)	Dry weight of plant (g)	Moisture content (g)	% of moisture
Control	94	41.83	20.25 ± 0.89	53.53	29.82	23.71	44.29
Lyari industrial	**76**	16.8	14.69 ± 1.15	15.4	7.60	7.80	50.60
Lyari sewerage	82	33.07	13.43 ± 1.06	17.2	8.30	8.90	51.70
Lyari mix	88	17.11	22.25 ± 0.9	29.02	13.41	15.61	53.79

Table 5. Effect of different treatments on germination and growth of Masoor

Treatments	% of Germination	Speed of Germination	Height of plant cm	Fresh weight of plant (g)	Dry weight of plant (g)	Moisture content (g)	% of moisture
Control	80	27	11.45 ± 0.5	3.1	1.70	1.4	45.16
Lyari industrial	34	13	0.0	0.0	0.00	0.00	0.00
Lyari sewerage	20	7.5	0.0	0.0	0.00	0.00	0.00
Lyari mix	0	0	0.0	0.0	0.00	0.00	0.00

Zero indicated mortality

Table 6. Effect of different treatments on germination and growth of Chili

Treatments	% of Germination	Speed of Germination	Height of plant cm	Fresh weight of plant (g)	Dry weight of plant (g)	Moisture content (g)	% of moisture
Control	72	24.5	5.82 ± 0.38	14.57	6.27	8.30	56.97
Lyari industrial	46	19.1	3.64 ± 0.38	3.0	1.20	1.80	60.00
Lyari sewerage	46	9.85	0	0.0	0.00	0.00	0.00
Lyari mix	44	7.85	5.37 ± 0.84	17.81	3.88	13.93	78.2

Zero indicated mortality

Table 7. Effect of different treatments on germination .and growth of Spinach

Treatments	% of Germination	Speed of Germination	Height of plant cm	Fresh weight of plant (g)	Dry weight of plant (g)	Moisture content (g)	% of moisture
Control	100	23.4	4.19 ±0.4	26.21	6.34	19.87	75.60
Lyari industrial	92	42.5	6.21 ±0.36	24.00	5.43	19.57	81.54
Lyari sewerage	98	20.6	5.01 ±0.37	39.71	7.84	31.87	80.20
Lyari mix	100	45	5.75 ±0.84	29.45	9.34	20.11	68.29

Table 8. Effect of different treatments on germination and growth of Lucaena

Treatments	% of Germination	Speed of Germination	Height of plant cm	Fresh weight of plant (g)	Dry weight of plant (g)	Moisture content (g)	% of moisture
Control	70	18.83	5.4 ± 0.74	10.2	5.46	4.74	46.40
Lyari industrial	58	5.7	11.91 ± 1.22	5.2	3.10	2.10	40.30
Lyari sewerage	52	16.5	0.0	9.4	4.60	4.80	51.06
Lyari mix	54	16	8.33 ± 0.76	9.64	4.18	5.46	56.63

Table 9. Effect of different treatments on germination and growth of Thespesia

Treatments	% of Germination	Speed of Germination	Height of plant cm	Fresh weight of plant (g)	Dry weight of plant (g)	Moisture content (g)	% of moisture
Control	52	5.19	11.72 ± 1.2	35.65	14.66	20.99	58.87
Lyari industrial	54	55.98	13.77 ± 0.47	38.38	13.71	24.67	64.27
Lyari sewerage	38	3.8	9.75 ± 0.8	17.9	6.12	11.78	65.81
Lyari mix	50	3.5	10.46 ± 0.89	54.28	18.04	36.24	66.76

Table 10. Amount of Organic and Heavy Metals in Samples

Serial No	Name of Plant	Sample weight (g)	% of organic content	% of Ash/minerals
1	*Zea mays* L., maize(N)	2.0	75.0	25.0
2	*Zea mays* L., maize(LS)	NIL	NIL	NIL
3	*Zea mays* L., maize(LM)	NIL	NIL	NIL
4	*Zea mays* L., maize)(LI)	NIL	NIL	NIL
5	*Helianthus annuus* L., sunflower(N)	2.9	89.9	10.1
6	*Helianthus annuus* L., sunflower(LS)	NIL	NIL	NIL
7	*Helianthus annuus* L., sunflower(LM)	2.0	85.0	15.0
8	*Helianthus annuus* L., sunflower(LI)	NIL	NIL	NIL
9	*Abutilon indicum* (L.) Sweet., abutilon (N)	3.0	76.6	23.4
10	*Abutilon indicum* (L.) Sweet., L., abutilon (LS)	2.5	84.0	16.0
11	*Abutilon indicum* (L.) Sweet., L., abutilon (LM)	3.0	86.7	13.3
12	*Abutilon indicum* (L.) Sweet., L., abutilon (LI)	NIL	NIL	NIL
13	*Phaseolus lunatus* L., lobia (N)	3.0	90.0	10.0
14	*Phaseolus lunatus* L., lobia (LS)	NIL	NIL	NIL
15	*Phaseolus lunatus* L., lobia (LM)	3.0	86.6	13.4
16	*Phaseolus lunatus* L., lobia LI)	NIL	NIL	NIL
17	*Lens esculenta* Moench, masoor (N)	2.0	80.0	20.0
18	*Lens esculenta* Moench, masoor (LS)	NIL	NIL	NIL
19	*Lens esculenta* Moench, masoor (LM)	NIL	NIL	NIL
20	*Lens esculenta* Moench, masoor (LI)	NIL	NIL	NIL
21	*Capsicum annuum* L., chilies (N)	1.5	66.6	33.4
22	*Capsicum annuum* L., chilies (LM)	2.0	80.0	20.0
23	*Capsicum annuum* L., chilies (LS)	NIL	NIL	NIL
24	*Capsicum annuum* L.. chilies) (LI)	NIL	NIL	NIL
25	*Spinacia oleracea* L., spinach (N)	2.0	80.0	20.0
26	*Spinacia oleracea* L., spinach(LS)	2.5	68.0	32.0
27	*Spinacia oleracea* L., spinach(LM)	3.0	70.0	30.0
28	*Spinacia oleracea* L., spinach (LI)	2.0	85.0	15.0
29	*Leucaena leucocephala* (Lam.) de Wit, lucaena (N)	1.5	86.6	13.4
30	*Leucaena leucocephala* (Lam.) de Wit, lucaena (LS)	2.0	90.0	10.0
31	*Leucaena leucocephala* (Lam.) de Wit, lucaena (LM)	3.0	90.0	10.0
32	*Leucaena leucocephala* (Lam.) de Wit, lucaena (LI)	2.0	90.0	10.0
33	*Thespesia populnea* (L.) Soland. ex Correa thespesia (N)	3.0	93.3	6.7
34	*Thespesia populnea* (L.) Soland. ex Correa, thespesia (LM)	3.0	96.6	3.4
35	*Thespesia populnea* (L.) Soland. ex Correa, thespesia(LS)	2.0	90.0	10.0
36	*Thespesia populnea* (L.) Soland. ex Correa,thespesia (LI)	3.0	83.3	16.7

N = Neutral or Control LS = Lyari Sewerage
LM = Lyari Mix LI = Lyari Industrial
NIL = Seedlings not survived

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