EFFECT OF POLLUTED WATER OF LYARI AND MALIR RIVERS ON SOME PLANT SPECIES

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Abstract

The aim of this study was to find out possible toxic effects on plants due to the use of polluted water for cultivation. The effects of polluted water from six locations viz. Lyari industrial, Lyari sewerage, Lyari mix, Malir sewerage, Malir industrial, Malir mix and tap water on 9 different test species viz. *Zea mays* L. (maize), *Helianthus annuus L.* (sunflower), *Pisum sativum* (pea), *Phaseolus lunatus L.* (lobia), *Lens esculenta Moench* (masoor), *Cicer arietinum,* (chana), *Spinacia oleracea L.* (spinach), *Leucaena leucocephala Lam.* and *Thespesia populnea(L.)Sol. ex* were examined for the percentage of germination, rate of germination and radicle growth. Germination and growth were recorded on every alternate day. Lobia when treated with Lyari sewerage showed 100% germination. The rate of germination for lobia was 98% in Malir sewerage and Malir mix as compared to control which was 94%. It is shown that percentage of germination and rate of germination were stimulated by the chemicals of the water but the length of radicle of lobia was suppressed by waste water. It was also observed that the test species *T. populnea* and *P. sativum* were drastically affected by the treatment of Lyari industrial and Malir industrial waste water. Average rate of germination for *L. leucocephala* in Lyari treatment was 63% and 43% in case of Malir treatment. The average radicle elongations for *Leucaena* were 28mm and 7.2mm in polluted water of Lyari and Malir rivers respectively. This indicated that Lyari waste water was less toxic than Malir water for the growth of the plant species.

Introduction

Karachi the largest industrial city of Pakistan has about 5000 registered and hundreds of unregistered industrial units in Karachi. There are two main rivers in Karachi Lyari and Malir. Three forth of these industries are discharging their effluents into the Lyari river and the rest into different channels including Malir river and both the rivers enter into the sea. Lyari the most important waste water channel become a river when it enters the suburbs of Karachi as an open drain. Lyari river passing through various parts of the city discharges at Gulbai before entering into the sea. Lyari river is a seasonal river and has become a drainage system which has connection with branches of industrial effluent and domestic wastewater.

The water flowing in it originates from domestic sewerage and industrial effluent. The latter is discharged by various industries in the S.I T.E area comprising of 4000 acres and 300 major industries and almost 3 times as many small units. Sixty percent of these are textile mills while the other deals with chemicals, detergents, vegetable oil, beverages and food products (Beg *et al.,* 1984). There is an untreated impact of about 200mgd wastewater discharged by Lyari River (Khan *et al.,* 1999). Enormous quantities of untreated municipal and industrial wastes are being drained into the sea resulting in serious degradation of marine environment and adjoining coastal areas (Beg *et al*., 1984). Industrial effluent when discharged without treatment leads to serious environmental consequences.

The waste generated from the industries and other sources contain organic and inorganic pollutants (Uzair *et al*., 2009). The effluent affects agricultural lands and adjoining rivers areas creating secondary pollution (Kisku *et al*., 2000). The industrial waste water contain heavy metals and are real problem to marine and terrestrial ecosystems because they do not biodegrade and remain in the ecosystem (Smeijkalova *et al*., 2003; Igwe *et al*., 2005).

Industries in Pakistan epecially textilones utilize millions of gallons of water a day and discharge it either after treatment only to meet NEQS or without treatment. It is often the only source of water for irrigation. Urban agriculture has an important role in planning of a town. Waste water can be used to convert the idle land into green belts which are important for a city like Karachi. Due to the high price of chemical fertilizer, farmers sometime prefer wastewater because of its high nutrients contents. Therefore, they consider applying waste water to agriculture lands is a more economical alternative than using canal or tube well water. However if heavy metals are present in the waste water, they could be health hazards to the population. Therefore, the purpose of the study was to see the effect of different types of polluted water on germination and radicle growth of various plant species, to evaluate the toxicity of these waste waters.

Materials and Methods

Water samples were collected from several locations. Lyari mix (LM) was taken, where the mixing of industrial effluent and domestic sewerage had been completed and it was about to discharge into the sea. The second collection point was near Site Police Station and it was pure domestic sewerage (LS). The third sampling station was located where industrial effluent (LI) was discharging at Haronabad just adjacent Siemens Chorangi. For Malir river i.e. MM (Malir mix), MS (Malir sewerage) and MI (Malir industrial) polluted water was collected from waste water treatment plant at Korangi Industrial Area located near National Refinery Ltd. The selections of above points were based to cover the maximum area and industries coming in the area of Malir and Lyari rivers. Control water was taken from tap water. These polluted and control waters were applied on nine different kinds of seeds.

Ten seeds of a species were placed on a filter paper in sterilized Petri plate. Five replications were used for each type of seed. Three ml of water was poured in each replication on daily basis. Numbers of seeds germinated were noted every day while lengths of radicles were recorded every alternate day. Percentage of germination, speed of germination and radicle elongation were calculated.

The speed of germination index was calculated as described by Khandakar and Bradbeer (1983).

$$S= [N1/1+N2/2+N3/3+\ldots\ldots\ldots\ldots Nn/n]\times 100$$

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 have germinated by the end of the experiment). This has advantage over percent germination because it is usually more sensitive indicator of allelopathic effects (Wardle *et al*., 1993). Length of radicale was calculated and analysis of variance was applied. .

Data was analyzed by Repeated Measured Design (RMD) using statistical analysis soft ware productive (SPSS) version 10 (Nie *et al*., 2009). Duncan Multiple Range Test (Duncan, 1955) at 5% probability was also applied to compare individual treatments.

Results and Discussion

Results of Repeated Measured Design (RMD) and Duncan Multiple Range Test at 5% probability among treatments are shown in Table 1 and Table 2. Graphical representation of different polluted water with control is shown in Fig 1.

Higher or equal to control seed germination (72% to 82 %) was recorded in maize when treated with Lyari industrial, Lyari sewerage, Malir sewerage and Malir mix polluted water. It may be due to the higher amount of nutrients than ordinary tap water, however Malir industrial water considerably reduced the amount of germination. It showed that the chemicals present in Malir industrial water were toxic to maize seeds.

Sunflower seeds showed higher germination 74% and 84 % in Malir mix and Lyari sewerage, respectively. This species was sensitive to all other four types of polluted waters, showing 20% to 48% germination. Pea seeds were highly sensitive to polluted water, showing 32% and 34% germination in Lyari mix and Lyari sewerage respectively, while in other polluted water only less than 10% seeds were able to germinate due to the highly toxic chemicals.

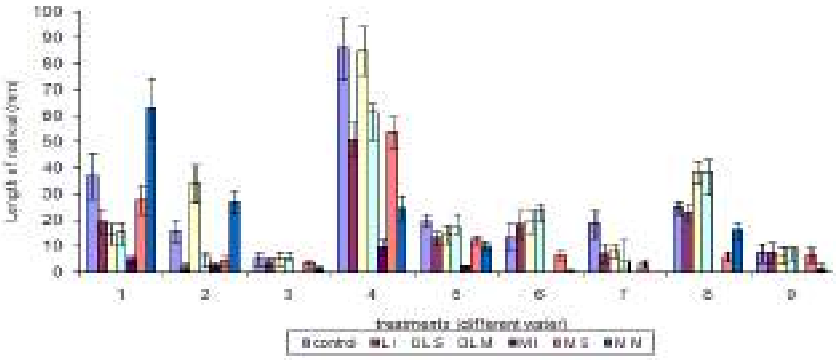

Fig. 1. Graphical representation of the effect of different polluted water with control on length of radical of different species.

Note: Z.m=*Zea mays*, H.a=*Helianthus annuus*, P.s=*Pisum sativum*, P.l=*Phaseolus lunatus*, L.e=*Lensesculenta*, C.a=*Cicer arietinum*, S.o=*Spinacia oleracea*, L.l=*Leucaena leucocephala* and T.p=*Thespesia populnea*, LI=Lyari industry, LS= Lyari sewrage, LM= Lyari mix, MI= Malir industry, MS= Malir sewrage, MM=Malir mix

Table 1. Effect of Lyari water on germination, speed of germination and radical length of plant:

	Control			Lyari industrial			Lyari sewerage			Lyari mix		
Species	**% seeds germination**	**Speed of germination**	**Mean length of radicle (mm)**	**% seeds germination**	**Speed germination**	**Mean length of radicle (mm)**	**% seeds germination**	**Speed of germination**	**Mean length of radicle (mm)**	**% seeds germination**	**Speed of germination**	**Mean length of radicle (mm)**
Z.m	72	35	37.08,±8.53a	72	18	19.5,±4.90b	72	14	14.4,±3.88c	52	32	15.5,±5.55b
H.a	64	10.66	15.9,± 4.13a	20	3.33	1.8,±1.26b	84	33.3	34.02,±7.09c	26	9.5	5.84,±3.56b
P.s	12	2.66	4.84,±2.36a	8	1.33	3.8,±1.67a	34	5.66	5.02,±2.56a	32	10.5	5.48,±1.23a
P.l	94	18.83	86.3,±11.7a	84	16.5	51,±6.69b	100	20.66	85.36,±9.74a	84	14	61.98,±10.62b
L.e	100	50	19.66,±2.42a	94	47	13.06,±2.40b	82	13.16	14.48,±3.65b	92	89	17.48,±3.20b
C.a	64	29.5	13.26,±5.30a	62	20.8	18.32,±5.08a	82	15.33	18.98,±4.42a	88	28.5	24.0,±4.86a
S..o	60	10	18.48,±5.60a	56	8	7.12,±3.7b	30	7.66	8.22,±2.53b	20	8	4.0,±2.35b
L.l	100	50	24.82,±2.54a	98	44.75	22.75,±3.5b	100	49	38.36,±4.32c	76	95	38.18,±8.26c
T.p	24	4	7.2,± 3.94a	36	5.75	7.5,±4.02	28	8.33	6.44,±3.31a	32	12.5	9.3,±5.03a

Note : Number followed by the same letters in the treatments columns etc are non- significantly different according to column Duncan multiple range test at $P<0.05$ level ± standard error, mm=millimeter,Z.m=*Zea mays* (maize), H.a=*Helianthus annuus* (sunflower), P.s=*Pisum sativum* (pea), P.l=*Phaseolus lunatus* (lobia), L.e=*Lens esculenta* (masoor), C.a=*Cicer arietinum* (chana), S.o=*Spinacia oleracea* (spinach), L.l=*Leucaena leucocephala* and T.p=*Thespesia populnea*

Table 2. Effect of Malir water on germination, speed of germination and radicle length of plant species:

	Control			Malir industrial			Malir sewerage			Malir mix		
Species	% seeds germination	Speed of germination	Mean length of radicles mm	% seeds germination	Speed of germination	Mean length of radicals mm	% seeds germination	Speed of germination	Mean length of radicles mm	% seeds germination	Speed of germination	Mean length of radicles (mm)
Z.m	72	35	37.08, ±8.53a	34	17	4.8,±1.26c	78	19.5	27.74,±5.66 a	82	70	63.14,±11.31 ab
H.a	64	10.66	15.9,± 4.13a	48	6	2.58,±0.73c	36	7.33	4.3,±1.73b	74	67	26.88±4.34 b
P.s	12	2.66	4.84,±2.36a	0	0	0	10	1.6	3.26,±1.40a	6	1	1.36±0.66a
P.l	94	18.83	86.3,±11.7a	26	4.3	9.61,±3.28d	98	21.8	53.8,±5.97c	98	22.3	24.74±4.53b
L.e	100	50	19.66,±2.42a	24	12	1.92,±0.79d	100	43.5	12.56,±1.50 c	100	98	9.78±1.82d
C.a	64	29.5	13.26,±5.30a	0	0	0	36	19	6.44,±1.59	6	1.5	0.66±0.42
S..o	60	10	18.48,±5.60	10	2.16	0	4	0.83	2.9,±1.27b	10	2.5	0
L.l	100	50	24.82,±2.54	74	16.5	0	60	30	5.76,±1.99b	60	98.5	16.06±3.03
T.p	24	4	7.2,± 3.94	0	0	0	8	2	6.46,±2.86a	8	1.33	1.7±1.30b

Note : Number followed by the same letters in the treatments columns etc are non- significantly different according to column Duncan multiple range test at P<0.05 level ± standard error , mm=millimeter, Z.m=*Zea mays* (maize), H.a=*Helianthus annuus* (sunflower), P.s=*Pisum sativum* (pea), P.l=*Phaseolus lunatus* (lobia), L.e=*Lensesculenta* (masoor), C.a=*Cicer arietinum* (chana), S.o=*Spinacia oleracea* (spinach), L.l=*Leucaena leucocephala* and T.p=*Thespesia populnea*

Lobia showed highly resistance to all polluted water, showing 84% to 100% seed germination, except polluted water of Malir industrial, where its germination was significantly reduced to 26 %. Masoor seeds also showed the same response with different polluted water, its germination was reduced to 47% for the same Malir industrial water.

Lyari polluted water enhanced the seed germination of channa while almost all the Malir polluted waters were highly toxic to this specie. Only Malir sewerage supported 36% seeds germination. Similar results were obtained with spinach, *Leucinia* and *Thespesia* species. It is shown in Table 1 and Table 2 that the Lyari industrial water was highly toxic to sunflower and pea, while Malir industrial was highly toxic to all species except sunflower and *Leucaena.*

Masoor and leucinia showed highest (89% and 98%) speed of germinations in both Lyari and Malir mix polluted water while maize and sunflower showed highest (70 % and 67%) speed of germination in Malir mix only. Radical length of maize was 14 mm and lobia length 85mm was obtained in lyari sewerage water while masoor and *Lecucaena* showed maximum length 89 mm and 95 mm in lyari mix water respectively. In Malir polluted water radicle growth (54 mm) was recorded in Lobia with sewerage water while 63mm growth of maize was recorded in Malir mix water.

It is evident from the Table 1 that in all polluted water of Lyari river, response of species i.e. pea, masoor, chana, spinach and thespesia was same and no significant difference was recorded in the length of radical growth regardless of the type of water. As for all Malir water was concerned, there was a significant difference in the response of test species between Malir industrial and rest of the two treatments. Therefore Malir industrial water is considered the most highly toxic water for the plant growth. *Thespesia* was drastically affected under the polluted water of Lyari industrial and Malir industrial areas and after germination these could not survive and seeds died afterwards due to toxicity of industrial waste waters and in special concerning to Malir area**.**

The results showed that Lyari river waste water was less toxic than Malir water as far as germination of seeds were concerned. This gave an additive support to the opinion that some plants showed tolerance against the effect of some chemicals and toxicity. The observations at different time periods were not independent so the repeated measure design was applied for analysis of variance (ANOVA). The highly significant differences among treatment for length of radicals $F=16.37<0.001$ was observed in ten days. The study showed that radical elongation of most of species was more in case of Lyari waste water than the Malir river water. Each species has its own physical and chemical requirements and industrial waste may or may not suppress the germination of certain species. Similar conclusion was also made by (Uzair *et al*., 2009 and Khan *et al*., 2013).

The leather factories are centralized in Korangi industrial area in the vicinity of National Refinery Ltd. Maximum amount of polluted water from tanneries discharge into the Malir river adjacent to these factories

Babyshakila and Usha, (2009) studied the growth of *Vigna radiate* using effluent of leather factories. Different proportions of effluents were used for various trials. They also concluded that tannery effluent can be used for growth of plant but in dilute form. This is in agreement with the result of the present study as polluted water of Malir river did respond even without any dilution but to less extent.

Tabari *et al*., (2006) studied on the topic Impact of Municipal Wastewater on Growth and Nutrition of Afforested *Pinus eldarica* Stands. It was displayed that all growth parameters measured in *P. eldarica* trees were statistically greater in effluent–irrigated areas than in well-watered area. As a whole, the use of effluent in the irrigation can be an overflowing resource from the nutrient elements required for plants (Yadav *et al*., 2002; Toze, 2006). As a matter of fact, high nutrient concentration in effluent as compared to those in the well water cause more nutrient accumulation in the soil (Stewart and Flinn, 1984; Stewart *et al*., 1990; Keller *et al*., 2002; Selivanovskaya *et al*., 2001; Emongor & Ramolemana, 2004) and makes easy the access of plants to the high nutrient concentration and increases the growth.

Our study agreed with these studies as far as the maize, sunflower, lobia, channa, leucinia in lyari polluted water were concerned. Similar results were found with maize and sunflower with Malir polluted water. However reverse was the response of the rest of the species, because these species were more sensitive to toxic chemical and the nutrient present in the water unable to enhance the growth. Different species showed different response when treated with various types of polluted water. In some species, germination was not affected, but radical growth was severely affected or even killed by the toxic chemicals. Species which were highly tolerant to the toxic chemical and their growth not effected by waste water and are still environmentally not suitable, if they accumulate heavy metals found in polluted water (Akhtar *et al*., 2012). Therefore, before making any suggestions regarding polluted water to be used for irrigation, chemical analysis for heavy metals are highly recommended for soil, water and plants.

Conclusion

It is concluded that the Lyari river waste water was less toxic than Malir water as far as germination of seeds were concerned. Species which were highly tolerant to the toxic chemical and their growth not effected by waste water are still environmentally not suitable, if they accumulate heavy metals found in polluted water.

Therefore before making any suggestions regarding polluted water to be used for irrigation, chemical analysis for heavy metals are highly recommended for soil, water and plants.

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