Pak. J. Bot., 41(4): 1659-1665, 2009.

EFFECT OF INDUSTRIAL WASTE ON SEED BANK AND GROWTH OF WILD PLANTS IN DHABEJI AREA, KARACHI, PAKISTAN

MUHAMMAD UZAIR[*], MOINUDDIN AHMED[**] AND KANWAL NAZIM[*]

[*]*Department of Zoology*, [**]*Department of Botany*
Federal Urdu University of Arts Science and Technology,
Gulshan-e-Iqbal campus Karachi, Pakistan
e-mail- m_uzairjoji@yahoo.com

Abstract

An experimental trial was conducted at Dhabeji area to see the effect of chemical industry waste (organic with heavy metals) on seed bank of barren area of Dhabeji. An industrial sludge and its ash content were used in different concentrations, 10Kg and 20Kg sludge, 10kg and 20kg ash respectively to see the effect on seed bank, germination and growth of wild plants. After rainfall 17 species appeared in control viz., *Gynandropsis gynandra* (L.) Briq., *Aerva javanica* (Burm. f.) Juss, *Zygophyllum simplex* L., *Tribulus terrestris* L., *Dactyloctenium scindicum* Boiss, *Chloris barbata* Sw., *Cyperus rotundus* L., *Indigofera cordifolia* Heyne ex Roth, *Salsola baryosma* (R.& S.) Dandy, *Indigofera hochstetteri* Baker *and Heliotropium strigosum* Willd, while remaining 6 species viz., *Digera muricata* (L.) Mart., *Amaranthus viridis* L., *Blepharis sindica* stocks ex T. Anders, *Panicum antidotale* Retz., *Prosopis juliflora* (Swartz) DC. and *Leucaena leucocephala* (Lam.) de-Wit were recorded in control and treated plots. Number of seedlings, height, fresh weight and dry weight of these species were determined. It has been observed that 20kg sludge showed better response on fresh weight and dry weight of *D. muricata*, *A. viridis* and *P. antidotale* while the same treatment seemed to have positive effect on germination and height of *L. leucocephala*. It is suggested that this particular type of industrial waste is toxic (due to heavy metals) to some species while some species showed better growth due to presence of organic matter.

Introduction

Industrial waste is a main source of pollution for all environments. It requires on-site treatment before discharging on land (Emongor *et al*., 2005). The problems of disposal of industrial waste whether solid, liquid or gas, all three types of wastes have the potential of ultimately polluting water. This polluted water, in addition to other effects, directly affects soil, not only in industrial areas but also in agriculture fields, as well as the beds of rivers, creating secondary source of pollution (Kisku *et al*., 2000; Barman *et al*., 2000). Soil ecosystem all over the world have been infected by various anthropogenic actions resulting in health hazards through food chain (Tu *et al*., 2000; Dahmani-Mueller *et al*., 2001; McGrath *et al*., 2002).

Karachi is the largest industrial city of Pakistan. In the production process of industries, a lot of solids, semi-solid and liquid wastes are generated that may contain substantial amount of toxic organic and inorganic pollutants and if dumped in the environment without treatment then this may lead to serious environmental consequences. This will also undoubtedly deteriorate soil productivity and adversely affect crop production in the surrounding land (Islam *et al*., 2006). Industrial waste containing toxic heavy metals are real problem to the environment, since they are not degraded like organic matter and persist in the ecosystem heaving accumulated in different tropic levels of the food chain (Smejkalova *et al*., 2003; Igew *et al*., 2005).

Since there is no scientifically managed landfill site, industrial waste being dumped in the vicinity of Karachi city (so called authorized dumping sites) in open designated areas and due to this practice, the biodiversity of the area is being affected. Beside most of the industries are illegally discharging untreated waste, containing toxic heavy metals in different undesignated open fields and barren areas of Karachi that also creates hazards for human health and deteriorate the local flora and fauna. Though under studied industrial waste is not being spread illegally on open fields, consequences need to be determined if they are spread in wild areas. Physical and chemical composition of the industrial waste varies due to the nature of the industry. Therefore waste of each industry should be tested chemically and by bioassay trials to see the effect on ecosystem. Bearing these points in mind present investigation was carried out to observe the impact of the particular industrial sludge and ash on the natural seed bank, survival and growth of wild plants in Dhabeji wild area.

Materials and Method

A field experiment was conducted at Dhabeji area in order to evaluate the effect of a particular industrial waste on seed bank of barren soil and growth of wild plants. The trial was laid out in RCBD (Randomized complete block design) method. The field was alienated into 15 blocks and the size of each block was 10 feet^2. In this study 5 treatments were used including control with three replicates. Industrial waste was collected from a waste site of a chemical industry in the form of sludge. Chemical analysis of waste was performed (Atomic absorption PG 990) and amount of heavy metals were detected. Dry sludge was crushed in small pieces by an ordinary electrical grinder and was burnt in the incinerator up to 900^{o}C until it is converted into ash. Treatments were used in different weight i.e., 10kg and 20kg sludge, 10kg and 20kg ash respectively. These were broadcast in all plots except control. These plots were left until the rainy season. After rain, number and type of seedlings emerged in each plot were recorded. Growth of these seedlings were observed upto four months then harvested. Height, fresh weight and dry weight of harvested plants from each treated plots was obtained separately.

The data were analyzed statistically (Steel & Torrie, 1984). Means were compared by Duncan's multiple range test (Duncan, 1955).

Results and Discussion

Seedlings of 17 wild species appeared in the control plots after rain, while only 6 species were recorded in treatment plots. The species appeared in control were *Gynandropsis gynandra, Aerva javanica, Zygophyllum simplex, Tribulus terrestris, Dactyloctenium scindicum, Chloris barbata, Cyperus rotundus, Indigofera cordifolia, Salsola baryosma, Indigofera hochstetteri* and *Heliotropium strigosum.* Regardless of the amount of waste, among 17 only 6 species viz., *Digera muricata, Amaranthus viridis, Blepharis sindica, Panicum antidotale, Prosopis juliflora and Leucaena leucocephala* were recorded in treated plots. It seems that seeds of above 11 species could not germinate due to the toxicity of this particular industrial waste. However other 6 species showed tolerance to this waste. Each species has its own physical and chemical requirements and industrial waste may or may not suppress the germination of certain wild species. The application of both organic material and mineral fertilizer in the field could be highly important and may release nutrients slowly and gradually, which consequently affect plant growth (Ahmed *et al*., 2006).

Particular industrial waste is considered hazardous due to presence of toxic heavy metals, though 90% of its composition based on water and organic matters. Chemical analysis of this waste showed cobalt (422.22 mg/kg), copper (3.22 mg/kg), nickel (3.22 mg/kg), lead (25 mg/kg), zinc (8.12 mg/kg), manganese (534.35 mg/kg), iron (1298.81 mg/kg), sodium (1169.38 mg/kg), calcium (315.55 mg/kg), aluminum (34.10mg/kg) and sulfur (700mg/kg). Ash contained higher amount of heavy metals due to incineration of water and organic matter from the waste.

Table 1 to 6 showed the effect of waste on 6 surviving wild species and summarized data by ANOVA. The number of seedlings, height, fresh weight and dry weight of each species is presented in these tables. Table 1 represents the number of seedlings, height, fresh weight and dry weight of *Digera muricata* under different treatments. Highest number of seedlings, 40±11 was recorded in 20kg ash treatment, while lowest number of seedlings appeared in 20kg sludge treatment. Higher amount of sludge reduced the seed germination of this species while higher amount of ash promoted the germination and this effect was significantly different. Though maximum height was recorded in control, while maximum fresh weight and dry weight were recorded in 20kg sludge however, no significant differences were recorded between the treatments.

Response of *Amaranthus viridis* is shown in Table 2. The maximum numbers of seedlings 9±4 were found in 10kg sludge while fresh weight and dry weight 630±429.22 and 148.33±117.34 respectively were recorded in 20kg sludge treatment. The lowest number of seedlings was observed in both 20kg sludge and 20kg ash treatment. It shows that high amount of sludge and ash reduces the seed germination while 20kg sludge treatment showed better response over this species. Although maximum height was found in 10kg ash but no significant differences were found between treatments.

Results of *Blepharis sindica* are presented in Table 3. Numbers of seedlings 27±6 were recorded in 20kg sludge while maximum height 16.51±0.73, fresh weight 1153.33±363.79 and dry weight 251.66±65.84 of this species were recorded in control. Minimum height, fresh weight and dry weight were found in 20kg ash. It should be indicated that 20kg sludge showed better effect on seed germination due to the presence of organic matter, while 20kg ash showed adverse effect on the overall growth of this species. However means showed no significant difference among treatments.

Table 4 shows the response of *Panicum antidotale.* The greater numbers of seedling 5±1 were recorded in 10kg ash treatments, while highest fresh weight and dry weight were observed in 20kg sludge. It is shown for this species that height, fresh weight and dry weight 15.24±7.75, 397.22±228.53 and 112.83±45.74 respectively were reduced in 20kg ash. Though 20kg sludge promoted the fresh weight and dry weight 880±477.21 and 278.14±197.66 respectively of the species but no significant differences were observed among treatments.

Response of ANOVA for *Prosopis juliflora* is presented in Table 5. Highest number of seedling and height 26±7 and 23.70±1.69 respectively were recorded in 20Kg ash treatment, while maximum fresh weight and dry weight 76.66±14.52 and 17.08±12.20 respectively were recorded when treated with 10Kg ash treatment. Lowest numbers of seedlings were found in control and lowest height 10.16±5.08, fresh weight 43.75±23.66 and dry weight 7±1.52 were observed in 10 kg sludge treatment. It shows that low amount of sludge decreased the height, fresh weight and dry weight while high amount of ash increased the seed germination and height of this species. Though low amount of ash promoted fresh weight and dry weight but no significant results were obtained among the treatments.

Table 1. Effect of Industrial sludge and ash on the mean number of seedling, height, fresh weight and dry weight of *Digera muricata* (L.) Mart.

Treatments	Number of seedlings	Mean of 25 plants		
		Height (cm)	Fresh weight (g)	Dry weight (g)
Control	ab 22±3	a 28.36±1.84	a 641.71±184.09	a 116.37±30.66
10kg sludge	ab 26±1	a 26.67±0.73	a 1217.96±591.45	a 179.73±68.46
20kg sludge	b 8±4	a 21.16±10.60	a 1766.66±1257.42	a 255±156.60
10kg ash	b 19±5	a 24.97±1.12	a 870.69±192.00	a 175.37±101.59
20kg ash	a 40±11	a 27.94±1.46	a 703.92±96.48	a 129.64±18.22
LSD	18.95	15.68	2145.25	319.01

Table 2. Effect of Industrial sludge and ash on the mean number of seedling, height, fresh weight and dry weight of *Amaranthus viridis* L.

Treatments	Number of seedlings	Mean of 9 plants		
		Height (cm)	Fresh weight (g)	Dry weight (g)
Control	a 8±3	a 20.74±10.37	a 140.57±87.11	a 43.91±26
10kg sludge	a 9±4	a 19.80±8.66	a 496.66±400.84	a 129.5±110.80
20kg sludge	a 3±1	a 21.14±11.13	a 630±429.22	a 148.33±117.34
10kg ash	a 5±1	a 25.82±1.12	a 346.66±101.37	a 127.5±36.99
20kg ash	a 3±1	a 19.47±9.76	a 348.33±209.37	a 103±52.65
LSD	12.83	29.30	1014.61	276.96

Table 3. Effect of Industrial sludge and ash on the mean number of seedling, height, fresh weight and dry weight of *Blepharis sindica* Stock ex T. Anders.

Treatments	Number of seedlings	Mean of 19 plants		
		Height (cm)	Fresh weight (g)	Dry weight (g)
Control	a 6±0	a 16.51±0.73	a 1153.33±363.79	a 251.66±65.84
10kg sludge	a 19±12	a 16.08±0.42	a 517.47±177.54	a 137.17±13.21
20kg sludge	a 27±6	a 15.51±0.23	a 750.82±142.29	a 153.65±50.02
10kg ash	a 16±7	a 15.00±0.30	a 750.21±494.40	a 139.22±83.54
20kg ash	a 24±3	a 14.39±0.84	a 476.54±75.19	a 113.1±48.18
LSD	21.27	2.11	926.02	173.39

Numbers followed by the same letters in the same column are not significantly different according to Duncan's Multiple range Test at $p<0.05$ level.
± Standard Error, g = Gram, cm = Centimeter

Table 4. Effect of Industrial sludge and ash on the mean number of seedling, height, fresh weight and dry weight of *Panicum antidotale* Retz.

Treatments	Number of seedlings	Mean of 10 plants		
		Height (cm)	Fresh weight (g)	Dry weight (g)
Control	a 3±1	a 24.55±2.24	a 466.66±130.17	a 133.25±108.56
10kg sludge	a 4±2	a 16.51±8.26	a 412.85±313.76	a 118.88±78.32
20kg sludge	a 5±2	a 17.35±8.68	a 880±477.21	a 278.14±197.66
10kg ash	a 5±1	a 23.45±2.13	a 867.77±566.79	a 246.66±123.46
20kg ash	a 4±1	a 15.24±7.75	a 397.22±228.53	a 112.83±45.74
LSD	7.01	23.80	1278.24	411.59

Table 5. Effect of Industrial sludge and ash on the mean number of seedling, height, fresh weight and dry weight of *Prosopis juliflora* (Swartz) DC.

Treatments	Number of seedlings	Mean of 20 plants		
		Height (cm)	Fresh weight (g)	Dry weight (g)
Control	a 7±2	a 20.32±0	a 65.83±36.29	a 14.00±6.26
10kg sludge	a 12±6	a 10.16±5.08	a 43.75±23.66	a 7±1.52
20kg sludge	a 20±11	a 19.38±1.93	a 54.85±16.98	a 12.57±7.67
10kg ash	a 12±3	a 21.59±2.19	a 76.66±14.52	a 17.08±12.20
20kg ash	a 26±7	a 23.70±1.69	a 48.80±14.72	a 7.91±5.60
LSD	23.85	9.82	79.47	22.58

Table 6. Effect of Industrial sludge and ash on the mean number of seedling, height, fresh weight and dry weight of *Leucaena leucocephala* (Lam.) de-Wit.

Treatments	Number of seedlings	Mean of 23 plants		
		Height (cm)	Fresh weight (g)	Dry weight (g)
Control	a 8±3	a 76.20±38.35	a 450±242.14	a 100±55.07
10kg sludge	a 12±5	a 101.60±10.16	a 329.27±98.06	a 88.04±24.30
20kg sludge	a 16±5	a 106.68±40.32	a 278.94±76.30	a 86.18±17.48
10kg ash	a 9±5	a 55.88±28.28	a 120±91.65	a 31.66±24.55
20kg ash	a 12±4	a 96.52±10.16	a 218.68±131.71	a 49.29±31.72
LSD	14.12	92.68	316.01	74.19

Numbers followed by the same letters in the same column are not significantly different according to Duncan's Multiple range Test at $p<0.05$ level.

± Standard Error, g = Gram, cm = Centimeter

The Maximum number of *Leucaena leucocephala* seedlings 16±5 and height 106.68±40.32 were recorded in 20 Kg sludge, while highest amount of fresh weight and dry weight 450±242.14 and 100±55.07 respectively were observed in control Table 6. The lowest height, fresh weight and dry weight 55.88±28.28, 120±91.65 and 31.66±24.55 were observed in 10 kg ash treatment. Low amount of ash decreased height, fresh weight and dry weight while higher amount of sludge increased the seed germination and height of this species. The highest amount of fresh weight and dry weight were recorded in control but response of treatments showed no significant difference.

It is evident from the above results that industrial sludge and ash show both positive and negative effects on seed bank depending on the type and amount of waste and kind of the wild species. It may be stated that different species showed different response in different amount of particular sludge and ash. It is suggested that if this particular industrial waste or even its ash, if thrown in open wild areas, above mentioned 11 natural plants would be eliminated because this waste seems highly toxic for their seed germination. In contrast among 6 surviving species *Prosopis juliflora* is highly tolerant, wide spread, having wide ecological amplitude and most aggressive alien species. Elimination of 11 species by the particular industrial waste, from the area will give more chance to this alien species. Never the less it may be concluded that this area would be dominated by *Prosopis juliflora*, therefore prompt action (scientific landfill sites) is required to stop spreading the industrial waste on open field, which may alter the natural vegetation and promoting certain exotic species. Since physical, chemical composition, amount and type of heavy metals vary in different industrial waste, it is recommended that each industrial waste should be tested by bioassay treatments, to investigate its degree of toxicity.

References

Ahmed, R., A. Khalid, M. Arshad, Z.A. Zahir and M. Naveed. 2006. Effect of raw (un-composted) and composted organic material on growth and yield of maize (*Zea mays* L.). *Soil & Environment*, 25(2): 135-142.

Barman, S.C., S.K. Sahu, S.K. Bhargava and C. Chatterjee. 2000. Distribution of heavy metals in wheat, mustard and grown in field irrigated with industrial effluent. *Bulletin of Environmental and Contamination Toxicology*, 64: 489-496.

Dahmani-Mueller, H., F. Van and M. Balabane. 2001. Metal extraction by Arabidopsis halleri grown on an unpolluted soil amended with various metal-bearing solids: a pot experiment. *Environment Pollution*, 114: 77-84.

Duncan D.B. 1955. Multiple range and multiple F-test. *Biometrics*, 11: 1-42.

Emongor, V., E. Nkegbe, B. Kealotswe, I. koorapetse, S. Sankwasa and S. Keikanetswe. 2005. Pollution Indicators in Gaborone industrial effluent. *Journal of Applied Sciences*, 5(1): 147-150.

Igwe, J.C., I.C. Nnorom and B.C.G. Gbaruko. 2005. Kinetics of radionuclides and heavy metals behaviour in soils: Implications for plant growth. *African Journal of Biotechnology*, 4(B): 1541-1547.

Islam, M.O., Md. H.R. Khan, A.K. Das, M.S. Akhtar, Y. Oki and T. Adochi. 2006. Impacts of industrial effluents on plant growth and soil properties. *Soil & Environment,* 25(2): 113-118.

Kisku, G.C., S.C. Barman and S.K. Bhrgava. 2000. Contamination of soil and plants with potentially toxic elements irrigated with mixed industrial effluent and its impact on the environment. *Water Air and soil Pollution*, 120 (1-2): 121-137.

McGrath, S.P., F.J. Zhao and E. Lombi. 2002. Phytoremediation of metals, metalloids and radionuclides. *Advances in Agronomy*, 75: 1-56

Smejkalova, M., O. Mikanova and L. Boruvka. 2003 Effect of heavy metal concentration on biological activity of soil microorganisms. *Plant Soil Environment*, 49(7): 321-326.

Steel, R.G.D and J.H. Torrie. 1984. *Principles and procedures of Statistics*. *McGraw Hill Book Co. Inc., Singapore*, pp. 172-178.

Tu, C., C.R. Zheng and H.M. Chen. 2000. Current status of the soil-plant system in a Copper gangue area. *Actual Pedol Sin* (in Chinese) 37: 284-287.

(Received for publication 2 January, 2009)