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Effects of Polluted Soil Extracts on Germination and Seedling Growth of Some Species.

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Abstract

The seeds of *Albizia lebbeck*, *Leucaena leucocephala* and *Peltophorum pterocarpum* show a high rate of germination in the soil extract of control (campus) as compared to polluted areas (city). Germination percentage was lowest in the soil extracts of Guruminder and M. A. Jinnah road.

The seedling length of *A. Lebbeck* and *P. pterocarpum* was not significantly altered by the soil extract of city areas, whereas *L. leucocephala* showed significant results. Reduction in root length was high in *P. pterocarpum*; similarly, it also showed a reduction in dry weight. This would indicate that *P. pterocarpum* was found to be the most susceptible species to automobile pollution. It showed reduction in germination, root and seedling length and biomass production. Tolerance of this species was also lowest as compared to other species.

Keyword: *Albizia lebbeck*, *Leucaena leucocephala*, *Peltophorum pterocarpum*, soil extracts, germination

Introduction

Heavy metals like cadmium, zinc, copper, nickel and lead are the important metals which are especially present in urban areas and roadsides. High levels of heavy metals are present in soil as compared to plant leaves and these metals are deleterious to plant growth. Higher doses of metals reduced the rate of germination [1]. The ideal temperature for seed germination was found to be 30°C. Higher temperatures nullified the toxic effects of zinc as well as cadium.

Of all the heavy metals, lead is of particular interest because of its toxic nature and widespread occurrance. Most of the workers have studied the toxic effect of lead on germination and seedling growth [5, 6]. Mahmood and Iqbal [8] studied the effect of automobile exhaust on germination of *A. Lebbeck*, *P. roxburghii* and *D. sissoo*. They found that *A. Lebbeck* was the most susceptible species to automobile pollution. Ahmed et al. [2] studied the effect of phytotoxic air pollution on chlorophyll and protein contents of some plants.

The main purpose of this study was to investigate the effect of polluted soil extract on the germination and seedling growth of some important tree species.

Materials and Methods

Seeds of *Albizia lebbeck* Benth., *Leucaena leucocephala* (Lam) de Wit. And *Peltophorum pterocarpum* DC. Backer ex. K. Heyne were collected from the campus area. All the seeds were first sterilized with 0.2% mercuric chloride solution for about 1-2 minutes and then rinsed throughly with distiller water. The seeds had tough seed coat, thus before sterilization all the seeds were rubbed on sand paper. 25 seeds of each species were transferred to sterilized petri-dishes, lined with 3 layers of filter paper and treated with 2ml of soil extract. 10 grams of dried and sieved soil (2mm) of Guruminder, M. A. Jinnah road, Shaheed-e-Millat road and Karachi University campus were extracted with 100 ml of distilled water overnight. Polluted and control treatments were replicated three times and the seed plates were kept in dark at room temperature. Range of temperature was 30-32°C. The seeds were examined daily after plating out and the number of germinated seeds were recorded. Seeds were considered to be germinated when the radicle was obvious. After one week, rood and seedling length were recorded and the seedlings' dry weight was determined after keeping them

in the oven at 80°C for 24 hours.

Tolerance testing: Seeds of each species were tested for heavy metal tolerance from the area of Guruminder, M. A. Jinnah road and Shaheed-e-Millat road. Mean indices of tolerance were calculated as percentage of each area using the following formula:

$$\text{Percentage of Tolerance} = \frac{\text{Mean root length in polluted soil solution}}{\text{Mean root lenght in distilled water}} \times 100$$

The data was analyzed by analysis of variance and student-Newman-Keuls multiple test.

Table 1. Effect of polluted soil extracts of different areas on germination and seedling growth of some species.

	Albizia lebbeck				*Leucaena leucocephala*				*Peltophorum pterocarpum*			
Treatmens	Percent Germination	Seedling lenght (cm)	Root lenght (cm)	Seedling dry wt. (mg)	Percent Germination	Seedling lenght (cm)	Root lenght (cm)	Seedling dry wt. (mg)	Percent Germination	Seedling lenght (cm)	Root lenght (cm)	Seedling dry wt. (mg)
University campus	92.0 ± 2.3	13.6 ± 0.3	a 4.9 ± 0.6	106.0 ± 13.5	97.3 ± 1.3	a 12.6 ± 0.2	5.7 ± 0.9	40.8 ± 0.6	92.0 ± 2.3	5.1 ± 0.1	2.0 ± 0.0	48.7 ± 6.4
Shaheed-e-Millat	92.0 ± 2.3	14.1 ± 2.1	a 5.5 ± 1.6	110.0 ± 6.1	98.7 ± 1.3	ac 12.5 ± 0.2	5.4 ± 0.2	40.2 ± 1.4	90.6 ± 5.8	4.9 ± 0.6	2.0 ± 0.0	42.2 ± 9.6
M.A. Jinnah	90.7 ± 1.3	13.7 ± 0.9	b 8.1 ± 1.4	104.6 ± 3.5	94.7 ± 3.5	b 14.6 ± 5.8	6.9 ± 0.8	43.0 ± 0.4	73.3 ± 10.4	4.8 ± 0.3	0.2 ± 0.0	41.1 ± 2.2
Guruminder	90.7 ± 3.5	13.1 ± 1.0	a 4.0 ± 0.4	99.2 ± 4.3	94.7 ± 5.3	ba 13.4 ± 5.8	5.9 ± 0.6	42.2 ± 0.8	80.0 ± 9.2	4.5 ± 0.0	0.1 ± 0.0	38.3 ± 7.5

Statistical analysis determined by analysis of variance. Numbers followed by the same letter in the same column are not significantly different ($p<0.05$) according to student Newman Keul Multiple Range test. ± Standard Error

Table 2. Percentage reduction in different parameters of some species as compared to control when treated with soil extracts of different areas.

	Albizia lebbeck				*Leucaena leucocephala*				*Peltophorum pterocarpum*			
Treatmens	Percent Germination	Seedling lenght (cm)	Root lenght (cm)	Seedling dry wt. (mg)	Percent Germination	Seedling lenght (cm)	Root lenght (cm)	Seedling dry wt. (mg)	Percent Germination	Seedling lenght (cm)	Root lenght (cm)	Seedling dry wt. (mg)
Shaheed-e-Millat	0.00	+ 3.23	+ 12.50	+ 3.77	1.37	0.69	5.79	1.61	+ 1.52	3.90	14.70	13.36
M.A. Jinnah	1.46	0.92	+ 66.37	1.29	2.74	+ 16.12	+ 21.25	+ 5.29	20.29	5.89	16.18	15.64
Guruminder	1.46	0.00	19.22	6.37	2.74	+ 6.59	+ 3.46	+ 3.46	13.04	13.10	33.82	21.37

+ Percentage increase

Table 3.Percentage tolerance of some species to polluted soil extracts.

	Percentage tolerance			
Treatments	*Albizia lebbeck*	*Leucaena leucocephala*	*Peltophorum pterocarpum*	Average for all species for each sites
Shaheed-e-Millat	112.58	94.21	85.30	97.36
M.A. Jinnah	166.37	121.25	83.82	123.81
Guruminder	80.78	103.46	66.18	83.47
Average of all sites for each species	119.91	106.37	78.43	

Table 4.Levels of Zn and Cu (ppm) in soil of different areas (soil extract made in water)

Location	Zn	Cu
University campus	0.050 ± 0.003	0.025 ± 0.007
Shaheed-e-Millat	0.040 ± 0.001	0.018 ± 0.001
M.A. Jinnah	0.043 ± 0.002	0.035 ± 0.007
Guruminder	0.045 ± 0.005	0.028 ± 0.004

± Standard Error

Results

The seeds of *A. Lebbeck, L. leucocephala* and *P. pterocarpum* were treated with extract of campus soil which was considered as control, showed high rate of germination (Table 1 and 2), whereas the seeds treated with soil extract of city areas showed comparatively less germination. Average percentage reduction in seed germination was more in *P. pterocarpum* and lowest in *L. leucocephala* as compared to control. This showed that *P. pterocarpum* was badly affected by the presence of copper (Table 4) which comes into the soil by the motor vehicle exhaust.

Seedling length of *L. leucocephala* was significantly altered by the soil extract of city areas (Table 1). Treatment with M. A. Jinnach road soil extract significantly inhibited the seedling length in relation to campus and Shaheed-e-Millat soil extract. In *A. lebbeck*, the seedling length was highest in the treatment of Shaheed-e-Millat soil extract, whereas the treatment of Guruminder, M. A. Jinnah road and campus showed more or less similar length. In *P. pterocarpum*, the seedling length of control was highest (5.13 cm) as compared to treated soil extract. The seedling length of this species decreased with increasing copper level. Guruminder soil extract showed lowest seedling length because zinc and copper level was higher at Guruminder.

The average percentage reduction in the seedling length of *P. pterocarpum* was highest in the soil extract of Guruminder as compared to control, whereas, in Shaheed-e-Millat soil extract, percentage reduction was less. In *A. lebbeck*, the seedling length was high as compared to control in all the treatment. In *L. leucocephala*, treatment of Shaheed-e-Millat soil extract showed percentage reduction as compared to control, whereas, the treatment of Guruminder and M. A. Jinnah road soil extract showed percentage increase as compared to control (Table 2).

The root length of *A. lebbeck, L. leucocephala* and *P. pterocarpum* was not significantly altered by the treatment. In *A. lebbeck* and *L. leucocephala*, root length were highest in the soil extract of M.A. Jinnah road, whereas in *P. pterocarpum*, root length was highest in control soil extract. The average percentage reduction of root length of all the species were also recorded (Table 2). Average percentage reduction in the root length was highest in *P. pterocarpum* as compared to control. But *A. lebbeck* showed percentage increase in the treatment of Shaheed-e-Millat and M. A. Jinnah road soil extract. Only the treatment of Guruminder showed percentage reduction, which was 19.22%. Similarly, in *L. leucocephala*, treatment with Shaheed-e-Millat soil extract showed percentage reduction in the root lenght as compared to control, whereas the treatment of Guruminder and M. A. Jinnah road soil extract showed percentage increase.

The seedling dry weight of *A. lebbeck* and *P. pterocarpum* was also reduced by the treatment. Dry weight of control seeds was highest as compared to treated seeds, whereas, in *L. leucocephala*, the seedling dry weight was highest with the treatment of soil extract of M. A. Jinnah road, but the treatment of Shaheed-e-Millat and campus showed more or less similar weights. The average percentage reduction in the seedling dry weights was highest in *P. pterocarpum* as compared to control. In *A. lebbeck*, reduction in seedling dry weight was high with the treatment of Guruminder soil extract, but the soil extract of Shaheed-e-Millat road showed percentage increase as compared to control. In *L. leucocephala*, only the treatment of Shaheed-e-Millat soil extract showed reduction in dry weight, whereas, the soil extract of Guruminder and M. A. Jinnah road increased the dry weight as compared to control.

Tolerance test: The seeds of soil extract of campus were tested for tolerance against the soil extracts of polluted sites. Indices of tolerance are given in Table 3. It could be seen that percentage tolerance of *A. lebbeck* was highest in M. A. Jinnah road soil extract, lowest in the treatment of Guruminder. In *L. leucocephala*, tolerance was also high with the treatment of M. A. Jinnah road soil extract and lowest with the treatment of Shaheed-e-Millat soil extract. In *P. pterocarpum*, highest tolerance was found in Shaheed-e-Millat soil extract as compared to other treatments.

Discussion

The seed germination of *A. lebbeck, L. leucocephala* and *P. pterocarpum* was not significantly altered by the polluted soil extract. Although, the seeds were kept in the dark, the rate of germination was delayed for some days inpolluted soil extract. Askari et al. [3] have reported that percentage germination was slightly higher when the seeds were kept in dark as compared to light. Reduction in seed germination was highest in *P. pterocarpum* and lowest in *A. lebbeck*. This showed that *P. pterocarpum*

was badly affected by automobile pollution. This rate of seed germination showed that the seeds of *A. lebbeck, L. leucocephala* and *P. pterocarpum* were less affected by automobile pollution. This might be due to low solubility of heavy metals in water, since all the seeds were grown in soil extract of water where the concentration of zinc and copper was low (Table 4). No other trace metals were detected in soil extract of any site.

Krishnayys and Bedi [7] have observed that Pb pollution affect seed germination and variability near highways. The germination of seeds could also be affected by the development of unhealthy seeds by trees growing along the main roads in city areas. Bhatti and Iqbal [4] have reported that leaf length, leaf area and leaf weight of plants growing in the city were significantly reduced as compared to control. The results showed that seedling length of *A. lebbeck* and *P. pterocarpum* and root length of all three species were found to be insignificant. The seedling length *of L. leucocephala* was significantly affected by the polluted soil extract. Reduction in seedling and root length of *P. pterocarpum* was high in the treated soil extract as compared to control, and reduction was highest in Guruminder soil extract.

The reduction in dry weight was highest in *P. pterocarpum* and lowest in *L. leucocephala*. This would indicate that *P. pterocarpum* was badly affected by the polluted soil extract. *L. leucocephala*, one of the species studied in this experiment, showed comparatively less reduction in dry biomass as compared to other species. Siddiqui and Iqbal in their unpublished work have reported that *L. leucocephala* was comparatively less resistant to automobile pollution.

Average percentage tolerance of *A. lebbeck* was highest and lowest in *P. pterocarpum*. The growth rate and root length of *P. pterocarpum* was low; thus, the tolerance of this species was also low. In *L. leucocephala*, the tolerance was highest in M. A. Jinnah road soil extract followed by Guruminder and Shaheed-e-Millat soil extracts.

It is concluded that *P. pterocarpum* was found to be the most susceptible species to automobile pollution. The percentage germination, seedling length, root length and seedling dry weight of this species decreased with increasing levels of pollution in soil extract. In Guruminder soil extract, growth and tolerance of this species was lowest since traffic density was considered to be the highest with the result that pollutants which come mostly from autovehicle exhaust into the soil might have affected the seeds. *A. lebbeck* seeds showed more resistance against vehicular pollution, and showed highest tolerance and growth as compared to other species investigated.

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