Letter to Editor

Differential Tolerance of *Albizia Lebbeck* and *Leucaena Leucocephala* at Toxic Levels of Lead and Cadmium

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Abstract

Seed germination and seedling growth of *Albizia lebbeck* and *Leucaena leucocephala* were significantly ($p < 0.05$) reduced at 500 and 700 ppm of lead and cadmium as compared to control. 700 ppm of Pb showed the highest reduction in seed germination and seedling growth of both species. Lowest reduction in different parameters of *Albizia lebbeck* and *Leucaena leucocephala* were found at 500 ppm of Cd as compared to other treatments applied in this investigation. Percentage of tolerance was lowest at 700 ppm of lead than other treatments. *L. leucocephala* was comparatively more tolerant to Pb and Cd than *A. lebbeck.*

Keywords: Cadmium, germination, growth, lead, plant and toxicity

Introduction

The tremendous increase in auto vehicles in recent years has caused the atmosphere to become a continuous source of pollutants, including heavy metals. Plants show considerable amount of lead, cadmium and other metals in their tissues near busy roads [1, 18]. Tetra-ethyle lead, which is an anti knocking additive, is added to gasoline, which escapes from auto exhaust and goes into soil [26], thereby contaminating plants [1, 18] and soil [12]. The excessive uptake of these elements from the soil reduces the yield of plants because of a reduction in metabolic and nutritional processes [3, 4, 11]. Studies are available that show absorption of heavy metals inhibit activities of several enzymes [3, 11], seed germination and seedling growth [23, 14], anatomical changes [21] and decrease in nitrate reductase activities [4].

Heavy metals have been shown to be accumulating in the forest ecosystem [7] and have been suggested as contributing factors in forest decline [8].The progressive decline of trees in the last few years has prompted an increasing interest in general or specific risk assessment studies for tree ecosystems. The evolution of heavy metals tolerant in higher plants in response to severe metal contamination is one of the best documented examples of rapid population adaptation by natural selection. Plants that have evolved tolerance to one heavy metal are not necessarily tolerant to others, indicating metal specificity within tolerance mechanisms [10].

Lead and cadmium are non-essential elements. The harmful effects of Pb and Cd have been demonstrated by many workers [2, 3, 4, 16, 19].

The objectives of the present paper are to study the inhibition of seed germination and seedling growth of two tree species by high levels of Pb and Cd, and their implications of differences in metal tolerance.

Materials and Methods

Healthy seeds of *Albizia lebbeck* (L.) Bth. and *Leucaena leucocephala* (Lam.) de Wit. were collected from the University campus. The seeds were stored tightly at room temperature before treatments with metal solution. The seeds were rubbed with sand paper to soften the seed

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Table 1. Effects of different concentrations of Pb and Cd on germination and seedling growth of *Albizia lebbeck.*

	Albizia lebbeck					
Treatments (ppm)	Percent Germination	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Seedling dry Weight (gm)	Root/Shoot ratio
Control	a	a	a	a	a	a
	93.33±10.05	2.01±0.23	7.44±0.81	9.46±1.04	0.70±0.08	0.20±0.01
500 Pb	c	b	c	c	c	c
	60.00±6.49	0.54±0.06	2.82±0.32	3.36±0.38	0.45±0.04	0.18±0.02
	* 35.71	* 73.13	* 62.09	* 64.48	* 35.71	
500 Cd	b	c	d	d	b	c
	80.00±8.61	0.67±0.07	5.77±0.62	6.41±0.69	0.64±0.06	0.11±0.01
	* 14.28	* 66.66	* 22.44	* 32.24	* 8.57	
700 Pb	d	d	e	e	d	c
	26.67±2.91	0.11±0.01	0.91±0.11	1.02±0.12	0.34±0.04	0.13 ±0.02
	* 71.42	* 94.52	* 87.76	* 89.21	* 51.42	
700 Cd	a	b	b	b	b	b
	90.00±9.69	0.56±0.04	6.73±0.73	7.28±0.79	0.68±0.07	0.08±0.008
	* 3.56	* 72.13	* 9.54	* 23.04	* 2.85	

Statistical significance determined by analysis of variance, Number followed by the same letters in the same column are not significantly different ($p < 0.05$) according to Student Newman Keuls Multiple Range Test. ± standard error. * = percentage reduction as compared to control.

coat and were socked in 0.2 percent solution of mercuric chloride for one minute to avoid any type of fungal contamination during seed germination. The seeds were washed with distilled water and were placed in 90 mm diameter glass petridishes on filter papers. Twenty seeds were taken in each petridish for each treatment and were replicated three times. Metal treatments of Pb and Cd were prepared with lead nitrate and cadmium nitrate and were applied at 500 and 700 ppm of Pb and Cd. 2 ml of respective treatment was added to each petridish and at every alternate day, the old solution was replaced with a new solution. All the petridishes were kept at room temperature (25±2 ^{0}C) with six hourly light period provided by three mercury tubes (120W). After ten days, seed germination, maximum root, shoot and seedling length was recorded. Seedling dry weight was also obtained and the data was subjected to analysis of variance (ANOVA) and Student Multiple Range Test (SMRT).

Results

The effects of Pb and Cd on *Albizia lebbeck* at 500 and 700 ppm are shown in Table 1. The highest significant ($p<0.05$) effects in seed germination (26.67%) was found at 700 ppm lead compared to other treatments of Pb and Cd. Similarly, root, shoot, seedling length and dry weight of seedling also showed significant ($p<0.05$) reduction at 700 ppm of lead treatment. 500 and 700 ppm of Cd showed less effects on different parameters of *A. lebbeck* as compared to Pb. Decrease percentage of *A. lebbeck* at different concentration showed that 700 ppm Pb had the highest percentage of decrease in seed germination, root and shoot length and seedling dry weight as compared to other treatments. The percentage reduction was also great at 500 ppm Pb than 500 and 700 ppm of Cd treatments. The percentage of tolerance of *A. lebbeck* to different concentrations of Pb and Cd was given in (Table 3). The lowest tolerance (5.47%) was found at 700 ppm of Pb followed by 500 ppm Pb (26.86%), 700ppm Cd (27.86%) and 500 ppm Cd (33.33%).

The results showed that 500 ppm and 700 ppm Pb significantly ($p<0.05$) reduced the seed germination of *L. leucocephala* (Table 2). Whereas, Cd at the same level showed little effects on seed germination of *L. leucocephala.* Root, shoot and seedling lengths were also reduced significantly ($p<0.05$) at 500 and 700 ppm of Pb. The effect of Cd was also significant at 500 and 700 ppm but showed fewer effects as compared to Pb. On seedling dry weight of *L. leucocephala,* the effect of 500 and 700 ppm of Pb was significant ($p<0.05$), whereas Cd showed no effects at all. Decreased percentage of *L. leucocephala* showed that 500 and 700 ppm of Pb had the highest reduction as compared to Cd treatment (Table 2). The highest percentage reduction in root length of *L. leucocephala* was record at 700 ppm of Pb (96.90%) followed by 700 ppm of Cd (86.28%). Similarly, the lowest tolerance (3.09%)was found at 700 ppm Pb as compared to Cd (13.71%) at the same concentration (Table 3). 500 ppm

Table 2. Effects of different concentrations of Pb and Cd on germination and seedling growth of *Leucaena leucocephala.*

	Leucaena leucocephala					
Treatments (ppm)	Percent Germination	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Seedling dry Weight (gm)	Root/Shoot ratio
Control	a	a	a	a	a	a
	100.00 ±0.00	4.52 ±0.30	6.30 ±0.68	10.83 ±1.17	0.23 ±0.02	0.16 ±0.02
500 Pb	b	b	b	b	b	b
	50.00 ±5.43	0.35 ±0.04	1.15 ±0.13	1.50 ±0.17	0.09 ±0.01	0.32 ±0.04
	* 50.00	* 92.25	* 81.74	* 86.14	* 60.86	
500 Cd	a	c	c	c	a	c
	100.00 ±0.00	0.93 ±0.01	3.82 ±0.41	4.76 ±0.51	0.23 ±0.02	0.70 ±0.08
	* 0.00	* 79.42	* 39.36	* 56.00	* 0.00	
700 Cd	c	d	b	b	b	a
	33.33 ±3.74	0.14 ±0.02	1.14 ±0.12	1.28±0.14	0.09 ±0.01	0.12 ±0.01
	* 66.67	* 96.90	* 81.9	* 88.18	* 60.8	
700 Cd	d	e	c	d	a	d
	93.33 ±10.94	0.62 ±0.07	3.25 ±0.35	3.87 ±0.42	0.23 ±0.02	1.35 ±0.17
	* 6.67	* 86.28	* 48.41	* 64.26	* 0.00	

Statistical significance determined by analysis of variance, Number followed by the same letters in the same column are not significantly different ($p < 0.05$) according to Student Newman Keuls Multiple Range Test. ± standard error. * = percentage reduction as compared to control.

Table 3. Percentage tolerance of *Albizia lebbeck* and *Leucaena leucocephala* to different concentrations of Pb and Cd.

Treatment (ppm)	*A. lebbeck*	*L. leucocephala*
500 Pb	26.86	7.74
500 Cd	33.33	20.57
700 Pb	5.47	3.09
700 Cd	27.86	13.71

of Pb also showed considerable low tolerance (7.74%) as compared to 500 ppm Cd (20.57%).

Discussion

The result showed that lead and cadmium at different concentrations reduced seed germination, root, shoot and seedling length and seedling dry weight in *Albizia lebbeck* and *Leucaena leucocephala*. Similarly, Dalal and Bairgi [5] have found reduction in seed germination, root, shoot and seedling length of jute varieties, *Corchorus olitorius* cv JRO 524 and *C. capsular* JRA 321 at different levels of Pb, particularly at 20 mg/l. Javid and Sahar[16] have also found reduction in seed germination and seedling growth in maize at 5 to 100 mM lead nitrate treatment. Heavy metals have been shown to reduce growth of trees in a number of studies [17]. The distribution and frequency of red spruce mortality are associated with high levels of pollutant deposition.

Iqbal *et al.,* [15] have studied the influence of Cd toxicity on germination and growth on some common trees. Mahmood and Iqbal [20] reported that seeds of *A. lebbeck* and *Dalbergia sisso* from polluted areas of Karachi showed significant reduction in seed germination due to the presence of Pb in vehicular exhaust. The reduction in root length in *A. lebbeck* and *L. leucocephala* was great at different concentrations of Pd and Cd treatments as compared to shoot and seedling length. This was also confirmed by Stefan *et al.* [24] in some other species. The reduction in root length may be due to accumulation of metals within the root, which reduced the rate of mitosis in the meristematic zones of roots, especially blocking the metaphase in meristematic cells; therefore, roots showed reduction in length as demonstrated by Goldbold and Kettner [8] and Sharifah and Hishashi [22]. Lerda [19] observed that 50, 100 and 200 ppm Pb stopped the growing processes in plants after 24 hours. These findings confirm that Pb causes inhibition in root growth.

Tree species regeneration could be reduced by many factors, including changes in ecosystem demographics, inadequate production of viable seed, animal's depredations, allelopathy, reduced seed germination and poor seedling survival or development. Seed germination is a critical reproductive stage, which may be sensitive to high acidity and or high concentrations of trace metals. Although tree seed germination response to heavy metals varies with species it is generally less sensitive to metals than seedling development [13].

It was also observed by the present study that seed germination was less affected by lead and cadmium treatment at different concentrations as compared to root, shoot and seedling length and seedling dry weight. Further studies would be required to evaluate seed germination and early seedling development under more variable environmental conditions.

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