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LEAD HARMS SEED GERMINATION & GROWTH OF *ALBIZIA LEBBECK* (L.) BENTH. AND *PROSOPIS JULIFLORA* (SW.) DC.

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Abstract

Lead produced significant (p<0.05) effects on various growth parameters of *A. lebbek*and *P. juliflora* i.e., root, shoot, seedling length, number of leaves, leaf area and seedling biomass. The seeds of *A. lebbeck* exhibited germination at 0ppm, 10pm, 20ppm and 30ppm in lab. Lead treatments at control to 10, 20, and 30ppm reduced the percentage of seed germination from 92% to 77% respectively in *P. juliflora.* Number of leaves, leaf area and biomass of both seedlings exhibited significant (p<0.05) decrease when treatments of lead were increased from 20 ppm to 30 ppm. Lead treatments of 25, 50 and 75 ppm were also carried out in pot experiment. Lead treatments at 75 ppm demonstrated much reduction in growth as compared with control. The rise in absorption of lead directly effects shoot growth and root length is also reduced. But at 25 ppm shoot growth of *A. lebbeck* was better than control but shoot growth of *P. juliflora* was reduced. The shoot length was much reduced by increase in concentration of lead. The seedlings grown in control soils have better growth as compared with lead treated soils. The increase in concentration of lead decreases the seedling size. The seedlings which were treated with the 25ppm and 50 ppm were almost of same size but 75 ppm caused much reduction in both seedlings growth. Increased concentration of lead reduced the dry weight. General fallouts of different limits showed that lead is much toxic element, which caused much reduction in seed germination and growth of both *A. lebbeck* and *P. juliflora.*

Key words: *A. lebbeck, P. juliflora,* Lead, Biomass, Germination, Pot conditions.

Introduction

Heavy metals in atmosphere disturb the morphological and physiological parameters of vegetation. The primary source of pollution is combustion of fossils fuel (Amin *et al*., 2013). The green vegetables and plants take up heavy metals. After the uptake these toxic elements are transferred to different tissues of plants, increase in translocation of heavy metals enhances quantity of these metals in plants more than that of soil (Khan *et al*., 2010). Heavy metals are not individually harmful for plants, if they are preceded in food chain they are also hazards for humans and other living organisms (Kumar *et al*., 2013).

Lead is heavy metal with atomic number of 82, having atomic mass 207.2 amu and have low melting point. Lead (Pb) is one of the most harmful pollutants present in soil, taken in plants by roots. Lead pollution directly disturbs ecosystem by entering into the food chain of organisms. The major sources of Pb are primarily automobile emission, paints chips, fertilizers, Pb-acid batteries, insecticides, pesticides and other industrial wastes (Barrutia *et al*., 2010). Pb is taken in plants by roots and sometimes by leaves (Amari *et al*., 2017). Pb effects plants and food chain (He *et al*., 2004; Belkhadi *et al*., 2010; Gallego *et al*., 2012; Saidi *et al*., 2014). Plants grown on lead polluted soils like roadsides have decreased growth (Asati *et al*., 2016). With increase uptake of lead by plants the ultra-structures of tissues, cells, chloroplast, mitochondria, nucleus, cell wall and cell membrane are altered in result different physiological processes of plants like photosynthesis, respiration and protein synthesis are effected which eventually lowers plant growth (Salazar & Pignata, 2014). High quantity of lead and cadmium effects metabolism rate of young *Phoenix dactylifera* (Abbas *et al*., 2016). The High concentrations of chromium and lead are also found to be stress full to the mustard seedling by decreasing growth (Al-Mahmud *et al*., 2018). The content of chlorophyll decreases with increase in Pb (Tandon & Srivastva, 2015). Lead directly effects pigments, decreasing rate of photosynthesis i.e. eventually decreased plant growth in Pea plant (Pichhode & Nikhil, 2017). The activities of enzymes like superoxidase dismutase and peroxidases increases with increase in Pb while catalases activity is decreased eventually effect metabolism in plants (Yang *et al*., 2011). To avoid phytotoxicity of different heavy metals like lead, plant have adopted mechanism like production of phytochelatins (PCs) and metallothioneins (Mts) (Lin *et al*., 2012; Saidi *et al*., 2014; Qing *et al*., 2015). Selenium can reduce uptake of lead and cadmiuim (Wu *et al*., 2016). The reed plants can uptake lead so they can be used to get rid of Pb from water (Khalid *et al*., 2017).

Albizia lebbeck L., belongs to family Mimosaceae. *A. lebbeck* is native species to deciduous and semi deciduous forests in Asia. It is a leguminous tree, 10-20 m tall mostly and has widespread canopy. It can also be found in moist semi-evergreen or evergreen forests usually occurring scattered. It is also a good source of timber for furniture and other woodwork (Mazhar *et al*., 2015).

Prosopis juliflora (Sw.) DC.belongs to family Fabaceae. It is very popular shrub, because it is involved in transmission of malaria especially during dry season. It is local specie of Mexico and Australia. This tree has height up to 12.5 meters (40ft) and its trunk is about 1.2 meters (3.9ft). It is used as forage and fodder for animals, wood is used in furniture. It is also used for environmental management. The aim of work was to investigate adverse effects of lead on different growth parameters of *A. lebbeck* and *P. juliflora.*

Materials and Methods

The experiment was conducted to know effects of lead on different growth parameters of *Albizia lebbeck* (L.) Benth. and *Prosopis juliflora* (Sw.) DC. Healthy seeds of *Albezia lebbek* and *Prosopis juliflora* were obtained from National Agriculture Research Center (NARC) Islamabad. For germination, seeds were purified and sterilized with sodium hypochlorite (0.5%) solution for 20 minutes. These seeds were then washed with distilled water. The seeds were water-logged for 12 hours. Petridishes were autoclaved to avoid pathogen attack. The seeds were then placed in petridishes with double layer of filter paper. The medium of germination for seeds was filter paper (Watman # 42). The control treatment received 5 ml of distilled water. The other petri dishes received 5 ml of solution of each lead treatment i.e. 10, 20, 30 ppm respectively. The control petri dish was kept moist by giving distill water when needed. The treated petri dishes were also kept moist by applying treatments when needed. The dishes were kept in the dark portion of the laboratory at room temperature (25 degree centigrade). Germination counts were noted day-to-day for a period of ten days. The pot experiment was laid out as completely randomized designed (CRD) with three treatments of lead contaminated soils in replicates. Lead treated soils and control soil were filled in 12 earthen pots having size (6 cm x 8 cm) length and breadth respectively. Each pot was filled with 50 gram of sample soil. The pots were given water and next day seeds were sown so that heat in soil was lost. Mechanical rubbing and cutting of seeds was done as pretreatment. Water was given daily as needs of seeds. The seed germination data was updated after four days. The reshuffling of pots was done every week to avoid effects of light or any other environmental factor. After two weeks germinated plants were shifted in disposable plastic glass pots. Each pot had one seedling. The pot soils samples received 25ppm, 50ppm and 75 ppm lead treatment respectively. The plants were collected after a month. Growth parameters like root length, shoot length, plant size was measured by meter-rule method with iron scale. Germination percentage and plant seedling growth parameters were determined (Iqbal & Rahmati, 1992). Data was analyzed by using analysis of variance (ANOVA) to check difference between control and treatments and Duncan's multiple range test (p<0.05) using the SPSS Statistics (20.0 version) software.

Results and Discussion

Overall it was observed that lead has adverse effects on different growth parameters of both *Albizia lebbeck* and *Prosopis juliflora.* The results presented that the seed germination, root growth, shoot growth, seedling growth, and dry weight of *A. lebbeck* were reduced in concentrations (10, 20, 30, 50 and75 ppm) of lead as compared to control (Tables 1.1 & 1.2). Different growth parameters of *P. juliflora* were observed to reduce in lead concentrations (10, 20, 30, 50 and 75 ppm) as compared to control (Tables 2.1 & 2.2). Plants exposed to lead, even at low levels, growth reduction occurs (Kopittke *et al*., 2010).

Lead directly prevents germination of seeds, growth of seedlings, length of parameters like root/shoot, tolerance index and biomass of root and shoot (Mishra & Tripathi, 2008). Same results are also observed in other studies at various lead concentrations all vegetative parts showed negative growth effects in *Pisum Sativum*, in *Zea mays* (Çimrin *et al*., 2007). The effects of lead are less significant (p<0.05) on the seed germination of the *A. lebbeck.* Lead treatments at 10, 20, and 30ppm reduced the percentage of seed germination from 92 % to 67% (Table 1.1). Almost more than eighty percent seeds were germinated in all concentrations of lead. But there was much reduction in seed germination at 30ppm lead concentration (Table 1.1). Seeds of *P. juliflora* also showed significant (p>0.05) reduction in seed germination as compared to control. Lead treatments at control to 10, 20, and 30ppm reduced the percentage of seed germination from 92 % to 77% respectively (Table 2.1). Germination is strongly inhibited by very low concentrations of Pb. Loss of seed germination due to lead is also reported in *Hordeum vulgare*, *Elsholtzia argyi*, *Spartina alterniflora*, *Pinus halepensis*, *Oryza sativa*, and *Zea may* (Islam & Hoque, 2014). The increase in concentrations of lead directly effects shoot growth. Shoot length of *A. lebbeck* was reduced from 4.78 cm to 3.35 cm with comparing control at 30 ppm treatment, respectively (Table 1.1). In lab. conditions shoot length of *P. juliflora* was reduced from 6.82 cm to 4.70 cm in control to 30 ppm treatment, respectively (Table 2.1). Even at low concentrations, lead effects all process of plant along with shoot growth in wheat (Li *et al*., 2020). The growth of root was reduced as the quantity of lead increased. Root length of *A. lebbeck* was reduced from 2.15 cm to 1.75 cm in control to 30 ppm treatment, respectively (Table 1.1). Root elongation of *P. juliflora* was reduced from 2.95 cm to 1.85 cm in control to 30 ppm treatment, respectively (Table 2.1). Root elongation is significantly inhibited by lead in Mesquite (*Prosopi* ssp.) (Arias *et al*., 2010). Dry weight of seedlings which were grown in lead treated soils was similar to control in *A. lebbeck* but dry weight of *P. juliflora* was reduced (Tables 1.1 & 2.1). Plant biomass is reduced by lead exposure (Singh *et al*., 2010).

In pots, the shoot growth of both *A. lebbeck* and *P. juliflora* was reduced from 21.97 cm to 12.06 and from 21.91 cm to 12.25 cm in control to 75 ppm of lead, respectively (Tables 1.2 & 2.2). The control had better shoot growth then other lead treated soils. The root growth of both *A. lebbeck* and *P. juliflora* were also reduced from 10.67 cm to 9.64 cm and from 10.67 cm to 6.72 cm in control to 75 ppm of lead respectively (Tables 1.2 & 2.2). Lead toxicity is also responsible for bent, swollen, short and broad roots, responsible for increased number of secondary roots per unit root length (Haider *et al*., 2006). The seedlings grown in control soils were well of size as compared to lead treated soils. Increased concentration of lead decreases the seedling length. The seedlings which were treated with 50ppm and 75ppm caused much reduction in seedling growth. The lead treatments 25, 50 and 75 ppm showed significantly reduce in dry weight. Same negative results of lead on different growth parameters are observed in *Pisum sativum* (Kevresan *et al*., 2001) and *Cynodon dactylon* (Shua *et al*., 2002) in *Lycopersicon esculentum* (Jaja & Odoemena, 2004), *Pomoea aquatic* (Gothberg *et al*., 2004), *Phaseolus vulgaris* and *Lens culinaris* (Haider *et al*., 2006).

Table 1.1. Effects of different lead concentrations on different growth parameters of *A. lebbeck* in Lab. conditions.

Treatment of lead (ppm)	Germination (%)	Shoot length (Centimeters)	Root length (Centimeters)	Seedling length (Centimeters)	Dry Wt. of seedling (Milligrams)
0	92.50 ± 2.50ab	4.78 ± 0.09b	2.15 ± 0.25b	6.23 ± 0.24b	8.65 ± 0.15bc
10	82.50 ± 2.50a	4.59 ± 0.28a	2.38 ± 0.10a	7.45 ± 0.39a	7.90 ± 0.25c
20	72.50 ± 2.50a	3.35 ± 0.12a	1.95 ± 0.15ab	5.25 ± 0.22ab	6.80 ± 0.38b
30	67.50 ± 2.50a	4.43 ± 0.45ab	1.75 ± 0.19a	5.88 ± 0.45a	4.08 ± 0.40a

Values followed by the same letters in same column are not significantly different (p<0.05) according to Duncan's Multiple Range Test

Table 1.2. Effects of different lead concentrations on different growth parameters of *A. lebbeck* in pot experiment.

Treatment of lead (ppm)	Root length (Centimeters)	Shoot length (Centimeters)	Seedling length (Centimeters)	No. of leaves	Fresh Wt. of Seedling (Grams)	Dry Wt. of Seedling (Milligrams)
0	10.67 ± 1.53a	21.97± 1.39b	37.46 ± 1.40c	36.00 ± 2.00c	1.00 ± 0.10a	376 ± 74.00a
25	11.43 ± 1.78a	12.06 ± 1.40a	30.50 ± 1.24b	23.00 ± 3.00bc	0.76 ± 0.040a	289.50 ± 70.00a
50	9.64 ± 0.25a	15.62 ± 0.89a	25.05 ± 1.62ab	30.00 ± 2.00ab	0.76 ± 0.095a	271 ± 31.00a
75	6.72 ± 0.63a	12.25 ± 0.85a	19.94 ± 1.66a	15.00 ± 1.00a	0.82 ± 0.050a	335 ± 55.00a

Values followed by the same letters in same column are not significantly different (p<0.05) according to Duncan's Multiple Range Test

Table 2.1. Effects of different lead concentrations on different growth parameters of *A. lebbeck* in Lab. conditions.

Treatment of lead (ppm)	Germination (%)	Shoot length (Centimeters)	Root length (Centimeters)	Seedling length (Centimeters)	Dry wt. of seedling (Milligrams)
0	92.50 ± 2.50b	6.82 ± 0.07b	2.95 ± 0.15b	9.82 ± 0.28b	8.95 ± 0.05c
10	87.50 ± 2.50ab	5.28 ± 0.38a	2.20 ± 0.20ab	7.48 ± 0.59a	8.10 ± 0.20bc
20	82.50 ± 2.50ab	5.18 ± 0.13a	1.85 ± 0.25a	7.04 ± 0.26a	7.30 ± 0.40b
30	77.50 ± 2.50a	4.70 ± 0.35a	1.95 ± 0.18a	6.60 ± 0.47a	5.00 ± 0.50a

Values followed by the same letters in same column are not significantly different (p<0.05) according to Duncan's Multiple Range Test

Table 2.2. Effects of different lead concentrations on different growth parameters of *P. juliflora* in pot experiment.

Treatment of lead (ppm)	Root length (Centimeters)	Shoot length (Centimeters))	Seedling length (Centimeters)	No. of leaves	Fresh wt. of Seedling (Grams)	Dry wt. of seedling (Milligrams)
0	10.67 ± 1.53a	21.97 ± 1.39b	37.46 ± 1.40c	36.00 ± 2.00c	1.00 ± 0.10a	376 ± 74.00a
25	11.43 ± 1.78a	12.06 ± 1.40a	30.50 ± 1.24b	23.00 ± 3.00bc	0.76 ± 0.040a	289.50 ± 70.00a
50	9.64 ± 0.25a	15.62 ± 0.89a	25.05 ± 1.62ab	30.00 ± 2.00ab	0.76 ± 0.095a	271 ± 31.00a
75	6.72 ± 0.63a	12.25 ± 0.85a	19.94 ± 1.66a	15.00 ± 1.00a	0.82 ± 0.050a	335 ± 55.00a

Values followed by the same letters in same column are not significantly different (p<0.05) according to Duncan's Multiple Range Test

In conclusion heavy metals, typically lead is not important element to plants, but it has ability to accumulate within various plant parts and harms all physiological developments. Lead presence in soil prevents germination of seeds. Atmospheric lead harms aerial parts of vegetation. Therefore, the Government and various environmental agencies are requested to control, heavy metals pollution particularly lead.

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