GROWTH OF *ALBIZIA LEBBECK* (L.) BENTH., IN DIFFERENT SOIL COMPOSITIONS OF KORANGI AND LANDHI INDUSTRIAL AREAS OF KARACHI, PAKISTAN

SYED ATIQ-UR-RAHMAN[*1] AND MUHAMMAD ZAFAR IQBAL[2]

[1]Department of Botany, Govt. Degree College, Buffer Zone, Karachi-7585
[2]Department of Botany, University of Karachi, Karachi-75270
[*]Corresponding author e-mail:atiq_falcon7663@yahoo.com

Abstract

The growth of *Albizia lebbeck* (L.) Benth., were studied in soils collected from Khan Towel, Tanveer Garment, One Tech Rubber and One Tech Ply Board factories in the vicinity of Korangi and Landhi industrial sites under natural environmental conditions. *A. lebbeck* plants which were grown in 25, 50 and 75% soils of all industries, displayed reduction in diverse growth variables as compared to plants which were grown in garden soil. Seventy five % Khan Towel factory soil and 25% Tanveer Garment factory soil showed more reduction in *A. lebbeck* growth than garden soil. Inhibition in growth was principally pronounced in 50% One Tech Rubber factory soil and 75% One Tech Ply Board factory soil as compared to garden soil. 50% One Tech Rubber factory soil was most hazardous depleting great numbers of growth parameters of *A. lebbeck*. A large numbers of growth parameters were stunted in 25, 50 and 75% Khan Towel factory soils as compared to garden soil. Seventy five % Khan Towel factory soil substantially depleted plant height, cover, leaves and leaflets number, shoot length, leaf dry weight, root/shoot and leaf weight ratios. Number of leaves, root length, leaflets numbers, leaf area, root/shoot and leaf weight and leaf area ratios were considerably low in growth in the treatment of 25% Tanveer Garment factory soil over the garden soil. Fifty% One Tech Rubber factory soil prominently retarded plant height, number of leaves and leaflets, plant cover, shoot length, leaf area, leaf dry weight, root/shoot, leaf weight ratios and specific leaf area as related to garden soil. Plant height, cover, root, shoot, seedling length, leaf area, root, leaf, total plant dry weights and root/shoot ratio were significantly lessened in 75% One Tech Ply Board factory soil.

Introduction

Due to economic growth, population increase, urbanization, industrialization and technological developments, a significant degree of pollutants are existed in the surrounding environment. Toxic pollutants in the environment have been progressively increasing in the environment (Iqbal *et al.*, 2001) and are discharged into the air by human activities (Nriagu & Pacyna, 1988). Karachi has three main industrial zones viz., Sindh industrial Trading Estate, Landhi Industrial Trading Estate and Korangi industrial area which are emitting excessive amount of industrial pollutants into the air, water and soil (Atiq-ur-Rehman & Iqbal, 2007). Kullberg (1974) has described that damage to vegetation particularly the water plants brought about by industrial effluents. *Albizia lebbeck* (L.) Benth. is cultivated for ornamental purposes and sink for pollution in the verge of industrial locations of Karachi (Atiq-ur-Rehman, 2007). *A. lebbeck* is probably native to tropical and subtropical Asia and East Africa but, introduced and cultivated all over the tropics. Some workers demonstrated relation of different soil characters with plant. The soil pH also has an indirect effect on plants (Walter, 1971). Soluble salts produced a significant impact on the plant communities (Tivy, 1982). Changes in leaf water relations under water stress were examined by Saito & Terashima (2004). Sulphur is predominantly available to plants as sulphate in the soil and the sulphur demand is fulfilled by its uptake through the roots (Herschbach *et al.*, 2005). Seed germination, root length, shoot length and seedling dry weight of *A. lebbeck* were decreased with application of 700 μg^{-ml} of Cu and Fe solution (Iqbal & Rahmati, 1992). Seed germination, root length, seedling length and dry biomass of *A. lebbeck* were reduced with increased concentration of 125μg^{-ml} of zinc (Iqbal & Shafiq, 1999). Iqbal and Atiq-ur-Rehman (2002) have determined that the increase in concentration of Cr reduced the dry weight of *Leucaena leucocephala*. Root, shoot length and dry weight of *A. lebbeck* seedlings were reduced with ferric and copper treatments (Iqbal & Atiq-ur-Rehman, 2005). Industries e.g. towel, garment, rubber and ply board emit waste effluents and solid wastes, which pollute the soil of the nearby area. In view of harmful role of industries in Karachi, it is necessary to investigate the effects of various soil composition of polluted soil of industrial areas on the growth of *A. lebbeck*, since this plant is found growing in the surrounding of Korangi and Landhi industrial areas.

Materials and Methods

For soil analysis, two soil samples of Khan Towel, Tanveer Garment, One Tech Rubber and One Tech Ply Board factories including garden soil were collected and air-dried, lightly crushed and passed through a 2 mm sieve and kept in the laboratory. For mechanical analysis of soil, coarse sand was determined by sieve method using 0.05 mm sieve (USDA, 1951). Maximum water holding capacity (W.H.C.) was measured by the method of Keen (1931). Soil organic matter was determined according to Jackson (1958). Calcium carbonate concentration was determined by acid neutralization, as described by Qadir *et al.*, (1966). Bower & Wilcox (1965) methodology was used to determine total soluble salts whereas**,** soil pH was recorded by a direct pH-reading meter (MP 220 pH Meter) (Mettler, Toledo). Available sulfate in soil was determined by the turbidity method as described by Iqbal (1988), using a colorimeter (Photoelectric Colorimeter AE-11M). Soil analysis was also conducted for heavy metals by wet digestion. In this regard, one gram dried soil sample was taken in 50 ml beaker and digested with 5 ml concentrated nitric acid (HNO_3) + 5 ml concentrated perchloric acid ($HClO_4$), heated at 90 °C for 2½ hours. Thereafter, little amount of distilled water was added in the digested residue and filtered through Whatman filter paper No. 42 and solution volume was made up to 50 ml using distilled water and solution was diluted 10 times for copper, zinc and chromium analyses by atomic absorption spectrophotometer (Perkin Elmer Model No. 3100).

The experiment was conducted in a greenhouse at the Department of Botany, University of Karachi. Healthy and uniform-sized seeds of *Albizia lebbeck* (L.) Benth., were collected from Karachi University Campus. Due to hard seed coat, the seeds were slightly cut at one end and were sown in garden soil (loam soil) at 1 cm depth in large pots. The seeds were irrigated daily. After about one month period, uniform-sized seedlings were transplanted into pots of 19.8 cm in diameter and 9.6 cm in depth in varied soil ratio (25% factory soil + 75% garden soil; 50% factory soil + 50% garden soil; 75% factory soil + 25% garden soil) of Khan Towel, Tanveer Garment, One Tech Rubber and One Tech Ply Board factories at 0-30 cm depth from Korangi and Landhi industrial regions of Karachi. The garden soil was used as a control. The fraction of garden soil was one part manure and two parts fine sand. Since, in the preliminary studies, pure soils of all industries hardly showed any response to seed germination and seedling growth. So, polluted soils around there industries show that there industries are not properly disposing their toxic waste which is hazard for environment and ecosystem. There were six replicates for each treatment and the experiment was completely randomized. Only one seedling was grown in each pot and the plants were irrigated daily. Every week, reshuffling of pots was also done to avoid light/shade or any other greenhouse effects. Seedlings height, number of leaves and plant cover were recorded after every two weeks for ten weeks. After ten weeks, number of leaflets and leaf area of each plant were recoded and all the plants of *A. lebbeck* were carefully removed from the pots and washed thoroughly to measure root, shoot and seedling length. Root, shoot and leaves were separated for drying in an oven at 80 °C for 24 hours. Oven-dried weights of root, shoot and leaves and total plant dry weight were recorded. Root/Shoot ratio, leaf weight ratio, specific leaf area and leaf area ratio were also determined as mentioned by Atiq-ur-Rehman & Iqbal (2009a).

All data was statistically analyzed by ANOVA (Steel & Torrie, 1984) and DMRT (Duncan, 1955) ($p < 0.05$) using personal computer software packages Costat version 3.0 and SPSS version 10.0.

Reduction in percentage of all growth data was determined in treated soils of the factories relative to control soil as described by Atiq-ur-Rehman & Iqbal (2009b).

Results

Total soluble salts were greatly high in all factories soils particularly in Khan Towel factory soil (14.0 μg^{-g}) which resulted declination in many of the growth expressions of *A. lebbeck* as compared to garden soil (Table 1). Soil organic matter was low in all factory soil especially, Tanveer Garment factory soil had lowest organic matter (0.9%). Soil pH was with slight difference in all factories and garden soils, comparatively Tanveer Garment factory soil displayed slightly high pH (8.3) than other soil types. Zinc was in varied ranges in different soil types principally Tanveer Garment factory soil exhibited relatively more zinc concentration (0.090μg^{-g}) in comparison to garden soil. Coarse sand was great amount in all industrial soils primarily One Tech Rubber factory soil had high coarse sand (88.0%). Most of the industrial soil showed less amount of water retaining capacity whereas water holding capacity was adequately scarce (17.0%) in One Tech Rubber factory soil. Calcium carbonate was also in substantial quantity in all industrial soils while, One Tech Rubber factory soil demonstrated obvious calcium carbonate (36.5%) concentration. Chromium in all industrial soils also observed in more amount as compared to garden soil but One Tech Rubber factory soil exhibited prominently elevated chromium (6.899μg^{-g}) as correlated to garden soil. Available sulfate was also high in all industrial soils but One Tech Ply Board factory soil had great range of available sulfate (608μg^{-g}). Copper was in different ranges in different soil types but One Tech Ply Board factory soil showed higher copper (0.074μg^{-g}) concentration than to garden soil.

Table 1. Characteristics of garden and industrial areas soils

Sites	Course sand (%)	*W.H.C. (%)	Organic matter (%)	$CaCO_3$ (%)	Total soluble salts (%)	pH	Available sulfate (μg^{-g})	Cu (μg^{-g})	Zn (μg^{-g})	Cr (μg^{-g})
A	21±1 c	37±0 ab	4.3±0.3 a	12.8±0.2 c	3.8±0.2 d	8.1±0.0 ab	24±1 d	0.016±0.004 b	0.062±0.004 b	1.194±0.083 c
B	24±2 c	29±3 c	2.1±0.2 b	29.5±1.5 b	14.0±2.0 a	8.0±0.1 ab	575±13 a	0.023±0.012 b	0.033±0.001 c	4.139±0.093 b
C	47±0 b	31±2 bc	0.9±0.0 c	24.5±0.5 c	8.0±0.0 c	8.3±0.1 a	108±23 c	0.008±0.002 b	0.090±0.002 a	4.229±0.111 b
D	88±1 a	17±3 d	1.1±0.1 c	36.5±2.5 a	12.0±0.0 ab	8.2±0.1 ab	401±11 b	0.002±0.002 b	0.019±0.002 d	6.899±0.978 a
E	26±2 c	40±0 a	3.3±0.4 a	17.5±1.5 d	9.0±1.0 bc	7.8±0.2 b	608±45 a	0.074±0.002 a	0.003±0.002 e	1.404±0.406 c
L.S.D	5	7	1.1	5.4	3.7	0.4	86	0.020	0.008	1.742

A = Garden soil; B = Khan Towel factory soil; C = Tanveer Garment factory soil; D = One Tech Rubber factory soil; E = One Tech Ply Board factory soil. *W.H.C. = Water Holding Capacity.

Statistical significance determined by analysis of variance. Number followed by the same letters in the same column is not significantly different, according to Duncan's Multiple Range Test. Least significance difference (L.S.D.) values at $p < 0.05$ level.
± Standard error.

After ten weeks, plant height and number of leaves of *Albizia lebbeck* were hampered in 25, 50 and 75% Khan Towel factory soils whereas plant height was also slightly repressed in 25, 50 and 75% One Tech Rubber factory soils as related to garden soil. Little differences were observed after two weeks up to ten weeks in plant height, number of leaves and plant cover in different soil compositions of Khan Towel factory soil and garden soil. But, after ten weeks, 75% Khan Towel factory soil more confined with slight differences between other compositions and garden soil in plant height (5.20 cm) (Fig. 1a), number of leaves (3.83) (Fig. 1b) and plant cover (12.82 cm) (Fig. 1c) of *A. lebbeck* as compared to plant height (5.92 cm), number of leaves (6.17) and plant cover (15.83 cm) in garden soil.

Plant height was not significantly repressed after second week upto ten weeks between different compositions of Tanveer Garment factory soil. The results of no. of leaves were significant between garden and different compositions of Tanveer garment factory soils after second and third week. Significant amendment was also elucidated after second week in case of plant cover. Plant height (5.78 cm) (Fig. 2a) and number of leaves (5.50) (Fig. 2b) were restricted after ten weeks in 75% and 25% Tanveer Garment factory soils, consecutively than to plant height (5.92 cm) and number of leaves (6.17) in garden soil. 25 and 50% soils of Tanveer Garment factory primarily, 75% soil fairly enhanced plant cover (21.73 cm) (Fig. 2c) relative to plant cover (15.83 cm) in garden soil.

No significant differences were noted in plant height and no. of leaves after two weeks upto six weeks in One Tech Rubber factory soil and garden soil. Fifty% One Tech Rubber factory soil slightly reduced the plant height (4.92 cm) (Fig. 3a) after ten weeks relativity to the plant height (5.92 cm) in garden soil. After two weeks significant results were observed in plant cover but after fourth, six and eight weeks no significant results were recorded between all factory soil compositions and garden soil. The number of leaves (4.33) (Fig. 3b) and plant cover (12.73 cm) (Fig. 3c) was significantly decreased in 50% soil after ten weeks relativity to the number of leaves (6.17) and plant cover (15.83 cm) in garden soil.

In case of different soil compositions of One Tech Ply Board factory soil and garden soil, little difference was recorded after two weeks upto ten weeks in plant height. Number of leaves and plant cover were significantly decreased in 75% soil after third week but after second, fourth, sixth and ten weeks reduction was no significant between different soil compositions and garden soil. After ten weeks, 75% soil restrained the plant height (5.45 cm) (Fig. 4a), number of leaves (4.83) (Fig. 4b) and plant cover (14.48 cm) (Fig. 4c) as related to plant height (5.92 cm), number of leaves (6.17) and plant cover (15.83 cm) in garden soil.

A lot of growth parameters of *A. lebbeck* were curbed by employ 75, 50 and 25% soils of Khan Towel factory soil, sequentially as compared to garden soil. Shoot length, number of leaflets, leaf dry weight, root/shoot and leaf weight ratios of *A. lebbeck* were drastically retrogressed from the utilization of 75% Khan Towel factory soil whereas root, seedling length and total plant dry weight were virtually depreciated treating in 50% Khan Towel factory soil as compared to garden soil (Table 2). Root dry weight was obviously diminished in the application of 50 and 75% soil while, shoot dry weights was minimized by the use of 25, 50 and 75% Khan Towel factory soils.

Limitation was noticeable in root length, leaflets number, leaf area and root/shoot, leaf weight and leaf area ratios employing 25% Tanveer Garment factory soil as compared to garden soil (Table 2). Except root/shoot ratio in 75% soil all the parameters were enhanced in 50 and 75% Tanveer Garment factory soil.

There except leaf area ratio all growth perspectives were subdued from the treatment of 50% One Tech Rubber factory soil, shoot length, number of leaflets, leaf area, leaf dry weight, root/shoot ratio, leaf weight ratios and specific leaf area were evidently less than garden soil (Table 2). Root and seedling length, root and total plant dry weights were conspicuously decreased in 25% One Tech Rubber factory soil.

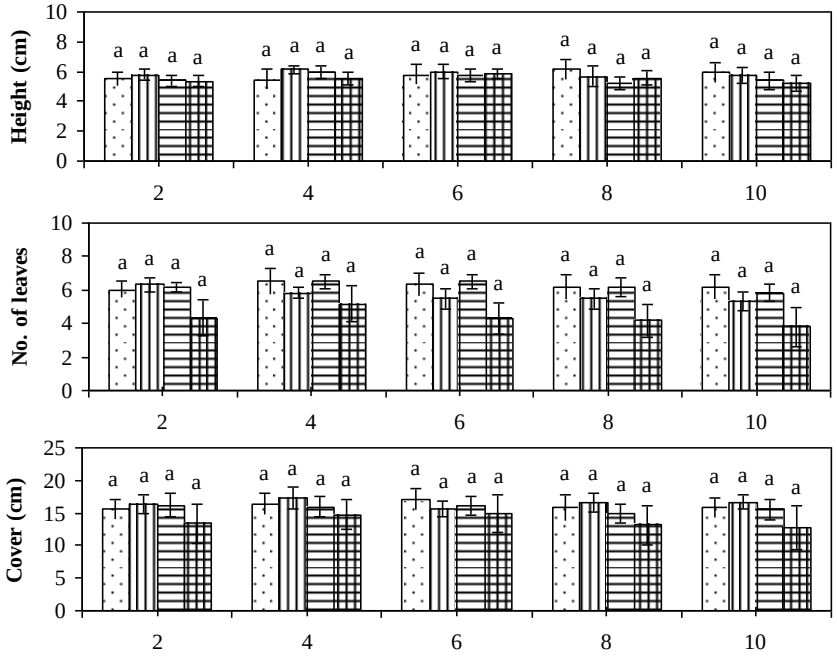

Fig. 1. a,b,c. Periodical growth of *Albizia lebbeck* in Khan Towel factory soil.

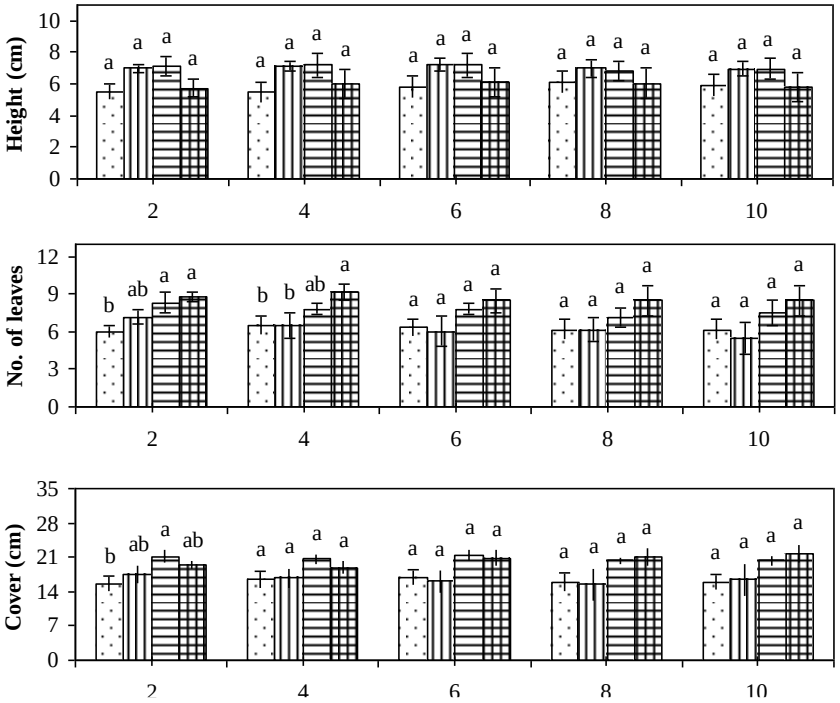

Fig. 2. a,b,c. Periodical growth of *Albizia lebbeck* in Tanveer Garment factory soil.

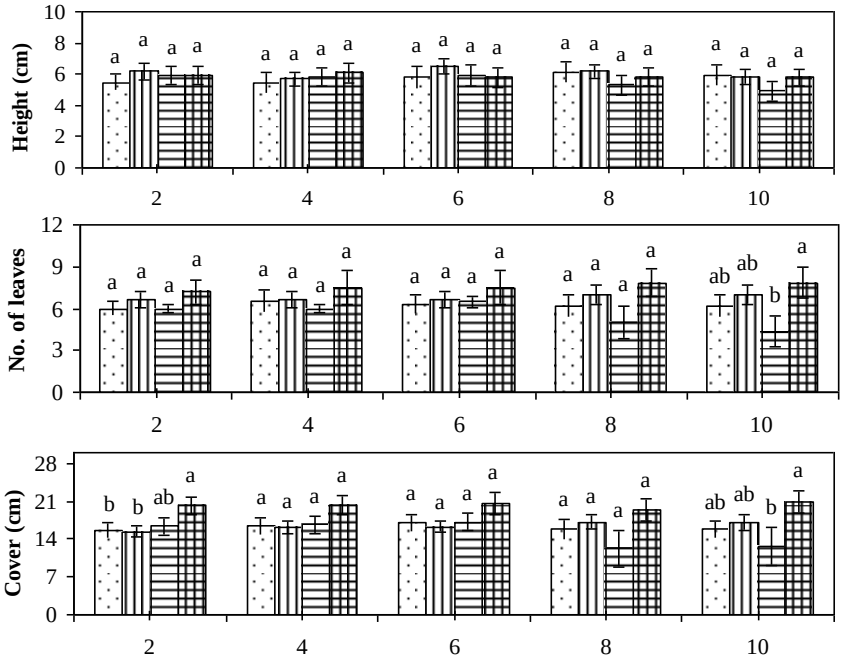

Fig. 3. a,b,c. Periodical growth of *Albizia lebbeck* in One Tech Rubber factory soil.

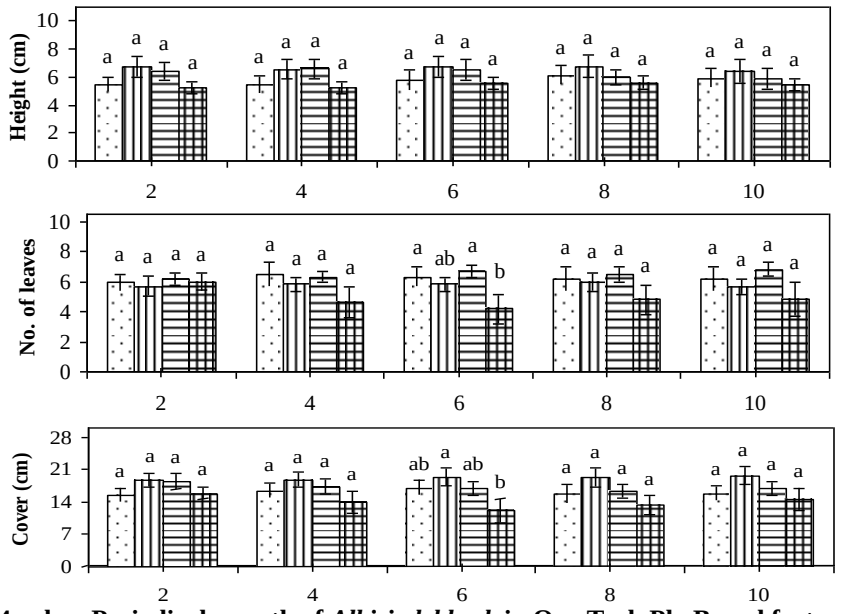

Fig. 4. a,b,c. Periodical growth of *Albizia lebbeck* in One Tech Ply Board factory soil.

A = Garden soil; B = 25% factory soil + 75% garden soil; C = 50% factory soil + 50% garden soil; D = 75% factory soil + 25% garden soil.

Statistical significance was determined by analysis of variance; same letters in a row are not significantly different ($p < 0.05$) according to Duncan's Multiple Range Test.

 Standard error.

75% One Tech Ply Board factory soil brought about manifest hindrance in root, shoot, seedling length, leaf area, root, leaf and total plant dry weights and root/shoot ratio, whereas shoot dry weight was less in 50 and 75% One Tech Ply Board factory soil as related to garden soil (Table 2). Root and total plant dry weights were decreased in 50% soil whereas rests of the parameters were increased in 50% soil and all variables were also enhanced in 25% soil.

Most of the growth variables of *A. lebbeck* were impeded in percentage by the application of 50% One Tech Rubber factory soil, 75% Khan Towel factory soil, 75% One Tech Ply Board factory soil and 25% Tanveer Garment factory soil respectively, over the garden soil (Table 3).

Table 2. Growth of *Albizia lebbeck* in factories soils.

Soils	Treatments	Root length (cm)	Shoot length (cm)	Seedling length (cm)	No. of leaflets	Leaf area (sq cm)	Root dry weight (g)	Shoot dry weight (g)	Leaf dry weight (g)	Total plant dry weight (g)	Root/Shoot ratio	Leaf weight ratio	Specific leaf area ($cm^2 g^{-1}$)	Leaf area ratio ($cm^2 g^{-1}$)
A	Control	9.15±0.80 a	8.47±0.77 a	17.62±1.44 a	54.61±7.92 a	11.27±2.55 a	0.10±0.02 a	0.04±0.01 a	0.05±0.01 a	0.20±0.04 a	2.30 ±0.41 a	0.27±0.02 a	211.49 ±19.68 a	57.74 a±5.45 a
	25%▲	8.52±1.0 a	8.67±0.59 a	17.18±1.23 a	48.22±4.43 a	11.04 ±1.57 a	0.08±0.01 a	0.03±0.00 a	0.04±0.00 a	0.14±0.01 a	2.38 ±0.22 a	0.25±0.02 a	314.85 ±44.90 a	79.41 ±10.92 a
	50%▲	5.37±0.54 b	8.22±0.58 a	13.58±0.65 a	55.22±10.11 a	10.87±1.98 a	0.06±0.01 a	0.03±0.00 a	0.04±0.01 a	0.12±0.02 a	2.21±0.32 a	0.31±0.03 a	283.14 ±29.56 a	89.31 ±11.71 a
	75%▲	5.78±0.99 b	7.95±0.95 a	13.73±1.91 a	40.28 ±14.95 a	11.58±4.71 a	0.06±0.02 a	0.03±0.01 a	0.03±0.01 a	0.13±0.04 a	2.13±0.69 a	0.22±0.06 a	296.33±107.06 a	91.65 ±40.53 a
	L.S.D.	2.59	2.18	4.08	29.80	8.73	0.05	0.02	0.03	0.09	1.31	0.10	179.08	64.78
B	Control	9.15±0.80 a	8.47±0.77 a	17.62±1.44 a	54.61±7.92 bc	11.27±2.55 a	0.10±0.02 a	0.04±0.01 a	0.05±0.01 a	0.20±0.04 a	2.30±0.41 a	0.27±0.02 ab	211.49±19.68 a	57.74 ±5.45 ab
	25%▲	8.53±1.42 a	9.80±1.01 a	18.33±2.29 a	48.61±11.03 c	10.41±2.34 a	0.11±0.03 a	0.05±0.01 a	0.05±0.01 a	0.21±0.05 a	2.05±0.26 a	0.19 ±0.04 b	216.22±54.66 a	46.62 ±11.54 b
	50%▲	10.38±0.53 a	10.40±0.67 a	20.78±0.82 a	89.44±10.65 ab	19.20 ±3.27 a	0.13±0.03 a	0.05±0.01 a	0.06±0.00 a	0.24±0.04 a	2.89±0.34 a	0.29±0.05 ab	309.60 ±51.04 a	90.22 ±22.51 ab
	75%▲	10.57±1.00 a	9.95±1.23 a	20.52±1.71 a	95.44±17.91 a	23.63±7.08 a	0.13±0.05 a	0.06±0.01 a	0.08±0.02 a	0.27±0.09 a	2.10±0.56 a	0.36±0.07 a	290.77 ±22.72 a	104.15±19.45 a
	L.S.D.	2.93	2.79	4.78	36.68	12.58	0.10	0.03	0.04	0.16	1.21	0.14	118.88	47.75

A = Khan Towel factory soil; B =Tanveer Garment factory soil.

▲ Soil compositions: 25% factory soil + 75% garden soil; 50% factory soil + 50% garden soil; 75% factory soil + 25% garden soil.

Statistical significance determined by analysis of variance. Number followed by the same letters in the same column is not significantly different, according to Duncan's Multiple Range Test. Least significance difference (L.S.D.) values at $p < 0.05$ level.

± Standard error.

Table 2 (continue). Growth of *Albizia lebbeck* in factories soils.

Soils	Treatments	Root length (cm)	Shoot length (cm)	Seedling length (cm)	No. of leaflets	Leaf area (sq cm)	Root dry weight (g)	Shoot dry weight (g)	Leaf dry weight (g)	Total plant dry weight (g)	Root/Shoot ratio	Leaf weight ratio	Specific leaf area ($cm^2 g^{-1}$)	Leaf area ratio ($cm^2 g^{-1}$)
C	Control	9.15 ±0.80 a	8.47±0.77 a	17.62 ±1.44 a	54.61±7.92 ab	11.27±2.55 b	0.10±0.02 a	0.04 ±0.01 a	0.05±0.01 a	0.20±0.04 a	2.30±0.41 a	0.27±0.02 a	211.49 ±19.68 a	57.74±5.45 a
	25%▲	7.60 ±0.74 a	8.93±0.59 a	16.53 ±1.08 a	63.94±7.30 ab	12.02±1.31 b	0.07±0.01 a	0.04 ±0.00 a	0.05±0.01 a	0.15±0.01 a	2.13±0.18 a	0.29±0.01 a	272.96 ±26.01 a	78.61±5.30 a
	50%▲	8.82 ±0.85 a	8.00±1.10 a	16.82 ±1.83 a	39.44 ±11.75 b	9.00±3.15 b	0.08±0.03 a	0.04 ±0.01 a	0.04±0.02 a	0.16±0.05 a	1.93±0.59 a	0.21±0.08 a	189.01±65.52 a	61.66 ±26.44 a
	75%▲	10.98 ±1.89 a	9.42±0.71 a	20.40±2.17 a	86.89±15.58 a	20.50 ±3.18 a	0.12 ±0.02 a	0.04 ±0.01 a	0.07±0.01 a	0.24±0.04 a	3.03 0.47 a	0.30±0.04 a	295.94 ±21.29 a	89.09 ±11.89 a
	L.S.D.	3.46	2.40	4.96	32.87	7.85	0.06	0.02	0.04	0.11	1.29	0.13	112.43	44.21
D	Control	9.15 ±0.80 a	8.47±0.77 a	17.62 ±1.44 a	54.61±7.92 a	11.27±2.55 a	0.10±0.02 a	0.04 ±0.01 a	0.05±0.01 a	0.20±0.04 a	2.30±0.41 a	0.27±0.02 a	211.49 ±19.68 a	57.74 ±5.45 a
	25%▲	9.60 ±1.41 a	10.07±1.02 a	19.67±2.02 a	59.44±5.89 a	16.18±2.24 a	0.10±0.02 a	0.05±0.01 a	0.05±0.01 a	0.20±0.04 a	2.38±0.51 a	0.28±0.03 a	316.22 ±30.30 a	93.04 ±17.11
	50%▲	11.30 ±1.36 a	9.05±0.59 a	20.35 ±1.81 a	70.67 ±6.36 a	13.57±0.98 a	0.07±0.01 a	0.03±0.00 a	0.05±0.01 a	0.15±0.02 a	2.38±0.35 a	0.31±0.01 a	328.69 ±43.27 a	101.34 ±13.03 a
	75%▲	7.40 ±1.83 a	7.92±0.97 a	15.32±2.24 a	55.61±12.67 a	10.11±2.86 a	0.05 ±0.02 a	0.03±0.01 a	0.03±0.01 a	0.11±0.03 a	1.72±0.57 a	0.27±0.07 a	265.91±65.98 a	89.58 ±32.17 a
	L.S.D.	4.13	2.53	5.61	25.48	6.70	0.06	0.02	0.03	0.10	1.38	0.12	128.00	57.65

A = Khan Towel factory soil; B = Tanveer Garment factory soil; C = One Tech Rubber factory soil; D = One Tech Ply Board factory soil.

▲ Soil compositions: 25% factory soil + 75% garden soil; 50% factory soil + 50% garden soil; 75% factory soil + 25% garden soil.

Statistical significance determined by analysis of variance. Number followed by the same letters in the same column is not significantly different, according to Duncan's Multiple Range Test. Least significance difference (L.S.D.) values at $p < 0.05$ level.

± Standard error.

Table 3. Percentage reduction in growth of *Albizia lebbeck* grown in soils of different factories in comparison with control soil.

Treatments	Soil▲	Plant height	No. of leaves	Plant cover	Root length	Shoot length	Seedling length	No. of leaflets	Leaf area	Root dry weight	Shoot dry weight	Leaf dry weight	Total plant dry weight	Root/Shoot ratio	Leaf weight ratio	Specific leaf area	Leaf area ratio
A	25%	3.4	13.6	5.5+	6.9	2.4+	2.5	11.7	2.0	20.0	25.0	20.0	30.0	3.5+	7.4	48.9+	37.5+
	50%	9.1	5.5	1.6	41.3	3.0	22.9	1.1+	3.5	40.0	25.0	20.0	40.0	3.9	14.8+	33.9+	54.7+
	75%	12.2	37.9	19.0	36.8	6.1	22.1	26.2	2.8+	40.0	25.0	40.0	35.0	7.4	18.5	40.1+	58.7+
B	25%	17.7+	10.9	3.9+	6.8	15.7+	4.0+	11.0	7.6	10.0+	25.0+	0.0	5.0+	10.9	29.6	2.2+	19.3
	50%	17.4+	21.6+	28.4+	13.4+	22.8+	17.9+	63.8+	70.4+	30.0+	25.0+	20.0+	20.0+	25.7+	7.4+	46.4+	56.3+
	75%	2.4	37.8+	37.3+	15.5+	17.5+	16.5+	74.8+	109.7+	30.0+	50.0+	60.0+	35.0+	8.7	33.3+	37.5+	80.4+
C	25%	1.2	19.9+	7.8+	16.9	5.4+	6.2	17.1+	6.7+	30.0	0.0	0.0	25.0	7.4	7.4+	29.1+	36.1+
	50%	16.9	29.8	19.6	3.6	5.5	4.5	27.8	20.1	20.0	0.0	20.0	20.0	16.1	22.2	10.6	6.8+
	75%	2.4	26.9+	32.2+	20.0+	11.2+	15.8+	59.1+	81.9+	20.0+	0.0	40.0+	20.0+	31.7+	11.1+	39.9+	54.3+
D	25%	8.1+	8.1	24.6+	4.9+	18.9+	11.6+	8.8+	43.6+	0.0	25.0+	0.0	0.0	3.5+	3.7+	49.5+	61.1+
	50%	0.7	10.7+	7.5+	23.5+	6.8+	15.5+	29.4+	20.4+	30.0	25.0	0.0	25.0	3.5+	14.8+	55.4+	75.5+
	75%	7.9	134.7+	8.5	19.1	6.5	13.1	1.8+	10.3	50.0	25.0	40.0	45.0	25.2	0.0	25.7+	55.1+

A = Khan Towel factory soil; B = Tanveer Garment factory soil; C = One Tech Rubber factory soil; D = One Tech Ply Board factory soil.

▲ Soil compositions: 25% factory soil + 75% garden soil; 50% factory soil + 50% garden soil; 75% factory soil + 25% garden soil.

+ Promotion; -= Reduction

Discussions

Khan Towel factory soil (75%) suppressed the growth of *A. lebbeck* which might be due to high quantity of total soluble salts. Salinity is a major reason reducing plant growth and productivity all over the world (Shereen *et al.,* 2005). The soil of a natural community is a part of the ecosystem which supports the community and affects on its characteristics (Whittaker, 1975).

Intensive hurdle in *A. lebbeck* growth were illuminated employing of 25% Tanveer Garment factory soil which may be due to great shortage of organic matter content, highest pH and amplified zinc concentration. Singh & Singh (1990) had assayed that two species, spruce and silver fir seed covered with humus gave higher germination and better seedlings growth than nursery soil, river sand and saw dust. Seedling growth and enzyme activities were found inhibited by zinc in *Phaseolus aureus* cv. R-851 (Veer, 1989).

A great numbers of growth appearances of *A. lebbeck* were constrained by the treatment of 50% One Tech Rubber factory soil because of real magnitude of coarse sand, calcium carbonate and chromium concentrations. Gohar *et al.,* (2003) revealed that soil texture had marked effect on root morphology of cotton plants. An appreciable amount of calcium carbonate (9.8-17.1%) is the characteristic features of arid zone soils (Aubert, 1960). Chromium is a noxious metal for plant growth and its high amount in soil might cause growth interference. The reduction in dry matter and inhibition to plant growth and development of *Triticum aestivum* L. cv. UP 2003 was found due to uptake of chromium from nutrient medium (Sharma & Sharma, 1996).

Higher amount of available sulfate and copper in One Tech Ply Board factory soil (75%) suppressed the prominent number of growth properties of *A. lebbeck.* Mahoney (1984) also experienced that ozone and sulfur oxide significantly reduced the leaf area ratio and root shoot ratio in yellow poplar seedlings.

The present investigation suggested that the soil of the industrial sites of Korangi and Landhi is detrimental for plant growth, especially at higher concentration of 75% and 50% soil compositions. Therefore, 50% One Tech Rubber factory soil displayed markedly sever effects on the growth of *A. lebbeck* reducing most of the growth variables. 75% Khan Towel and One Tech Ply Board factories soils also originated distinct hindrance in *A. lebbeck* growth. However, if soils of industrial land are mixed with garden soil, the plants presented better growth in soils as found there in less concentration of industrial soils which mixed with higher amount of garden soil. In the present study, One Tech Rubber factory soil also demonstrated great toxicity at higher 50% soil concentration. But, Tanveer Garment factory soil is somewhat better for growth of *A. lebbeck* because, it showed less reduction at higher concentration which may be cause low amount of total soluble salts and available sulfate in soil as compared to other industrial soils. Therefore, substantial amount of total soluble salts and available sulfate are considerably affected on *A. lebbeck* growth. Similar results were also conducted by Atiq-ur-Rehman *et al.,* (2011). They evaluated in other experiments which was conducted in different season (summer) that although all industrial soils exhibited reduction in *A. lebbeck* growth but less decrease in growth was elucidated in the utilization of Tanveer Garment factory soil relatively to other industrial soils whereas One Tech Rubber factory soil was considerably toxic. Atiq-ur-Rehman and Iqbal (2006) have elaborated that most of the growth variables of *A. lebbeck* were lessened by soil extract of One Tech Rubber factory soil. Similarly, the growth of *Peltophorum pterocarpum* was also conducted to be conspicuously decreased in 50% One Tech Rubber factory soil by Atiq-ur-Rehman and Iqbal (2009b). Atiq-ur-Rehman (2007) recorded that *Prosopis juliflora* growth from seeds of Karachi University and Korangi and Landhi industrial estates and *Azadirachta indica* growth from seedling of Karachi University were immensely suppressed in 50% Khan Towel factory soil while *L. leucocephala* growth was hugely retrogressed in 25 and 50% chiefly in 75% ratio of Khan Towel factory soil than other industrial soils. Atiq-ur-Rehman & Iqbal (2007) have reported that Tanveer Garment factory soil and Khan Towel factory soil was injurious for growth of *L. leucocephala*. Similarly, One Tech Rubber factory soil was remarkably hazardous for growth of *A. lebbeck* and Khan Towel factory soil is a severely deleterious for most of the plants particularly at higher concentration. Therefore it is suggested that for better plantation in industrial areas, garden soils should be mixed with polluted soils.

References

Atiq-ur-Rehman, S. (2007). *Effects of soil of industrial areas on plants.* Ph.D. thesis, Department of Botany. University of Karachi, Karachi, Pakistan. pp. 1-161.

Atiq-ur-Rehman, S. and Iqbal, M.Z. (2006). Seed Germination and Seedling Growth of Trees in Soil Extracts from Korangi and Landhi Industrial Areas of Karachi, Pakistan. *J. New Seeds* 8(4): 33-45.

Atiq-ur-Rehman, S. and Iqbal, M.Z. (2007). Growth of *Leucaena leucocephala* (Lam.) de-Wit, in different soils of Korangi and Landhi industrial areas of Karachi, Pakistan. *Pak. J. Bot.* 39(5): 1701-1715.

Atiq-ur-Rehman, S. and Iqbal, M.Z. (2009a). The effects of industrial soil pollution on *Prosopis juliflora* Swartz growth around Karachi. *Pak. J. Sci. Ind. Res.* 52(1): 37-43.

Atiq-ur-Rehman, S. and Iqbal, M.Z. (2009b). *Peltophorum pterocarpum* (DC.) Baker ex K. Heyne growth in soils of Korangi and Landhi industrial areas of Karachi, Pakistan. *J. Basic Appl. Sci.* 5(1): 7-16.

Atiq-ur-Rehman, S., Iqbal, M.Z. and Athar, M. (2011). Growth of *Albizia lebbeck* (L.) Benth. (Mimosaceae) in polluted soils of Landhi and Korangi industrial areas of Karachi, Pakistan. *Agric. Conspec. Sci.* 76(2): 1-6.

Aubert, L. (1960). Arid Zones Soils; study of their formation, characteristics utilizations and conservations. In: *The Problem of Arid zone*, UNESCO Publications, Paris 115-137.

Bower, C.A. and Wilcox, L.V. (1965). Soluble salts. Methods of soil analysis (eds. C.A. Black, D.D. Evans, L.E. Ensminger, J.L. White and F.E. Clark) part 2, American Society of Agronomy, Inc., Madison, Wisconsin, 933-951.

Duncan, D.B. (1955). Multiple Range and Multiple F-Test. *Biometrics* 11: 1-42.

Gohar, Z.N., Ahmad, R. and Gul, H. (2003). Growth and development of cotton roots at various soil textures under saline conditions. *Pak. J. Bot.* 35: 949-959.

Herschbach, C., Mult, S., Kreuzwieser, J. and Kopriva, S. (2005). Influence of anoxia on whole plant sulphur nutrition of flooding-tolerant poplar (*Populus tremula x P. alba*). *Plant Cell Environ.* 28: 167-175.

Iqbal, M.Z. (1988). Accumulation of sulfur in foliage of roadside plantation and soil in Karachi city. *Ecology* 29: 1-5.

Iqbal, M.Z. and Atiq-ur-Rehman, S. (2002). Effects of Cd, Zn, Cr and Pb on seed germination and seedling growth of plants. *Pak. J. Environ. Sci.* 1: 47-53.

Iqbal, M.Z. and Atiq-ur-Rehman, S. (2005). Effects of heavy metals on seed germination and seedling growth of *Albizia lebbeck* (L.) Benth. *Sci. Sindh* 12: 1-6.

Iqbal, M.Z. and Rahmati, K. (1992). Tolerance of *Albizia lebbeck* to Cu and Fe application. *Ekologia (CSFR)* 11: 427-430.

Iqbal, M.Z. and Shafiq, M. (1999). Toxic effects of zinc on different tree seedlings. *Pak. J. Sci. Ind. Res.* 42: 150-153.

Iqbal, M.Z., Yasmin, N. and Shafiq, M. (2001). Effects of salinity on germination and growth of two cultivars of wheat. *Ecoprint* 8: 7-11.

Jackson, M.L. (1958). *Soil Chemical Analysis.* Englewood Cliffs, NJ: Prentice- Hall, pp. 408.

Keen, B.A. (1931). *The Physical Properties of Soil.* New York: Longman Green and Company, pp. 380.

Kullberg, R.G. (1974). Distribution of aquatic macrophytes related to paper mills effluents in a Southern Michigan Stream. *Am. Midl. Nat.* 91: 271-281.

Mahoney, T.M. (1984). "Response of yellow poplar seedlings to low concentrations of ozone, SO_2 and NO_2". *Environ. Exp. Bot.* 26(1): 240-248.

Nriagu, J.O. and Pacyna, J.M. (1988). Quantitative assessment of worldwide contamination of air, water and soils by trace metals. *Nature* 333: 134-139.

Qadir, S.A., Qureshi, S.Z. and Ahmed, M.A. (1966). A phytosociological survey of the Karachi University Campus. *Vegetatio* 13: 339-362.

Saito, T. and Terashima, I. (2004). Reversible decreases in the bulk elastic modulus of mature leaves of deciduous *Quercus* species subjected to two drought treatments. *Plant Cell Environ.* 27: 863-875.

Sharma, D.C. and Sharma, C.P. (1996). Chromium uptake and toxicity effects on growth and metabolic activities in wheat, *Triticum aestivum* L. cv. UP 2003. *Indian J. Exp. Biol.* 34: 689-691.

Shereen, A., Mumtaz, S.,. Raza, S., Khan, M.A. and Solangi, S. (2005). Salinity effects on seedling growth and yield components of different inbred rice lines. *Pak. J. Bot.* 37: 131-139.

Singh, O. and Singh, V. (1990). Germination and growth of spruce and silver fir in relation to covering media. *Indian Forest* 116: 278-281.

Steel, R.G.D. and Torrie, J.H. (1984). Principles and procedures of statistics: Mc Graw Hill Book C., Inc., Singapore 172-177.

Tivy, J. (1982). *Biogeography. A study of plants in the Ecosphere* (2nd Edn). New York. Longman 397.

USDA. (1951). *Soil Survey Manual.* U.S. Department of Agriculture Hand Book No. 18 (U.S. Government Printing Office, Washington, D.C.).

Veer, B. (1989). Effect of nickel and zinc on seedling growth and hydrolytic enzymes in *Phaseolus aureus* cv. R-851. *Geobios* 16: 245-248.

Walter, H. (1971). *Ecology of Tropical and Sub Tropical Vegetation.* Oliver and Boyd-Edinburgh, UK, 539.

Whittaker, R.H. (1975). Nutrient circulation In *"Communities and Ecosystems"* 2nd eds. pp. 236-296. Macmillan Publishing Co., INC. New York.