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GROWTH OF *THESPESIA POPULNEA* (L.) SOLAND. EX CORREA IN SOILS OF KORANGI AND LANDHI INDUSTRIAL AREAS OF KARACHI, PAKISTAN

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ABSTRACT

The growth of *Thespesia populnea* (L.) Soland. ex Correa, was 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 areas. A numbers of growth parameters were higher in almost all of the industrial locations soils mainly of One Tech Ply Board factory soil, Tanveer Garment, Khan Towel and One Tech Rubber factory soils, respectively as compared to Karachi University soil. One Tech Ply Board factory soil fairly increased several growth properties like plant height, number of leaves, plant cover, shoot length, leaf area, root, shoot, leaf and total plant dry weights, specific leaf area and leaf area ratio whereas root, seedling length and root/shoot ratio were substantially enhanced in the treatment of Tanveer Garment factory soil. One Tech Rubber and Khan Towel factories soils raised a large number of growth parameters such as plant height, leaves number, plant cover, root, shoot and seedling length, leaf area, root, shoot, leaf and total plant dry weights, root/shoot ratio and specific leaf area as compared to University soil.

Key words: plant growth, soil pollutants, *Thespesia populnea*, industrial pollution.

INTRODUCTION

The industrial emissions affect the edaphic and climatic factors. Rapid industrialization, motorization and phenomenal growth in population have created environmental problems in Karachi (Iqbal and Shafiq, 1999). Toxic pollutants in the environment have been progressively increasing in the environment (Iqbal *et al.*, 2001). The physical and biological properties of soil need careful studies. Exposure to SO_2 is reported to bring severe reduction in the dry matter accumulation and yield of *Lolium perenne* L. cv. S23 (Bell *et al.*, 1979).

Heavy metals are used extensively in the industries (Raihan *et al.*, 1995). Heavy and trace metals present in the environment are hazardous to ecological systems and also to human health and plant growth (Shafiq and Iqbal, 2005). The absorption of heavy metals inhibits the seed germination and seedling growth (Singh and Srivastava, 1991; Iqbal and Siddiqui, 1992) and effects the growth and metabolisms of plant (Al-Helal, 1994). *Thespesia populnea* (L.) Soland. ex Correa, is a fast growing ornamental tree. The plant is grown as a shade tree and wind breaker. It is also used for manufacturing of craft, rope, dye, fibers, mats, paper and cloth and has medicinally importance. In Malir river some heavy metals of lead, copper and zinc were detected in soil in high amounts, which influenced the composition of plant communities in this area (Qamar-Uz-Zaman and Iqbal, 1994). In view of the pollution caused by the industries of Korangi and Landhi estates of Karachi, we have here investigated the effects of polluted soil of these industrial places on the growth of *T. populnea*.

MATERIALS AND METHODS

The experiment was conducted in greenhouse under the uniform natural environmental conditions at the Department of Botany, University of Karachi from July-9, 2003 to September 3, 2003 during summer season. The range of maximum temperature, minimum temperature, average temperature and atmospheric relative humidity during the experiment was between 29-35 °C, 26-28 °C, 28-32 °C and 28-94%, respectively. The weather was mostly cloudy and rainy with a range of 12:37-13:41 hours sun shine. Healthy and uniform-sized seeds of *Thespesia populnea* (L.) Soland. ex Correa, 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 forty days period, uniform-sized seedlings were transplanted into pots of 19.8 cm in diameter and 9.6 cm in soil depth (pot length) in soils of Khan Towel, Tanveer Garment, One Tech Rubber and One Tech Ply Board factories. These soils were collected from upper layer at 0-30 cm depth from Korangi and Landhi industrial regions of Karachi. The Karachi University soil was used as a control. In 50% pure soil of each factory, 50% garden soil [one part manure (1/3) + two parts fine sand (2/3)] was mixed. In the case of control, 50% pure soil of Karachi University was also mixed with 50% garden soil [one part manure (1/3 manure) + two parts fine sand (2/3 fine sand)]. Since, in the preliminary studies, pure soils of all industries hardly showed any response to seed germination

and seedling growth. 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. Daily climatic data, as average temperature, atmospheric relative humidity, weather out look and sun shine were recorded. Seedlings height, number of leaves and plant cover were recorded after every week for eight weeks. After eight weeks, number of leaves and leaf area (leaf length x leaf width x 2/3) of each plant were recorded and all the plants of *T. populnea* 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 determined. Root/Shoot ratio, leaf weight ratio (leaf wt./total plant wt. ratio), specific leaf area (leaf area/leaf wt. ratio) (SLA) and leaf area ratio (leaf area/total plant wt. ratio) were also determined.

For soil analysis, two soil samples of each locality were 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 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 and Wilcox, (1965) methodology was used to determine total soluble salts whereas**,** soil pH was recorded by a direct 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).

All data was statistically analyzed by ANOVA (Steel and 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 using the following formula:

$$\text{Percentage reduction (\%)} = \frac{\text{Mean value for control soil} - \text{Mean value for treatment soil}}{\text{Mean value for control soil}} \times 100$$

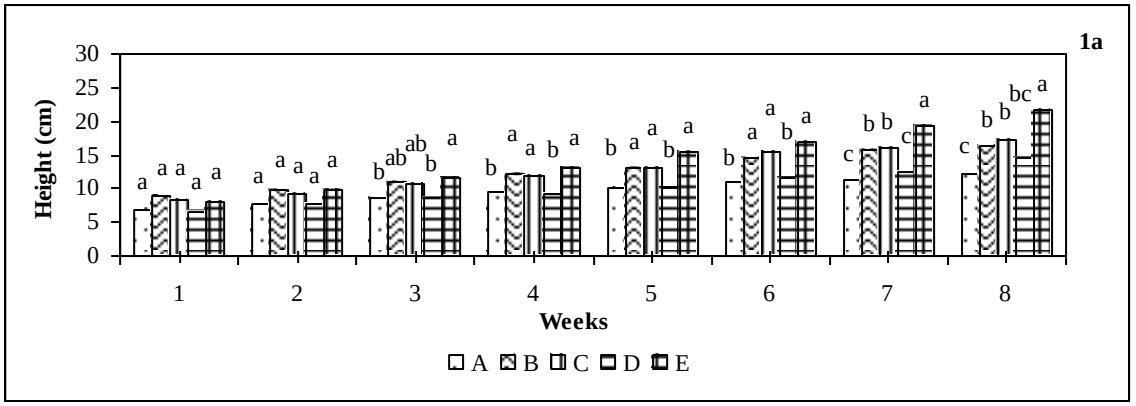
RESULTS AND DISCUSSION

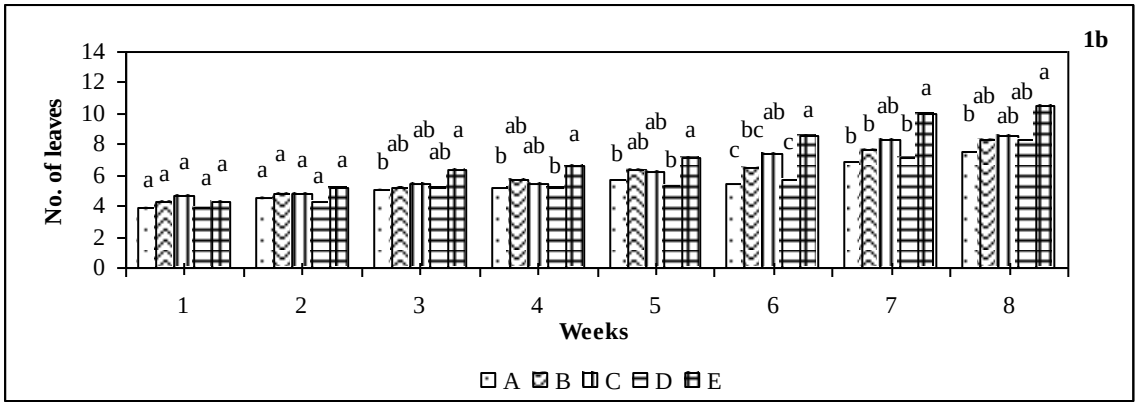
Plant height, number of leaves and plant cover of *Thespesia populnea* were enhanced with the application of industrial soils as compared to Karachi University soil. One Tech Ply Board factory soil generally, displayed better plant height (21.75 cm) (Fig. **1**a), number of leaves (10.50) (Fig. **1**b) and plant cover (58.67 cm) (Fig. **1**c) of *T. populnea* over the plant height (12.12 cm), number of leaves (7.50) and plant cover (29.33 cm) in University soil. The soil of One Tech Ply Board factory showed improvement in a lot of growth parameters of *T. populnea* principally, shoot length, leaf area, root, shoot, leaf and total plant dry weights, specific leaf area and leaf area ratio than to University soil (Tables 1-2). The growth of *Prosopis juliflora* the seeds of which were collected from Korangi and Landhi industrial estates were explicitly enhanced in One Tech Ply Board factory soil as compared to other industrial soils (Atiq-ur-Rehman and Iqbal, 2009a). One Tech Ply Board factory soil expressed greatest degree of water holding capacity and organic matter and lowest rate of calcium carbonate and pH level than to University soil (Table 3) which may be caused enhancement in growth. In those plant communities which had a higher percentage of soil organic matter, the water holding capacity of soil was consequently increased due to the colloidal nature of the organic matter (Singh, 1986). An appreciable amount of calcium carbonate (9.8-17.1%) is the characteristic features of arid zone soils (Aubert, 1960).

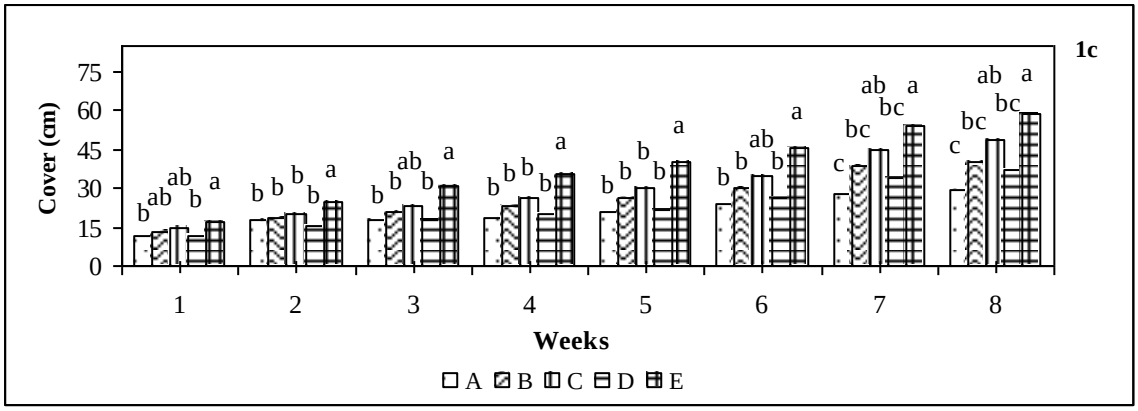
Tanveer Garment factory soil brought about discernible increment in root, seedling length and root/shoot ratio while, leaf weight and leaf area ratios were strongly hindered by employed of Khan Towel factory soil relatively to University soil. Many of the growth parameters were increased from Khan Towel and One Tech Rubber factories soils.

Most of the industrial lands soils had lower magnitude of coarse sand and chromium concentrations and adequate water holding capacity which may be caused elucidate progression in growth in factories soils. Gerard *et al.* (1982) revealed that soil texture is a factor which influences greatly on growth and yield of various crops. *Senna*

holosericea preferred to grow on high water holding capacity (Shafiq *et al.,* 1992). *Typha angustifolia* tolerated in full concentrations of Kasur tannery effluents and also depleted chromium content of the effluents upto a considerable extent whereas other species could not survive long (Ejaz *et al.,* 2005).







Figs. 1a, b & c: Growth of *Thespesia populnea* in soils of different areas.

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

In each soil type, 50% soil was mixed with 50% garden soil.

Same letters in a row are not significantly different ($p < 0.05$) according to Duncan's Multiple Range Test.

Table 1. Growth of *Thespesia populnea* in soils of different areas.

Treatments ▲	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Leaf area (sq cm)	Root dry weight	Shoot dry weight (g)	Leaf dry weight (g)	Total plant dry weight	Root/Shoot	Leaf weight	Specific leaf	Leaf area ratio ($cm^2 g^-$
A	14.92 b ±3.03	18.78 d ±0.72	33.70 c ±2.94	56.28 b ±10.37	0.08 b ±0.01	0.14 b ±0.02	0.27 b ±0.04	0.48 b ±0.07	0.60 a ±0.13	0.55 a ±0.02	210.61 a ±19.45	116.09 a ±14.10
B	17.28 ab ±2.51	23.67 bc ±1.63	40.95 abc ±3.90	102.98 b ±29.29	0.17 ab ±0.05	0.30 b ±0.19	0.43 b ±0.12	0.90 b ±0.24	0.61 a ±0.18	0.46 b ±0.03	233.34 a ±18.86	111.14 a ±12.86
C	22.78 a ±1.95	26.07 ab ±0.46	48.85 a ±1.97	140.10 b ±22.67	0.23 ab ±0.07	0.28 b ±0.03	0.55 ab ±0.08	1.06 ab ±0.17	0.80 a ±0.23	0.52 ab ±0.02	255.30 a ±19.85	133.48 a ±12.62
D	17.63 ab ±1.87	20.45 cd ±0.87	38.08 bc ±2.59	81.59 b ±9.93	0.13 b ±0.03	0.19 b ±0.01	0.33 b ±0.03	0.65 b ±0.06	0.63 a ±0.11	0.51 ab ±0.03	244.47 a ±7.69	125.78 a ±9.42
E	16.83 ab ±2.15	29.50 a ±2.57	46.33 ab ±4.60	232.87 a ±56.12	0.38 a ±0.13	0.47 a ±0.08	0.93 a ±0.26	1.77 a ±0.47	0.71 a ±0.13	0.52 ab ±0.01	260.00 a ±14.67	134.01 a ±6.18
L.S.D.	6.82	4.27	9.71	89.55	0.21	0.17	0.39	0.73	0.47	0.07	48.78	33.22

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

▲ 50% soil + 50% garden soil in all soil types.

Statistical significance was determined by analysis of variance; numbers followed by the same letters in the same column are not significantly different, according to Duncan's Multiple Range Test. LSD = least significance difference, value at $p < 0.05$ level.

± Standard error.

Table 2. Percentage increase in growth of *Thespesia populnea* in soils of different factories in comparison with control soil.

Treatments▲	Plant height	No. of leaves	Plant cover	Root length	Shoot length	Seedling length	Leaf area	Root dry weight	Shoot dry weight	Leaf dry weight	Total plant dry weight
A	33.7	11.1	36.4	15.8	26.0	21.5	83.0	112.5	114.3	59.3	87.5
B	43.0	13.3	66.8	52.7	38.8	45.0	148.9	187.5	100.0	103.7	120.8
C	19.4	11.1	26.3	18.2	8.9	13.0	45.0	62.5	35.7	22.2	35.4
D	79.5	37.7	100.0	12.8	57.1	37.5	313.8	375.0	235.7	244.4	268.8

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

▲ 50% soil + 50% garden soil in all soil types.

Table 3. Properties of different soil types.

Sites	Coarse 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	58 b ±0	27 b ±0	2.0 b ±0.3	17.8 c ±0.3	5.9 c ±0.7	8.4 a ±0.0	8 d ±0	0.002 c ±0.002	0.029 bc ±0.017	6.066 a ±0.046
B	24 d ±2	29 b ±3	2.1 b ±0.2	29.5 b ±1.5	14.0 a ±2.0	8.0 ab ±0.1	575 a ±13	0.023 b ±0.012	0.033 b ±0.001	4.139 b ±0.093
C	47 c ±0	31 b ±2	0.9 c ±0.0	24.5 b ±0.5	8.0 c ±0.0	8.3 a ±0.1	108 c ±23	0.008 bc ±0.002	0.090 a ±0.002	4.229 b ±0.111
D	88 a ±1	17 c ±3	1.1 c ±0.1	36.5 a ±2.5	12.0 ab ±0.0	8.2 ab ±0.1	401 b ±11	0.002 c ±0.002	0.019 bc ±0.002	6.899 a ±0.978
E	26 d ±2	40 a ±0	3.3 a ±0.4	17.5 c ±1.5	9.0 bc ±1.0	7.8 b ±0.2	608 a ±45	0.074 a ±0.002	0.003 c ±0.002	1.404 c ±0.406
L.S.D.	5	8	0.8	5.4	3.8	0.4	86	0.020	0.027	1.738

A = Karachi University 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 was determined by analysis of variance; numbers followed by the same letters in the same column are not significantly different, according to Duncan's Multiple Range Test. LSD = least significance difference, value at $p < 0.05$ level.

± Standard error.

But, many of the soil variables were adverse for growth of plants such as total soluble salts and available sulfate were marked in all of industrial locations soils comparatively to University soil prominently in Khan Towel and One Tech Ply Board factories soils but *T. populnea* intensively resisted and existed thrive with increase in growth in industrial soils.

In the present study, it was found that the soils of the industrial areas of Korangi and Landhi were not more affected on growth of *T. populnea* predominantly the soil of One Tech Ply Board factory. It was too found that if soils of industrial regions are mixed with garden soil, the plants demonstrated improve growth particularly in One Tech Ply Board factory soil, because mixture of garden soil supported enhancement in growth. The growth magnification in *Leucaena leucocephala* and *Azadirachta indica* was also elaborated in One Tech Ply Board factory soil (Atiq-ur-Rehman, 2007). Same findings were also observed in *Peltophorum pterocarpum* plants by Atiq-ur-Rehman and Iqbal (2009b). Iqbal and Shafiq, (1999) had suggested that *T. populnea* should be planted around zinc manufacturing industrial units. Therefore, the present investigation would suggest that *Thespesia populnea* is comparatively better to grow nearby Korangi and Landhi Industrial locations.

The findings of this research would be helpful in monitoring the tolerant plants species for cultivation in the verge of industrial sites. Furthermore, such information could also be useful for landscaping and urban planning.

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