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THE IMPACT OF AUTOMOBILE POLLUTED SOIL ON SEEDLING GROWTH PERFORMANCE IN SOME HIGHER PLANTS

Muhammad KABIR[1],Tabinda NOREEN[1], Muhammad Zafar IQBAL[2],
Muhammad SHAFIQ[2*], Mohammad ATHAR[3], Zia-ur-Rehman FAROOQI[2]

[1] Department of Biological Sciences, University of Sargodha, Ex Sub-campus Bhakkar, Thal University Bhakkar-30000, Punjab – Pakistan.
[2] Department of Botany, University of Karachi, Karachi, 75270 – Pakistan.
[3] California Department of Food and Agriculture, 3288 Meadowview Road, Sacramento, CA 95832 – USA.
* Corresponding author. E-mail: shafiqeco@yahoo.com, ORCID: 0000-0002-0488-8946

Abstract: Rapid increase in automobile density and discharge of different types of pollutants from automobile are a serious issue for whole civilized world and in Bhakkar also.Vehicle emission from automobiles released an enormous quantity of toxic pollutants likewise nitrogen dioxide, sulfur dioxide, carbon mono oxide, heavy metals particularly lead, cadmium in environment and produced harmful effects on germination and growth of plants. This study was aim to investigate the effect of automobile polluted soil on the growth of some tree species. In present study the variation in seedling growth performance of three different selected tree species namely, *Acacia nilotica* L., *Albizia lebbeck* L. (Benth.) and *Eucalyptus globulus* Labill. raised in roadside polluted soils of District Bhakkar, Pakistan were recorded in the pots. Results showed that root, shoot, seedling length, number of leaves, and seedling dry weight of *Acacia nilotica* grown in polluted road soils of Bhakkar-Khansar road showed a significant ($p<0.05$) decline. Statistical analysis of recorded data showed that root growth and leaf area of *Albizia lebbeck* in the soil of Bhakkar-Khansar road soil significantly ($p<0.05$) decreased as compared to control. Similarly, a significant ($p<0.05$) reduction in shoot, seedling length, number of leaves, leaf area and seedling dry weight performance of *E. globulus* in polluted soils of Bhakkar-Notak was recorded.

Keywords: biomass, soil pollution, tree, vehicles emission.

Introduction

Vehicle passengers and goods transport from one place to another and they have made life easy and convenient. Motor vehicle traffic is a major source of air pollution in urban areas and contributing 57%-75% of total emissions [WHO, 2006]. The automobiles activities emit various compounds likewise, nitrogen, sulphur, hydrogen fluorides, hydrocarbons, particulate matter, peroxy acetyl nitrates and heavy metals into atmosphere which put harmful effects on human, animals and to the trees [UABOI-EGBENNI & al. 2009]. The use of diesel and petrol fuel in automobiles contributes various pollutants into air with different concentrations depending upon the operating conditions of automobiles [COLVILE & al. 2000]. In China, vehicles participate only 7.2% in 1995 but it would grow up to 11.3% in 2020 [STREETS & al. 2001]. It is estimated that annual increase of vehicles is 37% in Pakistan [ILYAS, 2007]. Water and carbon dioxide are produced in the complete combustion of petroleum and diesel but usually incomplete combustion occur giving rise to various solid particles, liquids and gases [ANDA & ILLES, 2012]. Different plant species vary in extent of response to vehicle pollutants exposure. Researchers are claiming that vehicle emission is responsible for increase the level of toxic pollutants in environment due to ever increase in number of automobiles [SULISTIJORINI &

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al. 2008; KABIR & al. 2012; SHAFIQ, 2002; SHAFIQ & IQBAL, 2012] and ultimately negatively affecting germination and growth of plants. ZHAO & al. (2009) accounted an unfavorable effects of air pollution on growth of plants that might be due to some poisonous substances releasing from automobiles. Effect of automobile polluted soil on early seedling growth performance and biomass production of Neem (*Azadirachta indica* A. Juss.) [PARVEEN & al. 2016].

Species description

Acacia nilotica (L.) Willd. ex Delile is synonym of *Vachellia nilotica* (L.) P. J. H. Hurter & Mabb. [WFO, 2022] and belongs to family Fabaceae and used as application of afforestation in forestry. It grows commonly 3-15 meters high or sometime low as 1.5 meters. The seed germinate after a period of warm moist condition after scarification [PARSONS & CUTHBERTSON, 1992]. Its wood is useful in the production of fuel wood, charcoal, paper and medicines industry [KANAK & SAHAI, 1994]. When this plant is young, bark is whitish but it changed to dark gray when it gets matures and has deep taproot system with branching surface lateral roots [COX, 1997; MACKEY, 1997]. The fruit of *Acacia nilotica* is leathery pod and the color of pod varies from brown to dark gray, straight to curved and glabrous or velvety [BROWN & CARTER, 1998]. Growth rates are variable, it may mature in nine months under good environmental conditions or not for up to 13 years under harsh conditions [KRITICOS & al. 1999]. *Acacia nilotica* helps to improve the rural economy by providing fodder, timber, fuel, gum and medicines. This tree also play role to increase the soil fertility under its canopy [PANDEY & al. 2000]. *Acacia nilotica* is used in bridges, railway sleepers, sports goods, building of boats, carts, carriages, and construction of doors, window frames, decorative cabinets and carpentry work [KUMAR & KUMUD, 2010]. The distribution of *Acacia nilotica* includes Africa, Indian subcontinents and also planted in Pakistan along the roadside as shade tree along the field boarder as shelterbelts and windbreaker. It is of great value on both national and international level for timber and decorative wood and aromatic oil.

Albizia lebbeck L. (Benth.) is a member of family Fabaceae and subfamily Mimosaceae. *Albizia lebbeck* is commonly called as Siris tree, Shrin and Vaagei. It is deciduous woody tree and cultivated in gardens as ornamental plants, along roadsides as shade tree, on irrigated plantation and in farmlands. This deciduous tree is found all over the world especially in Pakistan, India, Bangladesh tropical and subtropical Africa and Asia [AHMAD & BEG, 2001]. It is large multi stemmed tree with widespread canopy (30 m). *Albizia lebbeck* is used as fodder crop of high quality for animal food. Its tree has shallow and extensive root system making it helpful in soil conservation through soil erosion control [PRINSEN, 1986]. *Albizia lebbeck* is a valuable timber species also used for furniture, flooring, carving posts and in various kinds of agricultural implements. The bark contains 15% tannin used in tanning and dying industry. Due to property of high saponin contents also used in detergents [VARSHNEY & BADHWAR, 1970]. Its bark produces brown reddish gum used as a part of Arabic gum [FAROOQI & KAPOOR, 1968]. The seed oil is used in the treatment of lesions in leprosy disease [RAGUPATHY & MAHADEVAN, 1991].

Eucalyptus globulus Labill. is a tall tree and member of family Myrtaceae. Most of the species of *E. globulus* are tall trees with height of 100 meter and girth of 20 meter. Almost all species of it are evergreen and very few species are deciduous [POHJONEN, 1989]. *E. globulus* is tolerant to moisture stress and low soil fertility. *E. globulus* is planted in garden, along roadside and parks. It is also found useful for fuel wood, charcoal, timber, plywood, paper pulp, oil, fiberboard, tannin, shade and shelter, source of nectar for honey and ornamental purposes [MOGES, 1998].

The ever increase in vehicle density is producing environmental pollution issues and is affecting growth of roadside plants. There is no scientific study is available on the effect of automobile polluted soil of Bhakkar on plant growth. Keeping in view of the constant increase in traffic activities which is polluting the soil of the area, thecurrent research experiments was conducted with the aim to compare the effects of automobile polluted soil on three different economic importanttree species namely, *Acacia nilotica* L. Willd. ex Delile, *Albizia lebbeck* L. (Benth.) and *Eucalyptus globulus* Labill. of Pakistan.

Material and methods

Description of experimental site

Bhakkar, is the principal city of Bhakkar District and located in Punjab, Pakistan. It lies on the left bank of the Indus river. It stands on the edge of the Thal or sandy plain overlooking the low-lying alluvial lands along; the river, a channel of which is navigable as far as Bhakkar during the floods. To the west of the town the land is low, well cultivated, and subject to inundation, while to the east the country is high and dry, treeless, and sandy. A rich extent of land irrigated from wells lies below the town, protected by embankments from inundations of the Indus, and produces two or three crops in the year.

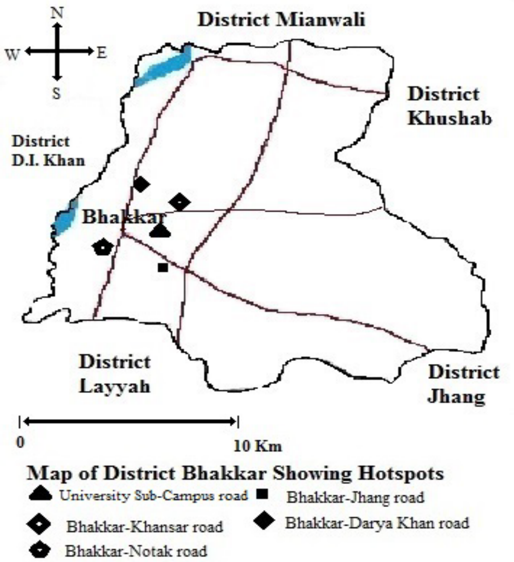

Figure 1. Map of District Bhakkar showing selected roads

Soil samples were collected from five different roadsides sites namely, (A = University Sub-Campus road, B = Bhakkar-Darya Khan road, C = Bhakkar-Jhang road, D = Bhakkar-Notak road and E = Bhakkar-Khansar road) at the depth of 0-45 cm from every site during 2018 and climatic data (Figure 1). The composit soil samples were collected from each site at equal distance. The soil samples were taken to laboratory in polythene bag and kept at room temperature for drying. All collected soil samples were slightly crushed and passed through a 2 mm sieve to get equal size particle distribution. The air dried soil was then shifted into clean polythene bags, labeled and stored in the laboratory. Weekly climatic data of District Bhakkar during growth experiments (01-06-2018 to 31-07-2018) was recorded (Table 1).

Table 1. Weekly climatic data of District Bhakkar during growth experiments (01-06-2018 to 31-07-2018)

Weeks	Temperature (°C)			Relative Humidity (%)			Sun shine (hours)	Weather outlook
	Min.	Max.	Mean	Min.	Max.	Mean		
1	38	44	40	66	74	70	14:15	Partially cloudy
2	39	43	41	56	72	64	14:25	Fair & Hot
3	35	43	39	58	72	65	14: 32	Warm & Humid
4	37	49	43	66	80	73	14: 25	Hot & Dry
5	40	44	42	61	85	73	14: 18	Hot & Dry
6	44	42	38	64	80	72	14: 13	Warm & Humid
7	37	43	40	56	92	74	14: 02	Hot & Dry
8	33	45	39	56	80	68	13: 56	Hot & Dry

Abbreviations used: Min. = Minimum; Max. = Maximum.
Source: Main Line Lower Land Reclamation Research Station Chak No. 37 TDA, Bhakkar.

The experiment for influence of polluted soil collected from five different roadsides sites (namely A = University Sub-Campus road, B = Bhakkar-Darya Khan road, C = Bhakkar-Jhang road, D = Bhakkar-Notak road and E = Bhakkar-Khansar road) on seedling growth of *Acacia nilotica* L. Willd. ex Delile, *Albizia lebbeck* L. (Benth.) and *Eucalyptus globulus* Labill. was conducted at the Department of Biological Sciences, University of Sargodha, Sub-Campus Bhakkar (Punjab, Pakistan) under natural environmental condition in pot. The vigorous, healthy and same size seeds of *Acacia nilotica*, *Albizia lebbeck* and *E. globulus* were collected from local National seed store of Bhakkar. The seeds were surface sterilized with 0.20% of sodium hypochlorite (NaOCl) solution for two minutes to avoid any fungal contamination and washed with thoroughly with distilled water.

The micropyle top of seeds of these plants' species were marginally cut to some extent with hygienic scissors to break external seed dormancy. Ten seeds were sown at 1.00 cm depth in earthen pots containing the soil of different polluted road such as A = University Sub-Campus road as control, B = Bhakkar-Darya Khan road, C = Bhakkar-Jhang road, D = Bhakkar-Notak road and E = Bhakkar-Khansar road. The earthen pots watered regularly. After two weeks of seed germination, equal size of seedlings was transplanted in plastic pots of 9.8 cm in depth and 7.00 cm in diameter. There were three replicates of each plant species seedling for each polluted roadside soil. One seedling was transplanted in each plastic pot and seedlings were watered regularly. After every week pots reshuffling were also carried out to prevent light shade or any other environmental effect. At the completion of experiment (eight weeks) the seedlings were removed from plastic pots, washed their roots with fresh water and measured the root, shoot, seedling length and leaf area with the help of iron scale and number of leaves were also counted. Seedling fresh weight was determined with the help of electrical balance. After that the seedlings were dried in a thermostatic drying oven at 80 °C and then oven dried weight of leaves, root, shoot and seedling were also determined by using electrical balance.

The root shoot ratio, leaf weight ratio, leaf area, specific leaf area and leaf area ratio were also determined by formula as given by ATIQ-UR-REHMAN & IQBAL (2009).

$$\text{Root/Shoot ratio} = \frac{\text{Root dry weight}}{\text{Shoot dry weight}}$$

$$\text{Leaf weight ratio} = \frac{\text{Leaf dry weight}}{\text{Total plant dry weight}}$$

$$\text{Leaf area} = \text{Leaf length} \times \text{Leaf width} \times \frac{2}{3}$$

$$\text{Spacific leaf area} = \frac{\text{Leaf area}}{\text{Leaf dry weight}}$$

$$\text{Leaf area ratio} = \frac{\text{Leaf area}}{\text{Total plant dry weight}}$$

Statistical analysis

Data of different growth parameters were analyzed statistically by analysis of variance (ANOVA) and Duncan Multiple Range Test (Duncan, 1995) at $p<0.05$ level on personal computer.

Results and discussion

The transport sector is an important source of environmental pollution. The chaotic and rapid vehicle growth is producing massive environmental pollution issues and is affecting not only the growth of plants but also might be influencing on the different characteristics of soil of the area. The influence of polluted soil collected from five different roadsides sites (namely A = University Sub-Campus road, B = Bhakkar-Darya Khan road, C = Bhakkar-Jhang road, D = Bhakkar-Notak road and E = Bhakkar-Khansar road) on seedling growth and seedling dry weight of *Acacia nilotica* (L.) Willd. ex Delile, *Albizia lebbeck* L. (Benth.) and *Eucalyptus globulus* Labill. with some variation was recorded (Table 2-10). Statistical analysis of recorded data showed that root, shoot, seedling length and number of leaves of *Acacia nilotica* were significantly ($p<0.05$) reduced in soil of Bhakkar-Khansar road as compared to other soil treatment (Table 2).

Table 2. Growth of *Acacia nilotica* in soil of different polluted roads

Roads	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Number of leaves	Leaf area (cm^2)
A	13.31± 0.24b	30.29 ± 0.95a	43.60 ± 1.16b	8.33 ± 0.15ab	7.46 ± 0.22a
B	10.30 ± 0.28bc	26.53 ± 0.77b	36.83 ± 1.05c	7.43 ± 0.44b	6.07 ± 0.30b
C	18.27 ± 0.36a	28.63 ± 1.22ab	46.90 ± 1.56a	10.00 ± 0.65a	6.72 ± 0.25ab
D	11.53 ± 0.34bc	23.57 ± 0.85c	35.10 ± 1.18c	6.55 ± 0.23bc	3.50 ± 0.23cd
E	8.44 ± 0.21c	20.67 ± 0.52d	29.11 ± 0.69d	5.81 ± 0.17bc	3.73 ± 0.25c

Symbol used: **A** = University Sub-Campus road; **B** = Bhakkar-Darya Khan road; **C** = Bhakkar-Jhang road; **D** = Bhakkar-Notak road; **E** = Bhakkar-Khansar road. ± Standard Error. Numbers followed by the same letter in the same column are not significantly different according to Duncan Multiple Range Test at $p<0.05$ level.

The significant reduction in seedling growth of *Acacia nilotica* wasconsideredmainly depended upon pollutants released from automobiles. Air pollution directly affects plants via leaves or indirectly via soil acidification [LIU & DING, 2008]. Root length, seedling length and number of leaves and seedling dry weight of *Acacia nilotica* grown in Bhakkar-Jhang road soil was recorded significantly greater as compared to University Sub-Campus road, Bhakkar-Darya

Khan road, Bhakkar-Notak road and Bhakkar-Khansar road showed some degree of tolerance to soil pollution (Table 3).

Table 3. Effects of soil of different polluted roads on root, shoot, leaf and seedling dry weight of *Acacia nilotica*

Roads	Root dry weight (g)	Shoot dry weight (g)	Leaf dry weight (g)	Seedling dry weight (g)
A	0.07 ± 0.002ab	0.13 ± 0.002ab	0.013 ± 0.002a	0.20 ± 0.001ab
B	0.07 ± 0.002ab	0.12 ± 0.001ab	0.009 ± 0.002ab	0.19 ± 0.001ab
C	0.08 ± 0.002a	0.15 ± 0.002a	0.010 ± 0.002ab	0.23 ± 0.002a
D	0.05 ± 0.001b	0.09 ± 0.001b	0.007 ± 0.001b	0.14 ± 0.001b
E	0.04 ± 0.001bc	0.09 ± 0.001b	0.008 ± 0.001b	0.13 ± 0.002b

Symbol used: **A** = University Sub-Campus road; **B** = Bhakkar-Darya Khan road; **C** = Bhakkar-Jhang road; **D** = Bhakkar-Notak road; **E** = Bhakkar-Khansar road. ± Standard Error. Numbers followed by the same letter in the same column are not significantly different according to Duncan Multiple Range Test at $p<0.05$ level.

Seedling fresh weight was significantly ($p<0.05$) high in plants developed from the soil of Bhakkar-Jhang road (0.32 g) as compared to control while other three polluted roads showed significant ($p<0.05$) reduction with control. Maximum seedling dry weight was recorded as 0.23 g for Bhakkar-Jhang road soil which was significantly ($p<0.05$) decreased to 0.20 g for control soil. The seedling's fresh weight and dry weight of *Acacia nilotica* showed significant ($p<0.05$) variations in different polluted roadside soils. Reduction in biomass of *Acacia nilotica* may be due to imbalance in carbon dioxide exchange as a result of which photosynthesis activities got reduced [SHAFIQ, 2002]. Only Bhakkar-Darya Khan road soil showed nonsignificant result with control. Specific leaf area of *Acacia nilotica* raised in Bhakkar-Jhang road soil demonstrated significant ($p<0.05$) increase in other polluted road side soil (Table 4). A better root/shoot ratio, leaf weight ratio and leaf area ratio of *Acacia nilotica* raised in Bhakkar-Khansar road soil was found as compared to other polluted road side soil.

Table 4. Root/shoot, leaf weight ratio, specific leaf area and leaf area ratio of *Acacia nilotica* in soil of different polluted roads

Roads	Root/Shoot ratio	Leaf weight ratio	Specific leaf area (cm^2 g^{-1})	Leaf area ratio (cm^2 g^{-1})
A	0.54 ± 0.02ab	0.07 ± 0.003a	573.85 ± 9.94b	37.30 ± 1.97a
B	0.58 ± 0.04a	0.05 ± 0.001b	674.44 ± 6.11a	31.95 ± 1.84b
C	0.53 ± 0.02ab	0.04 ± 0.001bc	672.00 ± 8.59a	29.22 ± 1.28bc
D	0.56 ± 0.03ab	0.05 ± 0.001b	500.00 ± 7.18c	25.00 ± 1.83c
E	0.44 ± 0.01b	0.06 ± 0.002ab	466.25 ± 5.97cd	28.69 ± 1.43bc

Symbol used: **A** = University Sub-Campus road; **B** = Bhakkar-Darya Khan road; **C** = Bhakkar-Jhang road; **D** = Bhakkar-Notak road; **E** = Bhakkar-Khansar road. ± Standard Error. Numbers followed by the same letter in the same column are not significantly different according to Duncan Multiple Range Test at $p<0.05$ level.

Plants growing along the roadsides facing continuously different challenges which would cause variations in the biochemical processes, total chlorophyll contents and storage of some metabolites [AGBAIRE & ESIEFARIENRHE, 2009]. Different plant species vary in extent of response to vehicle pollutants exposure. This variation in seedling growth of selected plant species may be related with the amount of vehicle pollutants [HONOUR & al. 2009]. Our results were according to the findings of IQBAL & SHAZIA (2004) that decrease in length (root, shoot and seedling) along with fresh and dry weight of *Albizia lebbeck* by the exposure to different vehicle pollutants (Table 5-6). In another study seedling growth of *Albizia lebbeck* and *Pongamia pinnata* showed significant ($p<0.05$) reduction in root, shoot and seedling length raised from polluted road soils [QADIR & IQBAL, 1991]. From the results of present research work it was indicated that soil of study area might be disturbed in future due to emission and settling of toxic pollutant from vehicles.

The observations recorded in the present study clearly indicated that pollutants emitted from the automobile exhaust exercised a decisive influence on seedling growth of *Albizia lebbeck*. The significance of germination and seedling growth is an extensively recognized factor in plant growth. A significant variation in seedling growth of *Alibizia lebbeck* raised in different polluted roadside soils of District Bhakkar was recorded. Statistical analysis of recorded data showed that the polluted soil influenced root, shoot and seedling length. number of leaves and leaf area, root, shoot, leaves dry weight, seedling fresh and dry weight, root/shoot ratio, leaf weight ratio, specific leaf area and leaf area ratio of *Albizia lebbeck.* Statistical analysis of recorded data showed that seedling length and number of leaves of *Albizia lebbeck* in the soil of Bhakkar-Notak road soil. The shoot, seedling length and number of leaves of *Albizia lebbeck* were significantly ($p<0.05$) greater in the soil of Bhakkar-Jhang road (Table 5).

Table 5. Growth of *Albizia lebbeck* in soil of different polluted roads

Roads	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Number of leaves	Leaf area (cm^2)
A	9.51 ± 0.59b	17.19 ± 0.48c	26.70 ± 1.19c	8.23 ± 0.27b	8.76 ± 0.09a
B	12.32 ± 0.96a	21.81 ± 0.66b	34.13 ± 1.35b	9.43 ± 0.33ab	7.43 ± 0.14ab
C	10.62 ± 0.52ab	27.81 ± 0.65a	38.43 ± 0.95a	10.11 ± 0.05a	6.42 ± 0.05b
D	7.81 ± 0.32bc	10.71 ± 1.02d	18.52 ± 1.25e	6.19 ± 0.80c	5.39 ± 0.12bc
E	6.25 ± 0.38c	14.01 ± 0.72cd	20.26 ± 0.98d	7.07 ± 0.33bc	4.12 ± 0.07c

Symbol used: **A** = University Sub-Campus road; **B** = Bhakkar-Darya Khan road; **C** = Bhakkar-Jhang road; **D** = Bhakkar-Notak road; **E** = Bhakkar-Khansar road. Numbers followed by the same letter in the same column are not significantly different according to Duncan Multiple Range Test at $p<0.05$ level. ± Standard Error

In present study the seedling dry weight performances of *Albizia lebbeck* was responded differently when raised in different polluted roadside soils of District Bhakkar (Table 6). A significant reduction in seedling fresh and dry weight, root, shoot, leaves dry weight of *Albizia lebbeck* was recorded in the soil of Bhakkar-Notak road. Leaf weight ratio was significantly ($p<0.05$) high (0.07) in control soil. The seedling growth of *Albizia lebbeck* showed better growth in soil of Bhakkar-Jhang road and Bhakkar-Darya Khan road as compared to control and soils of other roads. All the growth variables were significantly ($p<0.05$) reduced in soils of Bhakkar-Notak road and Bhakkar-Khansar road indicating its less tolerance and adaptability to these polluted soils. The seedling length of different plant species exhibited the reduction in root and shoot length as these parts are exposed to either direct or indirect automobile pollutants present in the soil [ALLOWAY & AYRES, 1997]. Maximum value of specific leaf area was recorded in Bhakkar-Darya Khan road soil (674.44 cm^2g^{-1}) and Bhakkar-Jhang road soil (672.00 cm^2g^{-1}) as compared to control (573.85 cm^2g^{-1}). Leaf area ratio was high in seedling of control soil (37.30 cm^2g^{-1}) and minimum was recorded in Bhakkar-Notak road soil (25.00 cm^2g^{-1}). Toxic nature of available pollutants in soil usually varied in soil and ultimately effect growth of plants. Reduction trend in different growth variables was not same but changes from soil to soil. Plants do not exhibit similar trend of susceptibility to pollutants. Major variations in response of plants to air born pollutants have been also reported by JACOBSON & HILL (1970). The long period of even low concentration of automobile pollutants exposure creates destructive effects on seed germination and plant growth with visible injury [JOSHI & SWAMI, 2009].

Table 6. Effects of of different polluted roads site soil on root, shoot, leaf and seeding dry weight of *Albizia lebbeck*

Roads	Root dry weight (g)	Shoot dry weight (g)	Leaf dry weight (g)	Seedling dry weight (g)
A	0.24 ± 0.003b	0.54 ± 0.005b	0.07 ± 0.001ab	0.78 ± 0.008c
B	0.28 ± 0.001ab	0.67 ± 0.004ab	0.08 ± 0.003a	0.95 ± 0.017b
C	0.34 ± 0.002a	0.78 ± 0.002a	0.08 ± 0.001a	1.12 ± 0.013a
D	0.17 ± 0.003bc	0.35 ± 0.003c	0.03 ± 0.002bc	0.52 ± 0.009d
E	0.23 ± 0.004b	0.42 ± 0.002bc	0.04 ± 0.001b	0.65 ± 0.007cd

Symbol used: **A** = University Sub-Campus road; **B** = Bhakkar-Darya Khan road; **C** = Bhakkar-Jhang road; **D** = Bhakkar-Notak road; **E** = Bhakkar-Khansar road. Numbers followed by the same letter in the same column are not significantly different according to Duncan Multiple Range Test at p<0.05 level. ± Standard Error.

Leaf area was significantly (p<0.05) high in the seedling raised in control (8.76 cm^2) while other polluted soils showed significant reduction in this parameter. Fresh (1.28 g) and dry weight (1.12 g) of seedling were significantly (p<0.05) high in soil of Bhakkar-Jhang road as compared to control (0.91 and 0.63 g respectively). A significant (p<0.05) increase was studied in root dry weight of seedlings grown in Bhakkar-Jhang road soil and Bhakkar-Darya Khan road soil recorded as 0.34 and 0.28 g respectively which was greater than control (0.24 g). Bhakkar-Khansar road soil (0.23 g) showed nonsignificant results with control. Maximum shoot dry weight (0.78 g) of seedling was recorded for Bhakkar-Jhang road soil which showed significant (p<0.05) result with control (0.54 g). Leaf dry weightof seedlings was high (0.08 g) developed from the soils of Bhakkar-Jhang road and Bhakkar-Darya Khan road when correlated with control (0.07 g). In our findings seedling's fresh weight and dry weight showed significant (p<0.05) variations in different polluted roadside soils. POWELL & al. (1996) reported that seedling fresh weight and dry weight got reduced under polluted environment. Both increase and decrease in biomass of seedlings were also recorded by NAWAZ & al. (2006).

Table 7 showed significantly (p<0.05) high values of Root shoot ratio in Bhakkar-Khansar road soil (0.55) and Bhakkar-Notak road soil (0.49) as compared to control (0.44). Bhakkar-Jhang road soil (0.44) showed nonsignificant result with control. Seedling developed in control soil showed significant (p<0.05) increase in leaf weight ratio (0.09) followed by Bhakkar-Darya Khan road soil (0.08) while prominent reduction was observed in Bhakkar-Khansar road soil (0.06) in relation with control. Highest value of specific leaf area (179.67cm^2g^{-1}) was recorded in the seedling grown in Bhakkar-Notak road soil as compared to control (125.14 cm^2g^{-1}). A considerable amount of Arsenic in air particulates and in diesel exhaust particulates found [TALEBI & ABEDI, 2005]. In comparison, the shoot height and root length of wheat were found more sensitive to arsenic and might be used as indicators for arsenic toxicity [LIU & al. 2005].

Other three roads showed significant low results with control. Leaf area ratio of *Albizia lebbeck* developed in control soil (11.23 cm^2g^{-1}) was greater while other polluted road soil showed significant (p<0.05) reduction in this parameter. Among the most important parts of plants, the leaf is the mainly receptive part of plant to be badly pretentious by automobile pollutants. In our research work all parameters related to leaf which includes number of leaves, leaf area, specific leaf area, leaf weight ratio, leaf dry weight and leaf area ratio were reduced significantly (p<0.05) in seedlings raised from polluted roadside soil. So, the leaf at all stages of growth act as best indicator to different automobile contaminants [SHAFIQ & al. 2009]. These pollutants are responsible for stomatal clogging, leaf injury, senescence and reduction in leaf weight [TIWARI & al. 2006]. The reduced leaf area results in reduction of absorbed radiations and subsequently reduction in photosynthesis. Hence, declined in fresh weight and dry weight of leaf is directly interrelated to harmful vehicle pollutants. Our results were supported by the work of SIBAK & GULYAS (1990) noted the decline in leaf size due to automobiles pollutants available in environment.

Table 7. Effects of different polluted roads site soil on root/shoot, leaf weight ratio, specific leaf area and leaf area ratio of *Albizia lebbeck*

Roads	Root/Shoot ratio	Leaf weight ratio	Specific leaf area (cm^2g^{-1})	Leaf area ratio (cm^2g^{-1})
A	0.44 ± 0.005b	0.09 ± 0.01a	125.14 ± 3.64b	11.23 ± 0.20a
B	0.42 ± 0.005bc	0.08 ± 0.02ab	92.88 ± 4.18c	7.82 ± 0.14b
C	0.44 ± 0.007b	0.07 ± 0.02ab	80.25 ± 6.45cd	5.73 ± 0.82c
D	0.49 ± 0.005ab	0.06 ± 0.03b	179.67 ± 3.64a	10.37 ± 0.55ab
E	0.55 ± 0.007a	0.06 ± 0.02b	103.00 ± 2.00bc	6.34 ± 0.45bc

Symbol used: **A** = University Sub-Campus road; **B** = Bhakkar-Darya Khan road; **C** = Bhakkar-Jhang road; **D** = Bhakkar-Notak road; **E** = Bhakkar-Khansar road. Numbers followed by the same letter in the same column are not significantly different according to Duncan Multiple Range Test at $p<0.05$ level. ± Standard Error.

The seedling growth in terms of root, shoot, seedling height, number of leaves, leaf area, seedling dry weight, root/shoot ratio, leaf weight ratio and specific leaf area ratio performance of *Eucalyptus globulus* Labill. was found different in polluted and non-polluted soils of District Bhakkar (Table 8-10). It might be mainly depending upon nature of pollutants released from automobiles. The significant ($p<0.05$) reduction in shoot length, seedling length, number of leaves and leaf area of *E. globulus* were recorded in the soil of Bhakkar-Notak road as compared to control. Bhakkar-Jhang road soil showed significant increase in root length (5.76 cm) of *E. globulus* as compared to control (4.03 cm). Number of leaveswere significantly ($p<0.05$) high in Bhakkar-Darya Khan road soil (10.23) and Bhakkar-Jhang road soil (9.42) than control (8.80).

Table 8. Growth of *Eucalyptus globulus* in soil of different polluted roads

Roads	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Number of leaves	Leaf area (cm^2)
A	4.03 ± 0.34b	11.59 ± 0.35c	15.62 ± 1.74b	8.80 ± 0.87b	6.40 ± 0.15a
B	4.93 ± 0.66ab	15.57 ± 0.90a	20.50 ± 1.52a	10.23 ± 0.71a	5.23 ± 0.31b
C	5.76 ± 0.62a	13.89 ± 0.56b	19.65 ± 1.32ab	9.42 ± 0.50ab	4.39 ± 0.35c
D	3.11 ± 0.46c	6.97 ± 0.14e	10.08 ± 1.38c	5.80 ± 0.38d	2.18 ± 0.25e
E	2.61 ± 0.57d	9.43 ± 0.70d	12.04 ± 0.40bc	7.20 ± 0.59c	3.87 ± 0.39d

Symbol used: **A** = University Sub-Campus road; **B** = Bhakkar-Darya Khan road; **C** = Bhakkar-Jhang road; **D** = Bhakkar-Notak road; **E** = Bhakkar-Khansar road. Numbers followed by the same letter in the same column are not significantly different according to Duncan Multiple Range Test at $p<0.05$ level. ± Standard Error.

Root, shoot, leaves dry weight, seedling fresh and dry weight of *E. globulus* significantly ($p<0.05$) decreased in soil of Bhakkar-Notak road (Table 9). A significant ($p<0.05$) increase was observed in fresh (1.05 g) and dry weight (0.86 g) of *E. globulus* seedlings grown in Bhakkar-Darya Khan road soil as compared to control (0.61 and 0.48 g respectively). Root, shoot and leaf dry weight of seedlings grown in different polluted roadside soil showed significant ($p<0.05$) results with control. Root dry weight (0.24 g), shoot dry weight (0.62 g) and leaf dry weight (0.12 g) was significantly ($p<0.05$) high in Bhakkar-Darya Khan road soil and other polluted road soil showed reduction in these parameters as compared to control (0.16, 0.32 and 0.07 g respectively).

Table 9. Growth of *Eucalyptus globulus* in soil of different polluted roads

Roads	Root dry Weight (g)	Shoot dry weight (g)	Leaf dry weight (g)	Seedling fresh weight (g)	Seedling dry weight (g)
A	0.16 ± 0.006b	0.32 ± 0.005bc	0.07 ± 0.005c	0.61 ± 0.06c	0.48 ± 0.006bc
B	0.24 ± 0.008a	0.62 ± 0.008a	0.12 ± 0.008a	1.05 ± 0.08a	0.86 ± 0.009a
C	0.19 ± 0.006ab	0.40 ± 0.005b	0.08 ± 0.016ab	0.75 ± 0.07b	0.59 ± 0.008b
D	0.09 ± 0.004c	0.16 ± 0.004cd	0.05 ± 0.003cd	0.37 ± 0.03d	0.25 ± 0.009cd
E	0.14 ± 0.004bc	0.21 ± 0.004c	0.06 ± 0.002cd	0.49 ± 0.05cd	0.35 ± 0.006c

Symbol used: **A** = University Sub-Campus road; **B** = Bhakkar-Darya Khan road; **C** = Bhakkar-Jhang road; **D** = Bhakkar-Notak road; **E** = Bhakkar-Khansar road. Numbers followed by the same letter in the same column are not significantly different according to Duncan Multiple Range Test at $p<0.05$ level. ± Standard Error.

The importance to the soil-root-shoot pathway for remediation of contaminated sites with polyaromatic hydrocarbons (PAHs) was reported [SCHWAB & DERMODY, 2021]. Root to shoot ratio, leaf weight ratio, specific leaf area and leaf area ratio of *E. globulus* found influenced by automobile polluted soil treatment. Root/shoot ratio, leaf weight ratio, specific leaf area and leaf area ratio of *E. globulus* in soil of Bhakkar-Darya Khan was recorded (Table 10). Root shoot ratio of *E. globulus* was higher in seedling established from the soils of Bhakkar-Khansar road (0.67) and Bhakkar-Notak road (0.56) when correlated with control (0.50) while Bhakkar-Jhang road soil (0.48) showed nonsignificant ($p<0.05$) results with control. Leaf weight ratio was high in the seedling raised from Bhakkar-Notak road soil (0.21) and Bhakkar-Khansar road soil (0.17) as compared to control (0.15). This parameter presented significant ($p<0.05$) reduction in the soil of other polluted sites. Specific leaf area was significantly ($p<0.05$) highest in control (91.43 cm^2g^{-1}) followed by Bhakkar-Khansar road soil (64.50 cm^2g^{-1}) while other three polluted road side soils showed reduction in this parameter. Leaf area ratio was significantly ($p<0.05$) more in control (13.33 cm^2g^{-1}) followed by Bhakkar-Khansar road soil (11.06 cm^2g^{-1}), Bhakkar-Notak road soil (8.72 cm^2g^{-1}) and Bhakkar-Jhang road soil (7.44 cm^2g^{-1}). Bhakkar-Darya Khan road soil (6.08 cm^2g^{-1}) had lowest value of leaf area ratio.

Table 10. Ratios of different growth variables of *Eucalyptus globulus*in soil of different polluted roads

Roads	Root/Shoot ratio	Leaf weight ratio	Specific leaf area (cm^2g^{-1})	Leaf area ratio (cm^2g^{-1})
A	0.50 ± 0.06bc	0.15 ± 0.003b	91.43 ± 6.76a	13.33 ± 0.69a
B	0.39 ± 0.12c	0.14 ± 0.002bc	43.58 ± 7.03cd	6.08 ± 1.07d
C	0.48 ± 0.17bc	0.14 ± 0.001bc	54.88 ± 2.90c	7.44 ± 0.99cd
D	0.56 ± 0.36b	0.20 ± 0.002a	43.60 ± 5.37cb	8.72 ± 1.06c
E	0.67 ± 0.13a	0.17 ± 0.002ab	64.50 ± 3.90b	11.06 ± 1.40b

Symbol used: **A** = University Sub-Campus road; **B** = Bhakkar-Darya Khan road; **C** = Bhakkar-Jhang road; **D** = Bhakkar-Notak road. **E** = Bhakkar-Khansar road. Numbers followed by the same letter in the same column are not significantly different according to Duncan Multiple Range Test at $p<0.05$ level. ± Standard Error

Changes in soil characteristics influence plant growth and development. The seedling growth performance of *Acacia nilotica* was significantly decreased in polluted soils of Bhakkar-

Khansar road and greater in Bhakkar-Jhang road. Similalrly, a significant decrease in seedling growth performance of *Albizia lebbeck* and *E. globulus* raised in Bhakkar-Notak roadside polluted soils were recorded. The present seedling growth data can be used for the benefits of ecology and improvement in local environment during plantation of vegetation in urbanized, contaminated and degraded soil.

Conclusion

Soil pollution due to release of pollutants from vehicle emissions effects plant growth. It was concluded that due to variation in resistance and sensitivity level to automobile polluted soil some significant changes in growth variables of selected woody plant species was recorded. The results of the present study confirmed that automobile activities polluted the soil of the some Bhakkar area and that make it differently for seedling growth performance of selected three plant species, *Acacia nilotica*, *Albizia lebbeck* and *E. globulus*. *Acacia nilotica* and *Albizia lebbeck* seedlings wereflourished well in the soils of Bhakkar-Jhang road. The seedlings length of *Acacia nilotica* and *Albizia lebbeck* raised in Bhakkar-Khansar and Bhakkar-Notak road soils were highly decreased. The recorded data also showed that seedling length of *E. globulus* were significantly ($p<0.05$) increased in the soil of Bhakkar-Darya Khan road soil and progressively decreased in Bhakkar-Notak road soil. Eco-friendly organizations in the city should be established so that problems of automobile pollution could be brought in the knowledge of citizen. Some advance techniques and enforcement of environmental protection laws should be implemented to reduce the level of automobile pollution.

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