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Growth parameters of *Leucaena leucocephala, Toona ciliata* and *Dalbergia sissoo* plants growing along roadside in Baddi Barotiwala and Nalagarh industrial area of Himachal Pradesh

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Abstract
The plants of *L. leucocephala, T. ciliata and D. sissoo* raised from seeds collected from different sites in Baddi Barotiwala and Nalagarh industrial area of Himachal Pradesh (situated at an altitude of 422-448 m above mean sea level and between $30^0$55' to $31^0$02' N latitude and $76^0$42' to $76^0$49' E longitude) were studied for different growth parameters. The study area The BBN region of Himachal Pradesh comes under low hills zone and broad leaved tree species are dominant vegetation. Lowest values of all the growth parameters were recorded from National Highway 21-A site which was most polluted area followed by Baddi Barotiwala link road, Kalka Charnia link road and Control site.

Keywords: Growth parameters, tree species, roadside, industrial area

Introduction
Trees in cities face stressful growing environment such as air pollution, environmental degradation, pressure for land space and traffic congestion etc. which suppresses performance and shorten life span of plants. Trees not only have an ornamental function in urban areas, but they may also improve the quality of urban life (Akbari 2002 and Brack 2002) [1, 2], having a role in carbon dioxide sequestration and oxygen releasing through photosynthesis.
Automobile exhaust emission showed toxic effects on seed germination and seedling growth of *Cassia siamea* (Shafiq and Iqbal, 2012) [6]. Seedling and root length were highly decreased for seeds of same species collected from polluted site where pollution levels was higher as compared to control site.
Siddiqui and Iqbal (1994) [8] investigated the effect of automobile pollution on seedling growth of roadside tree species *Cassia surattensis* (Burm F.), *Leucaena leucocephala* (Lam.) De-wit, *Parkinsonia aculeata* (L.) and *Sesbania sesban* (L.) Merill. The seeds of the most of the species collected from the polluted area showed significant reduction in growth as compared to control. Sharma *etal.,* 2018 also reported reductions in germination percentage of seeds of *L. leucocephala, T. ciliata and D.sissoo* growing along roadside as compared to control site.
The effect of air pollutants generated from the exhaust of industries and automobiles on the chlorophyll content of leaves has been studied by Sumitra *et al*. (2013) [9]. The leaf samples of *A. indica*, *Nerium oleander*, *Mangifera indica* and *D. sissoo* showed reduction in the photosynthetic pigments of plant leaves growing in highly polluted site as compared to non or less polluted ones. The main objective of this study was to study the effect of auto exhaust pollution on growth parameters of plants raised from seeds from sites with bearable pollution levels.

Objective
To study growth parameters of *Leucaena leucocephala*, *Toona ciliata* and *Dalbergia sissoo* plants growing along roadside in Baddi Barotiwala and Nalagarh industrial area of Himachal Pradesh.

Material and methods
The present investigation was undertaken in Baddi, Barotiwala and Nalagarh industrial area of Himachal Pradesh for assessing the effect of auto-exhaust emissions on seedling growth of tree species growing along roadside.

The study area is situated at an altitude of 422-448 m above mean sea level and lies between $30^0$55' to $31^0$02' N latitude and $76^0$42' to $76^0$49' E longitude. The BBN region of Himachal Pradesh has subtropical climate with winter season commencing from November to February, summer season from March to June followed by the monsoon period extending from July to September. Average rainfall in the district is about 1150 mm. The mean temperature ranges from 4^0C (during winter) to 42 ^{0}C (during summer). In order to study the vegetation distribution, amount of pollution and to select the study sites a survey was conducted in the region. Based on the survey four sites selected for study were as: i) National Highway 21 A; in Baddi industrial area, ii) Baddi-Barotiwala Link Road, iii) Kalka-Charnia Link Road iv) Control;-200m away from road in Kalka-Charnia Link Road.

As control, the non-polluted agricultural area surrounding Kalka-Charnia link road was purposefully considered. Based on the vegetation distribution three commonly occurring tree species were selected in all the four sites for study. The tree species selected were *Leucaena leucocephala* (Lamk.), *Toona ciliata* (Roem.) and *Dalbergia sissoo* (Roxb.). The seeds of different tree species were sown directly in to the polybags of size 11.43x 22.86 cm filled with the mixture of sand, soil and FYM in the ratio of 1:2:1. Seeds of *T. ciliata* and *L. leucocephala* were planted in July, 2014, whereas, seeds of *D. sissoo* were planted in April, 2015. There were five replications per tree species per site and five seedlings were maintained per replication. Recommended plant protection measures were applied uniformly whenever required.

The seedling growth parameters such as shoot length, root length, fresh shoot and root weight and number of leaves were recorded at termination of experiment in last week of June, 2015. For recording dry shoot and root weights the samples were dried in the oven at 80 °C for 48 hours and weights were recorded by using digital balance. Root shoot ratio was studied by dividing dry weights of roots with that of dry weight of shoots of seedlings from each replication of treatments/ site of all the selected tree species. The ratios were calculated for each tree species and all the sites.

Results and Discussion

Table 1: Variations in growth parameters of different plant species grown from seeds collected from different sites in BBN industrial area of Himachal Pradesh

Sites	Shoot length (cm)	Root length (cm)	No. of leaves	Fresh shoot weight (g)	Dry shoot weight (g)	Fresh root weight (g)	Dry root weight (g)	Root shoot ratio
Leucaena leucocephala								
National Highway 21-A (Baddi)	36.10	7.75	16.00	7.10	4.28	3.50	1.78	0.41
Baddi Barotiwala link road	38.50	8.90	18.00	8.50	5.40	4.46	2.15	0.39
Kalka Charnia link road	41.00	10.50	20.00	9.50	6.00	5.28	2.80	0.47
Control	45.00	12.00	22.00	11.00	7.20	6.44	3.28	0.45
$C.D_{(P=0.05)}$	1.47	1.16	1.67	0.84	0.61	0.21	0.13	0.05
Toona ciliata								
National Highway 21-A (Baddi)	22.00	9.00	7.00	8.20	5.40	3.50	2.20	0.40
Baddi Barotiwala Link Road	22.50	9.50	7.50	8.70	5.85	3.95	2.60	0.44
Kalka Charnia Link Road	22.86	9.88	8.00	9.10	6.50	4.20	3.00	0.46
Control	24.00	10.50	8.50	9.90	7.00	4.90	3.50	0.50
$C.D_{(P=0.05)}$	N.S	N.S	0.81	0.47	0.58	0.60	0.47	N.S
Dalbergia sissoo								
National Highway21-A (Baddi)	6.30	3.20	7.00	3.00	1.40	1.50	1.00	0.71
Baddi Barotiwala Link Road	6.90	3.60	7.80	3.50	2.00	1.80	1.20	0.61
Kalka Charnia Link Road	7.40	4.20	8.00	4.00	2.60	2.10	1.60	0.61
Control	7.95	4.80	8.60	4.50	3.00	2.50	2.00	0.67
$C.D_{(p=0.05)}$	0.43	0.25	0.80	1.05	0.32	0.21	0.30	N.S

Growth parameters of *Leucaena leucocephala*

The shoot length was significantly less (36.10 cm) in plants raised from seeds collected from National Highway 21-A, followed by Baddi Barotiwala link road and Kalka Charnia link road against 45.00 cm in control. The shoot length of plants raised from seeds collected from different sites differed significantly with each other.

The root length of plants raised from seeds collected from different sites was 7.75, 8.90 and 10.50 cm from National Highway 21-A, Baddi Barotiwala link road and Kalka Charnia link road, respectively, against 12.00 cm in control The root length of plants raised from seeds collected from National Highway 21-A and Baddi Barotiwala link road were significantly at par with each other and lower than other two sites. The root length of plants raised from seeds collected from Kalka Charnia link road was lower than control.

The number of leaves of plants was minimum (16.00) raised from seeds collected from National Highway 21-Aagainst 22.00 in seeds collected from control trees. The number of leaves in plants raised from seeds collected from different sites differed between sites.

The fresh shoot weight of plants raised from seeds collected from different sites was 7.10, 8.50 and 9.50 g in National Highway 21-A, Baddi Barotiwala link road and Kalka Charnia link road, respectively, against 11.00 g in seeds collected from control trees. The shoot length differed significantly among different sites.

The dry shoot weight of plants raised from seeds collected from different sites was maximum (6.00 g)in seeds collected from Kalka Charnia link road, respectively, against 7.20 g in control. The dry shoot weight of plants raised from seeds collected from Baddi Barotiwala link road and kalka charnia link road were at par with each other.

The fresh root weight of plants raised from seeds collected from different sites varied from 3.50 to 5.28 g and differed significantly between different sites being significantly high 6.44 g in control site

The significantly lowest dry root weight (1.78 g) was in seeds collected from National Highway 21-A, followed by Baddi Barotiwala link road and Kalka Charnia link road. The dry root weight of plants also differed significantly between different sites being maximum 3.28 g in control site followed by 2.80 g in Kalka Charnia link road and 2.15 g in Baddi Barotiwala link road.

The root shoot ratio of plants raised from seeds collected from different sites was 0.41, 0.39 and 0.47 in National Highway 21-A, Baddi Barotiwala link road and Kalka Charnia link road, respectively, against 0.45 in control. No significant differences in root shoot ratio were recorded between National Highway 21-A and Baddi Barotiwala link road and Kalka Charnia link road and control.

Growth parameters of *Toona ciliata*

The shoot length was significantly less (22.00cm) in*T. ciliata* plants raised from seeds collected from National Highway 21-A, followed by Baddi Barotiwala link road and Kalka Charnia link road against 24.00 cm in control. The shoot length of plants raised from seeds collected from different sites revealed no significant differences between sites.

The root length of plants raised from seeds collected from different sites was 9.00, 9.50 and 9.88 cm from National Highway 21-A, Baddi Barotiwala link road and Kalka Charnia link road, respectively, against 10.50 cm in control.

The number of leaves of plants was minimum (7.00) raised from seeds collected from National Highway 21-A against 8.50 in seeds collected from control trees. No. of leaves were found highest in plants raised from seeds collected from control which were at par with No. of leaves in Kalka Charnia link road. Similarly, no significant differences were found in No. of leaves in Highway 21-A and Baddi Barotiwala link road, Baddi Barotiwala link road and Kalka Charnia link road.

The fresh shoot weight of plants raised from seeds collected from different sites was 8.20, 8.70, 9.10 g in National Highway 21-A, Baddi Barotiwala link road and Kalka Charnia link road, respectively, against 9.90 g in seeds collected from control trees. The fresh shoot weight of plants raised from seeds collected from Baddi Barotiwala link road was at par with that of Kalka Charnia link road.

The dry shoot weight of plants raised from seeds collected from different sites was maximum (6.50 g) in seeds collected from Kalka Charnia link road, respectively, against 7.00 g in control. The dry shoot weight of plants raised from seeds collected from National Highway 21-A and Baddi Barotiwala link road were significantly at par with each other. Similarly, no differences in dry shoot weight of plants were observed in Kalka Charnia link road and control.

The fresh root weight of plants raised from seeds collected from different sites varied from 3.50 to 4.20 g and differed significantly between different sites, being significantly high in control site i.e., 4.90 g. The fresh weight of plants raised from seeds collected from Baddi Barotiwala link road was at par with both National Highway 21-A and Kalka Charnia link road

The significantly lowest dry root weight (2.20 g) was in seeds collected from National Highway 21-A, followed by Baddi Barotiwala link road and Kalka Charnia link road. The dry root weight of plants also differed significantly between different sites being maximum 3.50 g in control followed by 3.00 g in Kalka Charnia link road and 2.60 g in Baddi Barotiwala link road

The root shoot ratio of plants raised from seeds collected from different sites was 0.40, 0.44 and 0.46 in National Highway 21-A, Baddi Barotiwala link road and Kalka Charnia link road, respectively, against 0.50 in control. No significant differences in root shoot ratio were recorded between National Highway 21-A and Baddi Barotiwala link road and Kalka Charnia link road and control.

Growth parameters of *Dalbergia sissoo*

The shoot length was significantly less (6.30cm) in *T. ciliata* plants raised from seeds collected from National Highway 21-A, followed by Baddi Barotiwala link road and Kalka Charnia link road against 7.95 cm in control. The shoot length of plants differed significantly between sites.

The root length of plants raised from seeds collected from different sites was 3.20, 3.60 and 4.80 cm from National Highway 21-A, Baddi Barotiwala link road and Kalka Charnia link road, respectively, against 10.50 cm in control.

The number of leaves of plants was minimum (7.00) raised from seeds collected from National Highway 21-A against 8.60 in seeds collected from control trees. The number of leaves was highest in plants raised from seeds collected from trees away from road (control) which was also at par with number of leaves in plants raised from roadside trees in Baddi Barotiwala link road and Kalka Charnia link. No significant differences were found in number of leaves in plants raised from seeds from National Highway 21-A and Baddi Barotiwala link road.

The fresh shoot weight of plants raised from seeds collected from different sites was 3.00, 3.50, 4.00 g in National Highway 21-A, Baddi Barotiwala link road and Kalka Charnia link road, respectively, against 4.50 g in seeds collected from control trees. Lowest shoot weight was recorded in National Highway 21-A. However, it was also statistically at par with Baddi Barotiwala link road and Kalka Charnia link road.

The dry shoot weight of plants raised from seeds collected from different sites was maximum (2.60 g) in seeds collected from Kalka Charnia link road, respectively, against 3.00 g in control. The dry shoot weight of plants raised from seeds collected from National Highway 21-A and Baddi Barotiwala link road were significantly at par with each other.

The fresh root weight of plants raised from seeds collected from different sites varied from 1.50 to 2.10g and differed significantly between different sites, being significantly high in control site i.e., 2.50 g. The fresh root weight of plants was highest in Control and lowest in National Highway 21-A. The fresh root weight of plants also differed significantly between sites.

The significantly lowest dry root weight (1.0 g) was in seeds collected from National Highway 21-A, which was also at par with dry root weight of plants in Baddi Barotiwala link road (1.20 g) followed by Kalka Charnia link road (1.60 g). The plants in control recorded highest dry root weight (2.0 g) as compared to other sites.

The root shoot ratio of plants raised from seeds collected from different sites was 0.71, 0.61 and 0.61 in National Highway 21-A, Baddi Barotiwala link road and Kalka Charnia link road, respectively, against 0.67 in control. No significant differences in root shoot ratio were recorded between National Highway 21-A and Baddi Barotiwala link road and Kalka Charnia link road and control.

Similar studies have been reported by Qadir and Iqbal in 1991 [3], Growth of *Pongamia pinnata* (L.)Merril and *A. lebbeck*

was significantly decreased in seedlings raised from the polluted seeds as compared to control Significant reductions were observed in shoot length of the polluted seedlings of *P. pinnata* (49.16%) and *A. lebbeck* (23.27%) as compared to the seeds collected from unpolluted areas. Similarly, Shafiq and Iqbal (2003, 2005) [4, 5] have reported that plants growing adjacent to roadsides in Karachi city exhibited considerable damage in response to automobile exhaust emissions. They investigated toxic effects of motor vehicle emissions on seed germination and seedling growth of *Peltophorum pterocarpum* D.C. Baker Ex K. Heyne. In 2007 they found that germination and growth of *P. pterocarpum* seeds were significantly ($P<0.05$) affected in the seeds collected from the polluted areas as compared to the less polluted areas. Highest per cent decrease in seed germination was found in seeds collected from the extremely polluted area, followed by very much polluted, polluted and a little polluted areas as compared to the unpolluted area (control). Seedling and root lengths were also found reduced in plants raised from seeds of the same species collected from the extremely polluted area as compared to the control.

Conclusion

All the growth parameters (shoot length, root length, number of leaves, fresh shoot weight, dry shoot weight, fresh root weight, dry root weight and root shoot ratio) were found minimum in National Highway 21-A site followed by Baddi Barotiwala link road, Kalka Charnia link road and Control site. Effect of pollution was more pronounced in *L. leucocephala* i.e., it was found more sensitive to pollution followed by *D. sissoo* and *T. ciliata* was least affected. As *L. leucocephala* was affected most by auto-exhaust pollution and it is a fodder tree so its plantation should be avoided on roadside.

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