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Effect of Traffic Exhaust on Roadside Trees During Different Seasons

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Abstract

The effect of automobile pollutants on plants growing in Karachi during different seasons were studied. In response to the polluted environment, the phenology of *Guiacum officinale* and *Peltophorum pterocarpum* was highly affected at M. A. Jinnah road, the most polluted area of the city. Automobile emissions also significantly reduced the productivity of fruits and flowers in. *G. officinale*, whereas *Azadirachta indica* was found comparatively resistant to automobile emissions. The trees growing on the busy roads produced a significant effect on seed germination. The seeds of *Albizia lebbeck* showed significant reduction in germination as compared to *Peltophorum pterocarpum*.

Effective identification of air pollutant sources and their accumulation in plants would be helpful for environmental protection. The findings would also be helpful for understading the ecological value of vegetation which maintains water, climatic conditions and protection from the hazardous effect of air pollutants.

Keywords: Autovehicular emissions, germination, pollutant, season, tree.

Introduction

Air is necessary for life on earth. The addition of unwanted airborne matter changes the composition of the earth's atmosphere, possibly harming life and altering materials. We call such atmospheric contamination air pollution [26]. There has been widespread damage to trees, fruits, vegetation and ornamental flowers by air pollution. Photechemical (Oxidants) smog bleaches and glazes spinach, lettuce, alfalfa, tobacco and other leafy plants. Ethylene, a hydrocarbon that occurs in automobile and diesel exhaust, makes carnation petals curl inward and ruins orchids by drying and discloring their sepals. Atmospheric pollutants undoubtedly have some long-terms effects on plants by influencing CO_2 content, light intensity, temperature and precipitation [28]. Hesketch [13] and Gustafsson and Steinecke [11] suggested that high levels of motor vehicle traffic produces considerable emissions of air pollutants. Toxic trace metal ions can enter the soil from automobile emissions [17]. Vehicular emissions are receiving attention in some quarter [7], as evidenced by a Swedish newspaper stating "Catalytic converters destroy the ozone layer" [9]

Karachi is the largest city of Pakistan and about 22% of the total urban population of the country. Nearly half of the country's vehicles (taxis rickshaws, buses and private mini buses) are seen in Karachi [18]. The progressive increase in trade activities and an increase in the number of autovehicles along with the high rate of industrialization have affected the environment of the city. A few researchers have drawn attention to the effect of air pollution due to vehicular exhaust [2, 3, 4, 14, 15, 18]. The seeds of *A. Lebbeck* and *Dalbargia sissoo* collected from the polluted areas of the city showed significant reduction in germination [18].

Automobile exhaust produce a significant effect on seed weight and branch length of some roadside trees [14]. Prindle and Charles [22] described the damage caused to animals and agricultural crops by automobile. Derley et al. [6] noticed the damaging effects of gases and different compounds present in motor vehicle exhaust on leaves of a variety of crop plants. Automobile pollutants have also been shown to modify aminoacids [16]. Automobile emissions significantly reduced the productivity in. *G. officinale, F. bengalensis* and *Eucalyptus sp.* along with a significant reduction in leaf area and dry weight of most of the plants [4]. Early maturation and fall of fruits occurred at polluted sites as compared to the clean area [4]. Thery have further demonstrated that *F. bengalensis*, which has broader leaves, showed more visible injury than the *A. indica* near the road.

Air pollution studies are a matter of utmost concern. A study was initiated to investigate the effect of automobile pollution on roadside plants growing in the main city center during different seasons.

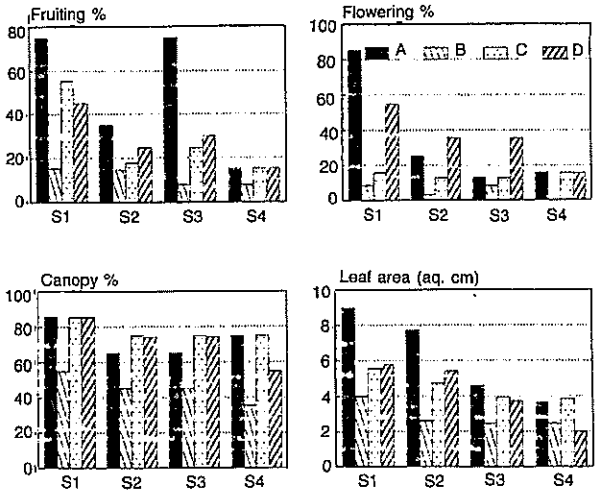


Fig. 1. Effect of autovehicular exhaust on the percentage of Fruiting, Flowering, Canopy and Leaf area of *Guiacum officinale*.
Symbols used:

A = Safari Park (Control)	B = M.A. Jinnah Road
C = University Road	D = Jail Road
S1 = Season June-July	S2 = August-September
S3 = October-November	S4 = December-January

Materials and Methods

A study was carried out to examine the effects of traffic exhaust during different seasons (June to January) on plants growing at different sites of the city (Safari Park, University road, Jail Road and M.A. Jinnah Road). At each site, *Guaiacum officinale* L., *Peltophorum pterocarpum* D.C. Backer ex K. Heyne and *Azadirachta indica* (L.) A. Juss of uniform height were chosen (DBH: diameter breast height). Quantitative characters such as percentage of fruiting, canopy and flowering, leaf area, color of leaves and flowers were recorded during four different seasons (June-July, August-September, October-November and December-January). All measurements are based on three replicates.

The seeds of *Albizia lebbeck* and *Peltophorum pterocarpum* were collected from polluted and clean areas of the city. The seeds of both species were rubbed with sand paper. All the seeds were soaked in one percent bleach and later on wash to avoid any type of fungal growth during seed germination. The germination test was performed in medium sized petridishes as in the laboratory. In each petridish, 10 seeds of each species were kept at room temperature and daily observation was made. Analysis of variance and Student-Newman-Keul Multiple range test was also carried out.

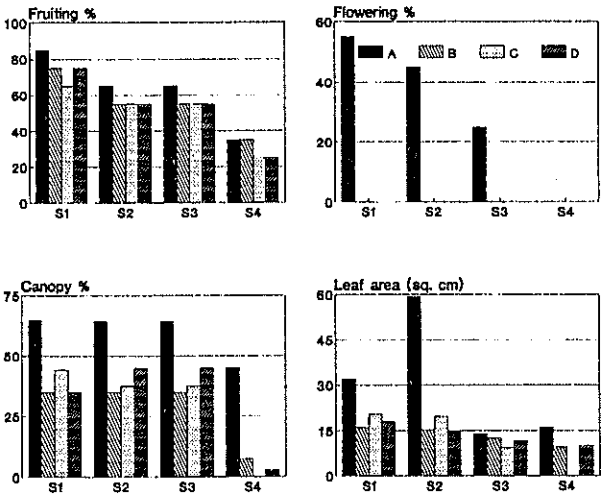


Fig. 2. Effect of autovehicular exhaust on the percentage of Fruiting, Flowering, Canopy and Leaf area of *Peltophorum pterocarpum*.
Symbols used:

A = Safari Park (Control)	B = M.A. Jinnah Road
C = University Road	D = Jail Road
S1 = Season June-July	S2 = August-September
S3 = October-November	S4 = December-January

Results

A significant reduction in the percentage of fruiting and leaf area of *G. officinale, A. indica* and *P. pterocarpum* was observed in winter season at M.A. Jinnah Road (Figs. 1, 2 and 3). The percentage of flowering of *G. officinale* during winter season at M.A. Jinnah Road was significantly reduced. Automobile pollutants significantly reduced the percentage of canopy for *P. pterocarpum* and *G. officinale* at the same site. The canopy of *A. indica* showed no effect in any of the seasons at the study area (Figs. 2 and 3). The color of leaves for *G. officinale, A. indica* and *P. pterocarpum* was found light green, green, and dark green in summer, which later turned to light green, yellow and yellow green in winter at all sites. Flowers have been the object of numerous studies from morphologic and anatomic aspects. The color of the flower for *G. officinale* remained purple white in summer and winter. The seed germination of *A. lebbeck* was highly affected in seed collected from M.A. Jinnah Road followed by Jail road, and University Road (Fig. 6). The color of the leaves for *G. officinale* was light green in summer and spring and later in winter it changed to light green yellowish in color at M.A. Jinnah Road, while the color of flowers in all seasons remain pale white at all the sites. The color of the leaves of *A. indica* were green in summer and spring while yellow green in winter at all sites. The color of the leaves for *P. pterocarpum* remained dark green in all seasons except winter, where it was yellowish green at all sites. The seed germination of *A. lebbeck* was significantly different between control and polluted sites of the city. However, the seed of *P. pterocarpum* showed a high percentage of germination and was found less affected by automobile exhaust at the polluted sites of the city.

Discussion

In Karachi city, the traffic density is high and the vehicles passing through the busy streets produce different types of pollutants. During the study, it was observed that the plants growing at M.A. Jinnah Road were more affected. Leaf area and seed germination was also affected as compared to less polluted areas of the city. At the polluted area, the rate of photosynthesis assimilation and reasonable

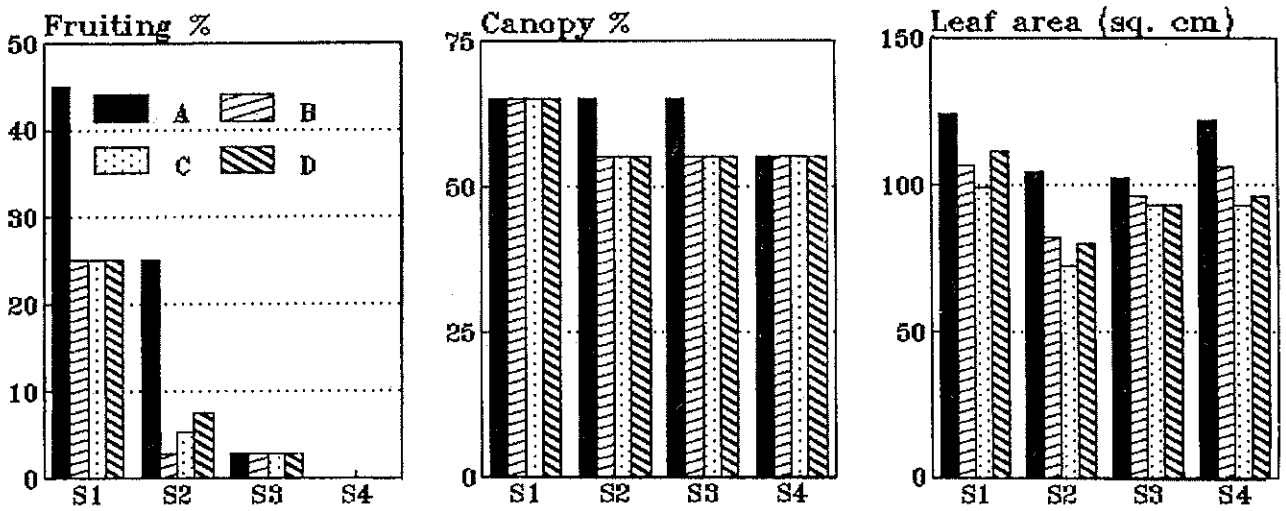


Fig. 3. Effect of autovehicular exhaust on the percentage of Fruiting, Flowering, Canopy and Leaf area of *Azadirachta indica*. Symbols used:

A = Safari Park (Control) B = M.A. Jinnah Road
C = University Road D = Jail Road
S1 = Season June-July S2 = August-September
S3 = October-November S4 = December-January

transpiration are disturbed, resulting in reduction of tree growth and biomass production. Reduced yields of flowers, fruits and seeds to ozone environment have been demonstrated by Heagle et al., [12]. Air pollution interferes with time of flowering, fruiting, senescence, shedding of fruits and the emergence of leaves. Early maturation of fruits occurred at polluted sites as compared to clean area. *G. officinale* and *P. pterocarpum*, which are mostly grown in the center of many roads in Karachi, showed significant reduction in fruit and leaf area in the polluted sites of the city. However, *A. indica* was found to be resistant to automobile pollutants. Growth and germination of some tree species were significantly affected by automobile emissions. Abdullah and Iqbal [1] found stomatal clogging in relation to automobile particulate matter and found 81% clogged stomata in *Polyalthia longifolia* at Gurumander. Many reports have shown that automobile exhaust has produced a significant effect on the growth of roadside plants. A signicant reduction in fruit production and leaf area of *G. officinale, A. indica* and *P. pterocarpum* was observed in winter at M.A. Jinnah Road. The presence of various types of pollutants derived from automobiles might be responsible for the reduction in growth of the plants. Bhatti and Iqbal [4] concluded that in response to the polluted atmospshere, the phenology of *Ficus bengalensis* and *Eucalyptus* sp. was highly affected due to automobile exhausts. They have also concluded that automobile emissions significantly reduced productivity, leaf area and leaf dry weight of *G. officinale, F. bengalensis* and *Eucalyptus* sp. at the polluted sites of the city as compared to control.

Beg et al., [3] concluded that those plants and trees which were found near the polluted source just along the roadside showed significant reduction in growth. Due to the effect of pollutants, chlorophyll is dissintegrated and CO_2 uptake is reduced, followed by a reduction in synthesized assimilates [19]. According to Hesketch [13], the motor vehicle is the most important source of atmoshperic pollution. Bhatti and Iqbal [4] determined that leaf size, leaf area and leaf dry weight in some roadside trees was less at the highly polluted as compared to less polluted sites of the city.

A significant reduction in the fruit production, flower and percentage of the canopy for *G. officinale* at the M.A. Jinnah Road might be due to the congestion and high density of vehicles as compared to the other points. A significant proportion of the total lead emitted by all vehicles was found on the edge of a highway in Newzealand. However, the lead content of soil and vegetation at the edge of the highway was high, gradually decreasing as distance from the highway increases [27]. Floral vascular system, floral morphology, and color development in flowers were carried out by some research worker [21, 23, 25]. The change in the color of leaves might be a change in leaf pigment. Ricks and Williams [24] found that in the most polluted station chlorophyll "a" degradation to chlorphyll "b" in *Quercus petraea*. The color of petals results from pigments in chromoplast (Caretenoids), in cell sap (Anthocynanins), and from various modifying conditions, such as acidity of cell sap [21]. A significant reduction in flowering might be due to the reduction in light intensity on the busy roads of the city.

The effects of automobile exhaust on seed germination varies from place to place and species to species. The seeds of the polluted sites showed less germination as compared to less polluted areas. The seed germination of *A. Lebbeck* was highly affected while *P. pterocarpum* was not affected by auto emissions. The germination of seeds could be affected by the development of unhealthy seeds by trees growing along the main road of the city area [4] *P. pterocarpum* seed, which showed most resistance against auto exhaust, might be due to its hard seed pod and thick seed coat. Darley et al. [6], noticed the damaging effects of gases and different compounds present in motor vehicle exhaust on the leaves of a variety of crop plants. A significant reduction in *A. lebbeck* was observed. The pods of *A. lebbeck* are not thick, which might be unable to resist the air pollutants and lead to a reduction in seed germination. The presence of Pb and other metals could be responsible for

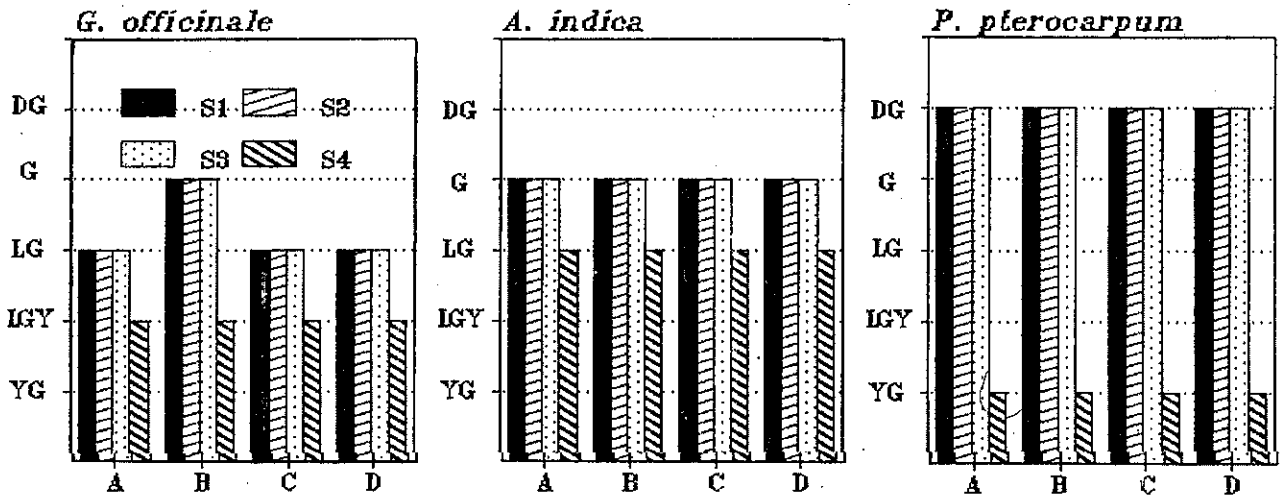


Fig. 4. Effect of autovehicular exhaust on the leaf color of *G. officinale, A. indica* and *P. pterocarpum*.

Symbols used:

A = Safari Park (Control) B = M.A. Jinnah Road
C = University Road D = Jail Road
S1 = Season June-July S2 = August-September
S3 = October-November S4 = December-January
P = Purple W = White L = Ligt D = Dark G = Green

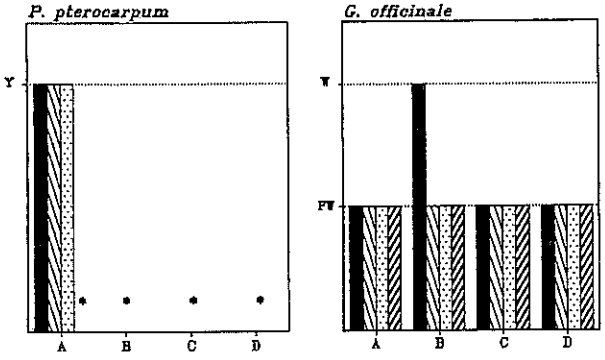


Fig. 5. Effect of autovehicular exhaust on the flower color of *G. officinale, A. indica* and *P. pterocarpum*.

Symbols used:

A = Safari Park (Control) B = M.A. Jinnah Road
C = University Road D = Jail Road
S1 = Season June-July S2 = August-September
S3 = October-November S4 = December-January
P = Purple W = White L = Ligt D = Dark G = Green
* = Not Found

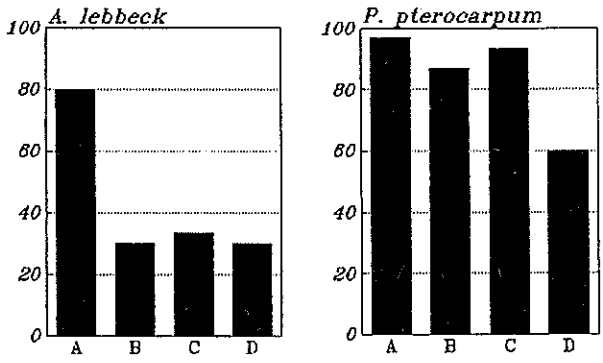


Fig. 6. Effect of autovehicular exhaust on seed germination of *Peltophorum pterocarpum* and *Albizia lebbeck*.

Symbols used:

A = Safari Park (Control) B = M.A. Jinnah Road
C = University Road D = Jail Road

the reduction in seed germination. Deposition of lead on the vegetation growing along the busy roads not only affects growth and germination, but also causes reduction in fruit production [20]. Sensitivity of germinating seeds has often been used to test and measure environmental pollution, particularly of toxicants in aqueous solutions [10]. Chang and Thompson [5], after soaking corn seeds in 0.01 M Sodium fluoride solution, found root cell multiplication more inhibited than cell elongation. Wong et al. [29] studied the inhibition of seed germination and root growth in road plants of *Brassica chinesis* and *B. parachinensis*.

There is a need to analyze automobile pollutants, which is a determining factor of type and extent of injury of particular plant species. The planting of *A. indica* along the road side would help in the reduction of airborne pollutants from automobiles.

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