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Research Note

Germination and Seedling Behaviours of Seeds of *Peltophorum pterocarpum* D.C.Baker Ex K.Heyne Growing under Motor Vehicle Emission

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Abstract: Motor vehicle emission showed toxic effects on seed germination and seedling growth of *Peltophorum pterocarpum* D.C.Baker ex K.Heyne. 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. A higher percentage of decrease in seed germination was found for the 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 highly decreased for the seeds of the same species collected from the extremely polluted area as compared to the control. A high percentage of seedling dry weight was found for the seeds of the same species collected from the extremely polluted area (62%), followed by very much polluted area (58%), polluted area (38%), and a little polluted area (28%) as compared to the control. According to the tolerance test, seedling growth of *P. pterocarpum* showed the lowest percentage of tolerance in the samples collected from the extremely polluted area (53%), followed by very much polluted area (71%), polluted area (89%), and a little polluted area (92%) as compared to the campus.

Key Words: Germination, growth, roadside tree, urban areas, vehicular emission

Introduction

Peltophorum pterocarpum D.C.Baker ex K.Heyne is a moderate sized, well-shaped evergreen tree with a dense crown. It is a native to South India. The tree grows fairly rapidly and is easy to cultivate. This tree is largely planted for ornamental purposes along roadsides. Roadside trees in cities are coming under pressure and diminishing due to the vehicular-traffic infrastructure and other community needs (Jim, 1998). Most vehicles emit black smoke due to incomplete combustion of fuel. Some toxic materials such as carbon particles, unburned and partially burned hydrocarbons, fuels, tar materials, lead compounds, and some other elements, namely constituents of petrol and lubricating oils, deposit on the surface of plants. These pollutants in combinations cause greater or synergistic effects on plants.

Trees in cities face an exceptionally stressful growing environment, such as air pollution, environmental degradation, pressure for land space, traffic congestion, and destruction of trees and green areas to accommodate urban development, all of which suppress their performance and shorten their life span (Gilbertson & Bradshaw, 1985; Bhatti & Iqbal 1988; Jehan & Iqbal, 1992; Sawidis et al., 1995; Jim, 1996, 1997, 1998; Webb, 1998; Shafiq & Iqbal, 1999; Aksoy et al., 2000; Shafiq & Iqbal, 2003; Shafiq & Iqbal, 2005). The pollutants emitted from motor vehicles adversely affect the germinability of seeds (Guderian, 1977; Wong et al., 1984; Türkan, 1988; Qadir & Iqbal, 1991). The seeds of *Dalbergia sissoo* Roxb., collected from different polluted areas of the city, showed significant reduction in germination as compared to the seeds collected from the less polluted areas (Mehmood & Iqbal, 1989). The seeds of *Cassia surattensis* Burm.f., *Leucaena leucocephala* (Lam.) de Wit, *Parkinsonia aculeata* L., and *Sesbania sesban* (L.) Merr. collected from the polluted areas showed significant reductions in germination as compared to the control (Siddiqui & Iqbal, 1994).

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The aim of the present research was to investigate the effects of motor vehicle pollutants on seed germination and seedling growth of *Peltophorum pterocarpum*.

Materials and Methods

Selection of sites

A. Unpolluted area (Karachi University Campus): This site is relatively free from motor vehicular activities as compared to other sites of the city. Karachi University Campus is clean and 20 km away from Quaid-e-Azam tomb. The sites in the urban area are disturbed mainly by motor vehicular activities and are within the main traffic network (Gulshan-e-Iqbal, Nazimabad, Shahrah-e-Faisal, and M.A. Jinnah Road), whereas Karachi University is a relatively clean area (Figure 1). Brief descriptions of the study areas are given below.

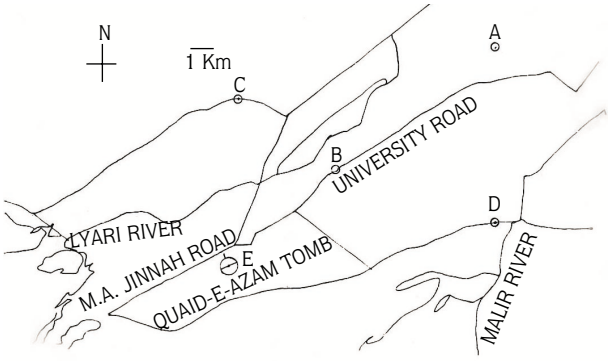

Figure 1. Map of the study area (A. Unpolluted area (Karachi University Campus); B. A little polluted area (Gulshan-e-Iqbal); C. Polluted area (Nazimabad); D. Very much polluted area (Shahrah-e-Faisal); E. Extremely polluted area (M.A. Jinnah Road).

B. A Little polluted area (Gulshan-e-Iqbal): Gulshan-e-Iqbal is located about 8 km north-east of the Quaid-e-Azam tomb. This place is comparatively open with low traffic.

C. Polluted area (Nazimabad): Nazimabad handles a large traffic volume, moving from the north to the west of the city. This site is about 10 km away from the north of Quaid-e-Azam tomb.

D. Very much polluted area (Shahrah-e-Faisal): This site is 15 km away from the eastern site of the Quaid-e-Azam tomb and is heavily influenced by traffic.

E. Extremely polluted area (M.A. Jinnah Road): Dense traffic from Gulshan-e-Iqbal, Nazimabad, Liaquatabad, and Shahrah-e-Faisal passes along this road. The slow movement of traffic causes toxic pollutants to build up in the area.

Seeds of *Peltophorum pterocarpum* D.C.Baker ex K.Heyne were rubbed by sand paper to break seed dormancy. All the seeds were soaked in 1% bleach solution for 1 min and later washed with double distilled water to avoid any type of fungal contamination during germination. Ten seeds of each species were kept in well-sterilised petri dishes (90-mm diameter) on Whatman filter paper No. 42 at room temperature (28 °C ± 2). Four 40-W tube lights were used as a continuous light source. There were 3 replicates and the experiment was completely randomised. The seed germination was regularly checked. The root and seedling lengths were measured after 10 days and their oven dry weights were obtained.

Indices of tolerance were determined by the formula given by Iqbal and Rehmati (1992):

Mean root length of polluted area seeds / Mean root length of campus seeds ×100

The data collected for different growth parameters were statistically analysed by analysis of variance techniques (Steel and Torrie, 1980) and Duncan's multiple range test (Duncan, 1955).

Results

Motor vehicle emissions showed toxic effects on seed germination and seedling growth of *P. pterocarpum* (Figures 2-4). Seeds of *P. pterocarpum* collected from the polluted areas showed a low percentage of germination, seedling length, root length, and seedling dry weight. A higher percentage of decrease in seed germination was found for the seeds collected from the extremely polluted area (39%), followed by very much polluted area (29%), polluted area (18%), and a little polluted area (12%) as compared to the university campus (Figure 2). Seedling length of *P. pterocarpum* was also greatly affected in the samples collected from the extremely polluted area (55 mm), very much polluted area (65 mm), polluted area (80 mm), and a little polluted area (85 mm) as compared to the unpolluted area (93 mm). A high percentage of decrease in the root

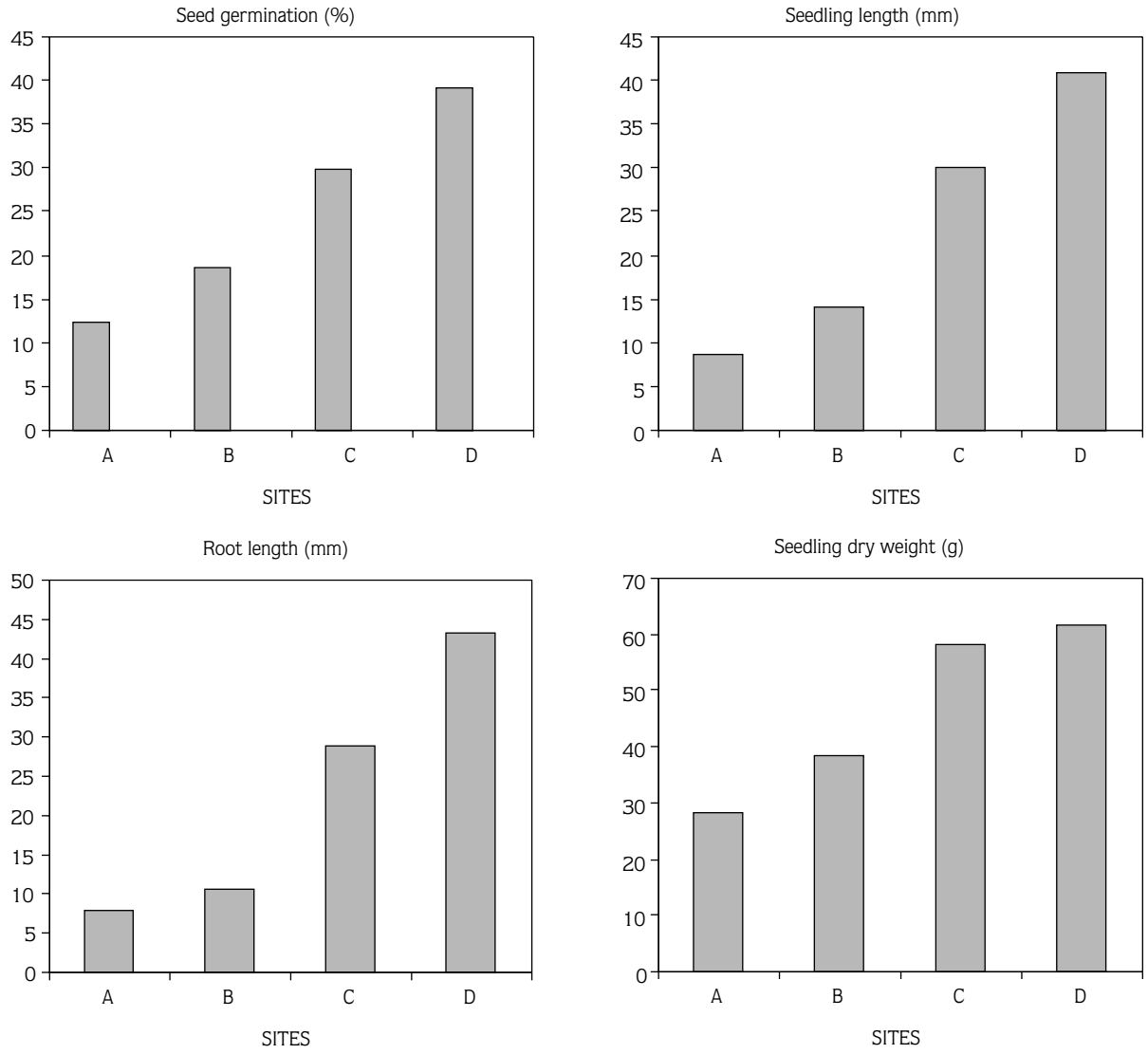

Figure 2. Percentage decrease in seed germination, seedling length, root length and seedling dry weight of *Peltophorum pterocarpum* as compared to the control.
SITES: (A. A little polluted area (Gulshan-e-Iqbal); B. Polluted area (Nazimabad); C. Very much polluted area (Shahrah-e-Faisal); D. Extremely polluted area (M.A. Jinnah Road).

growth was observed at the extremely polluted area (20 mm), followed by very much polluted area (27 mm), polluted area (34 mm), and a little polluted area (35 mm) as compared to the control area (38 mm). Seedling dry weight of *P. pterocarpum* also showed a decrease in the seeds collected from the city area as compared to the control. A high percentage of decrease in seedling dry weight was found for the seeds of the same species samples collected from the extremely polluted area (61%), very much polluted area (58%), polluted area (38%), and a little polluted area (28%) as compared to the control.

Seedling growth of *P. pterocarpum* showed the lowest percentage of tolerance in the samples collected from the extremely polluted area (52.63%) and very much polluted area (71.05%) as compared to the campus (Figure 4). Similarly, seedling growth of *P. pterocarpum* showed a better percentage of tolerance in

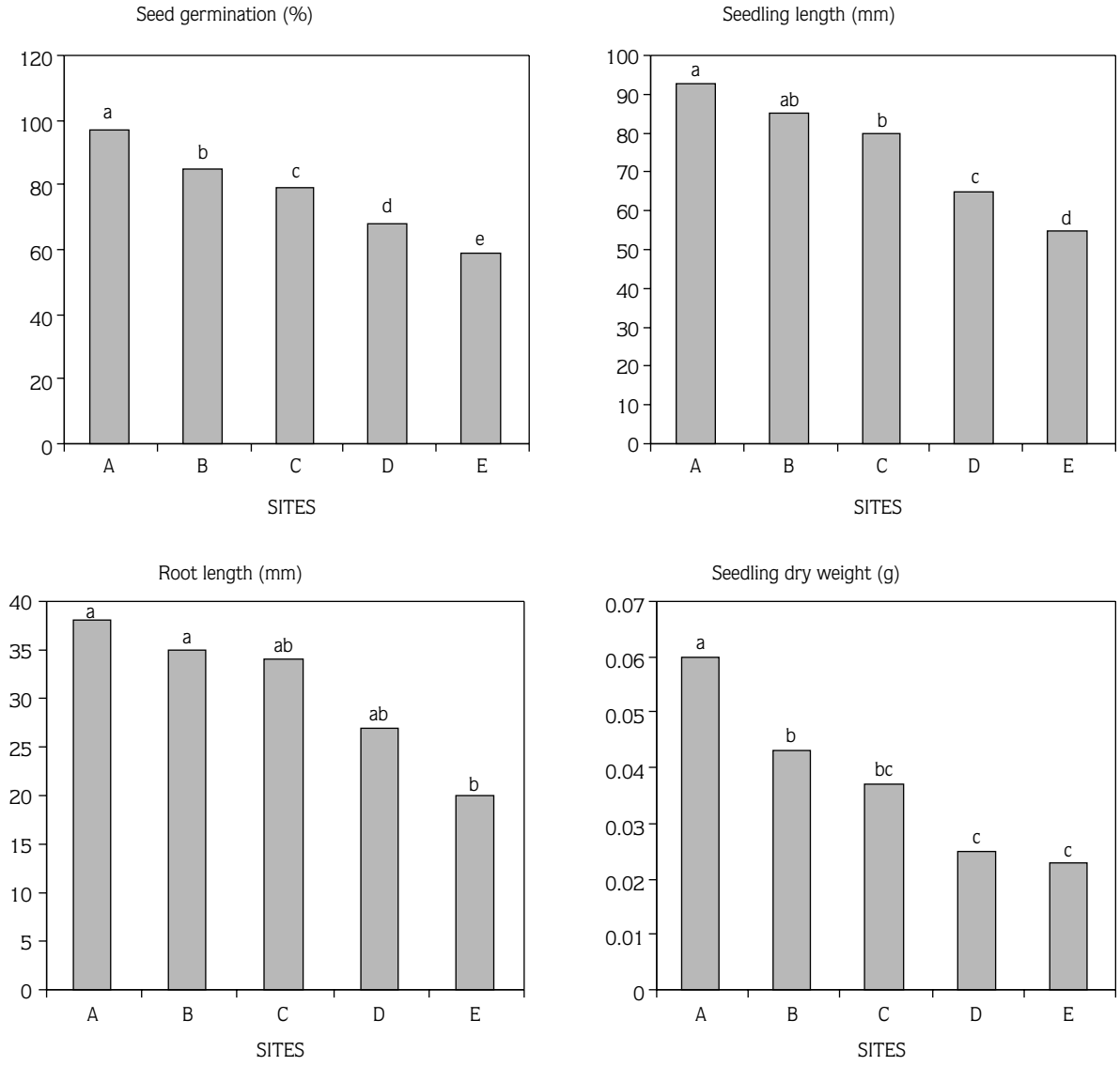

Figure 3. Effects of vehicle emissions on seed germination, seedling length, root length, and seedling dry weight of *Peltophorum pterocarpum* as compared to the control. Statistical significance determined by analysis of variance. Numbers followed by the same letters in the same bar not significantly different ($P < 0.05$) according to Duncan's multiple range test. SITES: (A. Unpolluted area (Karachi University Campus); B. A little polluted area (Gulshan-e-Iqbal); C. Polluted area (Nazimabad); D. Very much polluted area (Shahrah-e-Faisal); E. Extremely polluted area (M.A. Jinnah Road).

the samples collected from the polluted area (89%) and a little polluted area as compared to the campus.

Discussion

The effects of motor vehicle exhaust emission on seed germination varied from site to site depending on the degrees of pollution. The reduction in seed germination of *P. pterocarpum* could be due to the development of unhealthy seeds produced by trees growing along main roads of the city. The reduction in seed germination of *P. pterocarpum* collected from the extremely polluted area, very much polluted area, polluted area, and a little polluted area as compared to the control area agrees with the findings reported by Iqbal and Siddiqui (1996). They found reductions in seed germination of *Pongamia*

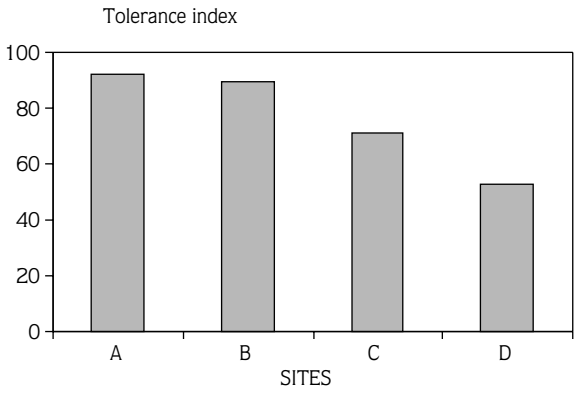

Figure 4. Tolerance index of *Peltophorum pterocarpum* as compared to the control.
SITES: (A. A little polluted area (Gulshan-e-Iqbal); B. Polluted area (Nazimabad); C. Very much polluted area (Shahrah-e-Faisal); D. Extremely polluted area (M.A. Jinnah Road).

pinnata (L.) Merr. and *Sesbania sesban* (L.) Merr. collected from other parts of the polluted areas. Similarly, in another study, seeds of *Dalbergia sissoo* Roxb., *Albizia lebbeck* (L.) Bth., and *Azadirachta indica* collected from different areas of the city showed significant reductions in germination as compared to clean areas (Mehmood & Iqbal, 1989; Qadir & Iqbal, 1991; Iqbal et al., 1997; Iqbal & Shafiq, 1999).

The root and seedling growth of *P. pterocarpum* were highly decreased in seedlings raised from the polluted seeds as compared to the control. Similar results have been found on seed germination and root growth of roadside plants *Brassica chinesis* and *Brassica parachinensis* (Wong et al., 1984). The other reason for a high percentage of reduction in seed germination of *P. pterocarpum* collected from the polluted sites of the city could be due to the thickness of pods. The pods of *P. pterocarpum* had a rough surface and some hairy structures. Air pollutants released from motor vehicles could enter seeds through the pods, thus leading to the development of unhealthy seeds. Accumulation of toxic products, such as dust from motor vehicles, which contains hydrocarbon and metals, is likely to be important in the reduction of seed germination and seedling growth of *P. pterocarpum*. Low percentages of seedling growth and dry weight of *P. pterocarpum* proved the failing viability of the seeds. This finding also demonstrated that the seeds of *P. pterocarpum* collected from the extremely polluted area are less tolerant to auto exhaust emission than the seeds of the same species collected from the very much polluted area, polluted area, a little polluted area, and the university campus, in descending order of importance. The degree of effectiveness of seeds could be due to their genetic ability and adaptation to the current environment. This decrease in growth of the polluted plants could be attributed to the presence of motor vehicle pollutants in the environment of different types of polluted area from where the seeds of *P. pterocarpum* were collected. The deposition of lead and soot particles from motor vehicle activities on the surface of pods could cause the low production of healthy seeds.

In view of the destructive and hazardous role of air pollution, it becomes necessary to grow resistant plant species and promote low-lead fuel to reduce motor vehicular pollution. A strong dedication from all civic agencies is required to preserve these tree species and prevent their extinction.

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